Project Code/Version No: SPT 2004 - v2

Low Carbon Networks Fund
Full Submission Pro-forma

Section 1: Project Summary

1.1 Project title

ARC - Accelerating Renewable Connections

1.2 Funding DNO

SP Distribution

1.3 Project Summary

Accelerating Renewable Connections (ARC) will facilitate the increased penetration of renewable generation gaining access to the distribution network in a timely manner. This will be achieved by; **empowering customers** to make informed choices relating to their connection requirements; **apply novel commercial and technical approaches** that will create the foundation for future connection options; **inform the development of business processes** required to facilitate a greater level of renewable generation; and **build upon the learning** developed from previous and existing LCN Funded projects to date through collaborating with other DNO partners.

The ARC solution will demonstrate this by; providing stakeholders with a richer source of information which will inform developers on the potential for traditional/smart connections; facilitating the role communities can play in balancing **community** generation with local demand; addressing the commercial and technical issues associated with exporting grid supply points (GSPs) and providing evidence to inform the debate on investment strategies of smart solutions, as identified by WS3 of the Smart Grid Forum.

The project has strong support from project partners and other stakeholders as well as internal buy-in. ARC will run for four years but is designed to create an enduring process and learning for future connections.

1.4 Funding

Second Tier Funding request (£k)	£7,421k		
DNO extra contribution (k)	£0k	**External Funding (£k)**	£321k

1.5 List of Project Partners, External Funders and Project Supporters

Project Partners: Smarter Grid Solutions, Community Energy Scotland, University of Strathclyde

Project Supporters: SHEPD, National Grid, Scottish Renewables

1.6 Timescale

Project Start Date	January 2013	**Project End Date**	December 2016

1.7 Project Manager contact details

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Section 2: Project Description

Project Aims and Objectives

The aim of the project is to accelerate the process and time to connect for renewable generation projects.

The key objectives of this project are to:
- Improve access to connect generation to the network;
- Accelerate the time to connect generation;
- Enable connections to be facilitated around constraints; and
- Create an enduring process and learning that can be rolled out across Great Britain.

The Problem to be Addressed

The Carbon Plan requires an increased contribution from low carbon generation to support the long term carbon reduction targets which has a significant bearing on the distribution network. Further, the Scottish Government has set targets for at least 500MW of local and community based renewable generation by 2020. The timeliness and cost of facilitating this generation onto the network is a key step in making this transition. However, the current perception of the connection application process from project developers is of prohibitive costs and long lead times to connect which, through stakeholder engagement, is a concern echoed frequently. The ARC project aims to address these issues by creating and demonstrating a new process for accelerating renewables connections in a controlled manner to avoid the network from being a barrier to the low carbon transition to the benefit of all parties.

Since 2009 the volume of generation applications in SPD has increased by circa 700%. In 2011 in excess of 90% of connection offers in SPD, with a combined generation capacity of approximately 270MW at 33kV and below were not accepted by customers due to a variety of reasons including time to connect and cost.

The application process, regulatory obligations and limited technical options available to DNOs can restrict design engineers from taking a more holistic approach to connecting renewable generation. The high volume of applications currently experienced can also result in network development with a lower utilisation than theoretically possible. This approach is increasingly restrictive given the high volume of additional generation seeking a connection and is not suited for the transition to an actively managed network.

The network in some areas is now fast approaching saturation point as a consequence of the large volume of renewable generation that has already connected. As a result, the capacity available for future connections will be substantially constrained which, by traditional methods, would be facilitated through a programme of significant and costly network reinforcement. Furthermore, the penetration of higher volumes of embedded generation on the distribution network is already having an impact upon the transmission system to the effect that, within some DNO areas, relatively small generation projects are unable to connect ahead of major reinforcement works being completed on the transmission system. During the preparation of this bid, we have developed a set of case studies (Appendix 5) based on recent applications to connect in the proposed trial area, in which examples of the problems described above can be found.

Whilst alternatives to reinforcement have been trialled in other LCNF and RPZ projects, the case studies highlight problems for which innovative solutions have yet to be demonstrated. These include, for example:
- How exporting grid supply points or constraints at both distribution and transmission can result in extensive project delays;
- How communities with the potential to provide coordinated or managed generation output with local demand or storage cannot currently be facilitated;
- How complex inter-tripping arrangements can restrict grid access; and
- How constraints across distribution voltage levels can result in expensive reinforcement works.

In addition to the physical constraints in connecting renewable generation, SPD has listened to the views of stakeholders, a key driver of the project. In preparation of this submission SPD ran a workshop with developers and stakeholders who raised concerns in the following areas:
- The lack of access to detailed information that enables them to make informed decisions on where to connect and helps them understand the costs involved;
- The lack of transparency of costs and processes;
- The lack of timely and coordinated investment in the network ahead of need; and
- The time and cost to connect new generation to network, often due to planning and completion of wider network reinforcement.

2: Project Description cont.

In our discussions with Community Energy Scotland (CES), these points have also been raised: "*Network access is a major barrier for many of the renewable projects CES are involved in; as much of the distribution network has little spare capacity or access is delayed due to transmission system constraints. As a result, the time and cost to connect renewable generation can be prohibitive to these schemes going ahead. Currently the market for new energy storage and management technologies is not mature, cannot be implemented under standard connection agreements with network operators and the installation of such solutions requires careful planning and technical analysis which only add to the overall cost. The double barrier of insufficient grid capacity, and the inability to deploy innovative solutions under current connection methodologies has to be overcome if the community and low carbon sector are to fully deliver in the future*".

In order to accelerate the connection of renewable generation, the ARC project has focused on the problems identified by both stakeholders and analysis of detailed case studies making the project relevant to the developer community and important stakeholders such as CES. By ensuring that the methods and trials are targeted at these real problems, SPD will substantially increase the levels of generation capacity connecting to the distribution network.

The Network Trial Location

The trial area chosen is the East Lothian and Borders region of Scotland which is located to the South East of Edinburgh and covers an area of 2700km^2. This area comprises a high penetration of existing generation, some of which is subject to operational constraints. The existing generation capacity currently exceeds the demand in parts of the region, leading to Grid Supply Points (GSPs) within the area to export power onto the transmission system. Currently the area benefits from 200MW of connected generation with a further 530MW of generator application/enquiries received. This high level of existing and pending generation at all voltage levels represents a typical future distribution network and is therefore ideal to trial new technologies and processes.

A diagram of the network area in included on page 10 and Appendix 2 highlights that SPD has the highest penetration of renewable generation in great Britain.

The Project Methods

The methods which will be trialled within the project to address the problems and deliver the objectives are:

1. Additional and more frequently updated network information to customers
This method will include more detailed and more frequently updated heat maps and elements of the Long Term Development Statement that can empower customers to make more informed connection choices.
2. Introduction of an enhanced connections process
This method will include a Viability Study option and a process to engage with SPD prior to the formal connection application being submitted to understand connection options.
3. Investigate and demonstrate the role communities can play in accelerating renewable connection
This method will consider how renewable energy projects can best be enabled within communities and connected within an actively managed network area.
4. Demonstrate commercial and technical solutions which accelerate connections at exporting GSPs
This method will identify and trial solutions to manage constraints around the boundary with the transmission network
5. Investigate and trial new technical and commercial solutions for constrained connections
This method will build on learning from other projects by applying active network management to new technical challenges including complex inter-tripping arrangements and constraints across voltage levels
6. Identify the process and inform the business case for 'smart enabling' of generation dominated areas
This method will develop and trial a new process for rolling out active network management in a limited top down approach to compare with an incremental approach applied in other projects
7. Define the process for identifying and implementing a 'smart enabled' area
This method will identify the process by which a DNO should go through to smart enable an area of network as part of a top-down roll-out approach
8. Avoid unnecessary duplication of other projects but build on previous learning where possible
This method will deploy technical resource to work at a detailed technical level with other LCNF project teams to avoid unnecessary duplication and identify opportunities to create additional learning

2: Project Description cont.

Project Structure

The project has been split into the three areas of the connections process and will be delivered through 6 workpackages. The three areas of the connection process are:

1. Connection Application - This is the process prior to a submitting a formal connection application where the developer will use SPD published information to decide what connection to apply for. Workpackage 1 will trial the methods associated with providing the renewable developers with additional or more regularly updated information and the introduction of a viability study process to help them consider connection options.

2. Connection Design - This is the process undergone by SPD to process the formal connection application and issue a connection offer to the developer. Workpackage 2 will implement trials of the methods associated with new internal tools, access to improved network data and the revision of policies and processes to incorporate smart options.

3. Network Construction and Connection - This is the process undergone to implement the physical works agreed within the connection offer accepted by the renewable developer. Workpackage 3 will implement the enabling technologies for the project and workpackage 4 will implement the on network trials associated with new commercial connection arrangements, for example with National Grid and local communities.

The project will be supported by an additional two workpackages to consider the wider business change aspects of the project, inform regulation and policy regarding DG connections, consider the investment case for a top-down roll-out of the project methods and facilitate knowledge transfer in and out of the project.

Project Trials

The project will trial the methods in the following workpackages:

Workpackage 1 - Empowering Customers

The empowering customers workpackage is focused on providing DG developers with the information required to properly inform them on viable connection options. It is expected that providing more granular and regularly updated information on the status of applications in the area will allow them to better decide whether or not to proceed with a formal grid application which will be economically viable. This may also include the status of the deployment of smart grid technology that is available for them to connect to, e.g. the Grid Supply Point or local Primary Substation is Active Network Management enabled, and the additional economically viable capacity that is available. SPD, as with other DNOs, have a number of statutory obligations including the annual publication of a Long Term Development Statement (LTDS) and a DG Connections Guide. The purpose of this workpackage would be to greatly enhance the process beyond the statutory obligations.

WP1.1 Establishing a Stakeholder Forum:

Creation of a Forum for stakeholders within the trial area to be established in the first half of 2013 and will aim to meet 3-4 times per annum for the duration of the project, depending on the level of interest. Parties to be invited include DG developers both new and existing, local authorities and local community representatives. Other relevant stakeholders will also have the opportunity to attend such as other DNOs. The purpose of the Forum is to raise awareness of the project, remove perceived barriers between planning authorities, developers and the DNO, discuss generation connection issues within the context of this project and receive feedback on the methods being trialled within the project.

WP1.2 Publication of a more frequently refreshed network data and network heat map with additional information on smart connection options

Trial the publication on a more regular basis of a sub-set of the LTDS or equivalent which provides data on connected, contracted and in process applications for DG connections. The trial will be used to determine how often the LTDS, or certain aspects of it, should be refreshed and published. At 11kV heat maps will trial a 'rule of thumb' view as to where cost effective connections will be possible based on distance from each substation and what can be accommodated either through traditional connections or the smart interventions i.e. firm and non-firm capacity. Analysis methods will be trialled which give a reliable indication of the likely energy export volumes for non-firm connections in given locations.

2: Project Description cont.

WP1.3 Viability Studies

A 'Viability Study' trial will be undertaken. In this trial SPD will work with the renewable developers prior to them making a formal connection application to help consider the potential options for their connection. Options will include for example non-firm connections, matching generation with demand or considering the balance between overhead lines or underground cables. Although informal communication exists at present, providing an indication of potential options based on the network loading alongside smart interventions will help empower developers to formally apply for the most cost effective and timely connection possible. The introduction of this step in the process prior to formal connection application will build on best practice feedback from developers following the implementation of a similar stage by SSE in the Orkney RPZ.

Workpackage 2 Connection Design

The connection design workpackage is focused on how SPD can trial process improvements and integrate the ability to consider smart interventions within the policies and processes used to deliver formal connection applications. The policies identified for change within this workpackage will feed the options that will be able to be considered by the Viability Studies in workpackage 1.

SPD will trial a process called 'Active Network Design' where the moving parts of the electricity system, smart interventions and interactive connection applications can be managed in order to process connections more quickly and to provide options to developers in workpackage 1. A key output of this stage will be a process by which new smart interventions can be trialled and adopted into policies beyond the ARC project. The connections design workpackage will therefore focus on the following activities:

WP2.1 Design policies

Review and update of internal design policies to identify process improvements, the application of smart interventions, new tools and developer options. To support the new policies, updates to commercial arrangements will be required such as actively managed non-firm connections, inclusion of smart interventions or how interacting with third parties will be achieved e.g. a community or National Grid. The project will apply learning from other projects by pro-actively seeking knowledge of other technological solutions that can be fast tracked through a proving phase and into a new policy option by other DNOs.

WP2.2 Network Visibility

A lack of network data, for example network loading, affects the design assumptions and the types of connection design engineers offer. This work package will leverage existing data sources, learning and models to improve network visibility without further investment in monitoring equipment. Of particular significance will be the use of the learning from other LCNF projects which have deployed extensive monitoring including; LV Templates for a low carbon future, Flexible Networks and various other Tier 1 and Tier 2 projects. This work package will trial a variety of novel estimation techniques to determine the operation of the network thus avoiding the need for extensive monitoring which would normally be cost prohibitive across such a vast area.

WP2.3 Planning tools

The alignment of network data sources (power flow and asset information with design tools) is required in order to review smart options and publish a sub-set of data in workpackage 1. SPD must implement a number of new planning tools to improve network visibility and allow new options to be considered. This activity will build on an existing SPD IFI project to integrate the data across existing internal systems and provide additional learning for other DNOs on how these sources can be evolved to better support connections processing.

New tools will be trialled for connection planners to allow easy analysis of smart interventions and consider the network more from the ability to transport power (what the developers actually want to know) as opposed to maximum rated output capability under worst case planning policies. This work will build on approaches already adopted by SSE and UKPN and will develop a suite of tools that can be adopted and supported across the planning teams.

2: Project Description cont.

Workpackage 3 Network Enablers

The network enablers workpackage is focused on the deployment of enabling technologies that are required in order to undertake the on network trials within workpackage 4. Enablers include communications, substation infrastructure and control systems platforms for Active Network Management (ANM). The workpackage will also consider what process SPEN should go through to plan the technical deployment of such enabling technology; this is seen as a key requirement for future intervention and understanding what aspects of technology should be implemented incrementally or via a top-down approach. The workpackage will address questions such as understanding what communications infrastructure is required, how and where operational data should be made available and how ANM can best be scaled across a license territory or geographical region.

A key aspect of this workpackage is to define a process for how best to enable an area with ANM, when the trigger for that investment should be made, and how to deliver an evolving ANM installation. Other LCNF projects are also attempting to answer similar questions, however the ARC project will uniquely trial a top-down approach to enable the trial area. SPEN has identified substations in the ARC project area which are at capacity, nearing capacity, or can accommodate more generation ('red', 'amber', 'green'). During the trial, substations identified as 'red' and 'amber' will be ANM-enabled. Therefore, a plan for the deployment of enablers can be provided without contradicting a key learning objective of the project which is about working out what process (top-down or incremental) is most appropriate for roll-out.

<u>WP3.1 Design and Evaluation of Enablers</u>

In order to implement smart options a number of enabling technologies are required to provide the infrastructure necessary for enabling customer connections. This workpackage will design and trial a process to assess what infrastructure is already available, what process to follow in order to identify and evaluate the technology options and provide a framework to identify the cost of enabling a specific area of network. This workpackage will deliver a process to evaluate the capability of a given site to be ANM-enabled including the technical evaluation of equipment, communications capability and data requirements.

The resultant processes will provide the means of identifying how enabling technologies should be deployed and become an integral part of the RIIO-ED1 and ED2 preparation.

<u>WP3.2 Telecoms Platform for Communicating across the Trial Network</u>

Across the trial area an expandable communication layer will be deployed to allow interaction with new generators and the feeding substations to support the ANM scheme. The project will be funding the core communications between substations where none currently exist, communication with existing generation and points of network constraint. Generators wishing to connect will pay for additional communication required as part of the ANM scheme should they wish to participate in the trial methods.

<u>WP3.3 ANM Platform for Managing Generators</u>

An ANM platform requires to be implemented in order to provide an autonomous and deterministic control system capable of interacting with controlled devices and customers in a safe and reliable manner. This platform will enable the deployment of ANM applications which will be targeted to manage the trials described in workpackage 4. The ANM platform will manage technical grid constraints and maximise network access within commercial terms. This workpackage will: establish a platform on which ANM applications can be deployed and targeted to specific network locations; establish a platform that can make best use of the communications infrastructure to provide the necessary redundancy and resilience; provide incremental learning by proving ANM as a technology which can be deployed effectively to deliver applications at each individual voltage level (132, 33 and 11 kV) and also uniquely across these voltages within the project; and prove the methodology, process and benefits associated with the provision of the ANM platform as a managed service.

<u>WP3.4 Substation environment</u>

A number of substations will require some replacement work to upgrade the auxiliary equipment including primary tap changer control panels and protection technology, to facilitate ANM controls. This workpackage will be used to deliver these enabling works and facilitate the trials described in workpackage 4.

2: Project Description cont.

Workpackage 4 Network Connection Trials

This workpackage will address the issues of exporting GSPs, enabling connection of generation around network constraints and facilitating community level connections. This workpackage presents a variety of scenarios that are common across DNOs in the UK. The various scenarios which will be trialled are described in Appendix 5 which provides example case studies of some of the solutions which will be deployed compared to the business as usual approach. The three principal trials which will be examined are: The interface with National Grid as a result of a surplus of generation feeding into the transmission network, the application of ANM for managing distributed generation around network constraints, and creation of a model for managing community scale generation locally.

4.1 Management of Exporting Distribution Networks

This workpackage will tackle the challenge of exporting GSPs as described more fully in Case Study 1. The workpackage will trial a way of providing National Grid with visibility of distributed generation connected (and contributing to energy export) from the GSP and the operation of the ANM system managing generation connected below that GSP. The workpackage will build upon a previous project conducted by WPD which demonstrated that it is possible to provide a link to share information between DNO and TSO control rooms. Although not novel in itself, this is an example of new functionality in GB (having been implemented elsewhere internationally). The ARC project will examine and build on such a link to demonstrate functionality associated with such connectivity. Subject to agreement with National Grid to participate in the trial and hence apply 'Connect and Manage' principles to distribution connected generation the workpackage will undertake the following trials:

- The demonstration of ANM software applications to manage both the pre-fault and post-fault power flows at the GSP to maintain the export of distributed generation within the capacity of the grid transformers;
- The implementation of ANM to manage power flow constraints beyond the distribution network boundary in partnership with National Grid and the Connect and Manage regime;
- The use of ANM to be enabled at specific times e.g. planned or unplanned outages;
- The use of ANM as an alternative to multiple individual inter-tripping schemes to provide coordinated management and enabling/disabling of individual intertrips;
- Define the National Grid requirements for visibility of an ANM scheme and implement a link from the ANM scheme to National Grid to provide visibility of scheme status and actions.

4.2 Active Management of Generation Around Constraints

The application of ANM to HV networks is already being trialled in other projects; specifically the Orkney RPZ (by SSE) and Flexible Plug and Play Low Carbon Networks project (by UK Power Networks). This workpackage will build on the learning from those projects and will target ANM applications to trial solutions to specific network constraint challenges such as those described in Case Studies 2, 3 and 4. Technical constraints to be managed by the ANM applications will include power flow and voltage. It is expected that SPD will deploy novel 'end point' devices to be incorporated within the ANM scheme for voltage and power flow control. Examples of such devices have been identified via the 'Expression of Interest' process run by SPD following the Initial Screening Submission but which will be selected ultimately based on the specifics of the network constraints caused by the generator and a competitive tender process.

In order to adopt a new technical solution SPD must ensure that they understand the safe adoption of that technology. The 'end point' devices identified by SPD will have to undergo testing prior to network installation. To accelerate the adoption of these options into the trials, and hence into policies, SPEN will leverage an existing investment the Power Network Demonstration Centre (PNDC). The PNDC will be used to undertake tests prior to network deployment. The actual end point devices to trial will be identified through the Viability Study process in workpackage 1.

SPD will trial the following to deliver the case studies where suitable connection applications are identified:
- ANM to provide distributed generators with non-firm or a combination of firm and non-firm connection access;
- Shared network access to non-firm connections;
- ANM applications to manage post-fault intertrip schemes or to replace intertripping arrangements with alternative arrangements to maintain access to non-firm grid access under outage conditions for both power flow, voltage management, and voltage step-change constraint
- ANM controllable end point devices (for example, the use advanced voltage control to manage the voltage at substations or novel generator control to manage voltage constraints)

2: Project Description cont.

WP 4.3 Community Level Connections

This workpackage will seek to address issues on the 11kV and low voltage networks as described in case studies 4 and 5. The workpackage will deploy trials to help manage the proliferation of small scale and community led initiatives to install renewable projects. The trial will explore and trial end point solutions to alleviate the problem of smaller scale generation at lower voltage levels negatively affecting capacity at higher voltage levels as described in case study 5.

The workpackage will partner with Community Energy Scotland, an organisation dedicated to assisting communities to develop small scale renewable schemes and who are particularly active in the project area. The work package will also partner with the University of Stratchlyde to model how community based schemes could operate. A Community Development Officer from within Community Energy Scotland will work with local communities and developers to help educate developers on the connection process and champion the options being made available within the ARC project. The Community Development Officer will work with communities and the University of Strathclyde to develop model solutions for trial.

As with workpackage 4.2 any new smart technologies will be trialled via the PNDC prior to on network deployment. The community level connections workpackage will undertake the following trials:

- Community based arrangements to match renewable generation with a local demand and coordinate the export and consumption of energy behind a defined boundary
- Application and rollout of community based energy management technology e.g. wind to heat systems to allow excess generation to be consumed locally rather than being constrained off where no flexible demand can be accessed
- ANM control to implement fail safe functions and interact with the community arrangements

Workpackage 5 Project Evaluation

The project evaluation workpackage will be used to examine the long term business change required for DNOs to implement the learning from the ARC project. The workpackage will therefore focus on both the organisational change aspects as well as inform key aspects of the regulatory model relevant to RIIO-ED1 and future network investment planning. Within DPCR5 DNOs have already noted a number of weaknesses with the DG Incentive and the project will investigate ways in which this could be improved to inform Ofgem on how DG incentives within RIIO-ED1 could be developed.

The project evaluation workpackage will therefore deliver the following support activities:

- The application of Six Sigma techniques to help deliver organisational and behavioural change. It is recognised that in order to adopt new policies and processes into an organisation that this will only be successful as an enduring solution if the people working in those areas are brought along with the project. This activity will focus on ensuring business change persist beyond the ARC trials and not only for the staff working on the specific project area but all staff across both license areas working on the processing of connection application.
- Consideration of the potential for regulatory changes within RIIO associated with the existing DG Incentive. The project learning will inform future discussions on the structure of the most suitable incentive mechanism for the connection of DG.
- Consideration of the present methods and process to apportion costs associated with smart interventions and how these are compatible with the well established and understood cost apportionment methods for conventional network reinforcement approaches. This activity will seek to understand and publish learning on what assets as part of a smart enablement should be owned as assets by the DNO and what should be considered as sole use assets for a DG developer. This is particularly relevant to the Workpackage 3 Enablers and will identify a process by which SPD can identify what the most cost effective method is to smart enable an area of network. This activity will build on the Strategic Investment Model being developed by UKPN and will focus on the process by which SPD should decide whether to smart enable a given area. It is envisaged that this activity will directly inform the strategy and costs for smart enabling works within RIIO-ED1.

2: Project Description cont.

Workpackage 6 Knowledge Transfer

To date in Low Carbon Network Fund (LCNF) projects the focus of knowledge transfer has been on dissemination; specifically the export of learning from individual projects. Most projects are therefore constructed to deliver various reports on the learning from trials which complements events such as the annual LCNF conference. The competitive nature of LCNF funding also means that each project must generate new learning and avoid duplication.

This workpackage focuses therefore on SPD adopting the learning from other projects, validating prior learning and has a unique and distinct focus on the transfer of knowledge *into* the project from other LCNF projects to avoid any unnecessary duplication and inform areas for additional learning. In practise this is envisaged to be a technical resource capable of interacting with the teams responsible for delivering projects in other DNOs to ensure that detailed technical learning is transferred to the ARC project and to enhance learning by drawing on areas of those projects that other DNOs feel could be expanded upon. SPD has discussed and agreed to collaborate in this way with SSE and UKPN who have both previously implemented ANM solutions.

In addition to the Knowledge Transfer 'In' function this workpackage will also include the dissemination of project learning, called Knowledge Transfer 'Out'. The workpackage will therefore deliver:

<u>WP6.1 Knowledge Import (Knowledge Transfer 'In')</u>

The project team will liaise with other projects, review specific project documents and work with other LCNF project teams in areas such as commercial arrangements, end device technologies, customer engagement, connections process, communications technologies and strategic investment models.

<u>WP6.2 Knowledge Export (Knowledge Transfer 'Out')</u>

The project will have a dedicated resource for knowledge transfer capture and will be responsible for managing the learning from the project. This will include documenting and publishing business process models associated with the decision making process within the trials, creation of reports on key elements and dissemination events including demonstrations through the PNDC. This technique will allow other DNOs to quickly follow the decision making process adopted by SPD and to communicate effectively the processes developed or trialled within the project. We will also be looking to reciprocate the Knowledge transfer 'In' process and the project team will be available to hold workshops with other DNOs to share project learning less formally through workshops as well as the formal channels.

<u>WP6.3 Power Network Demonstration Centre (PNDC) Facility</u>

The PNDC will be used to demonstrate some of the key components and network technology in a live and flexible environment prior to on network trial. These activities will be based on the specific end point technologies identified through the Viability Study process.

Further information on Dissemination is provided in Section 5.

A comprehensive breakdown of the work packages is provided in Appendix 4.

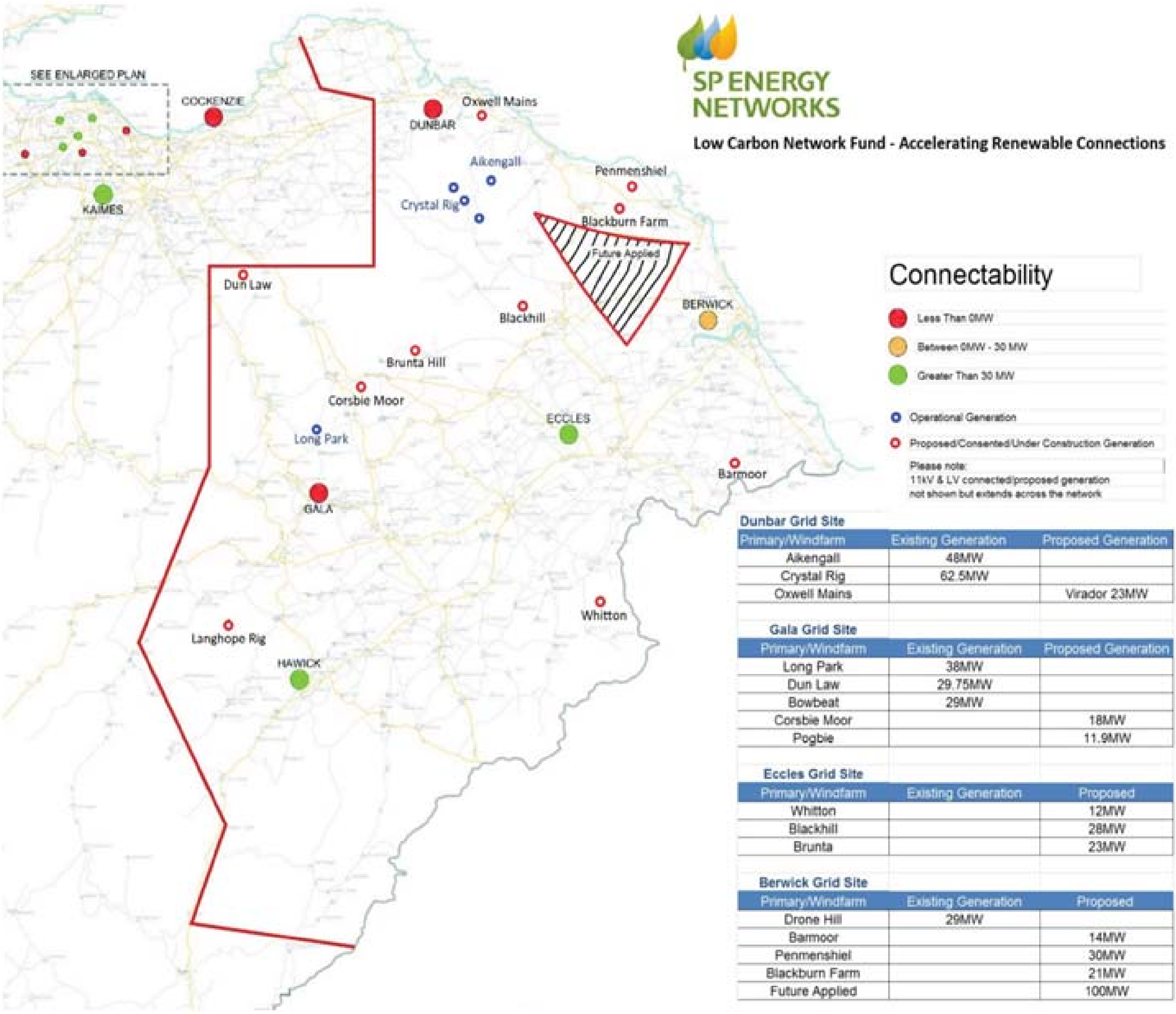
<u>Changes since the Initial Screening Process</u>

Since the submission of the ISP, we have sought expressions of interest from over 200 vendors and selected Smarter Grid Solutions as our key project partner. This has enabled us to fully define the novel technology and operational practices that are being deployed within the project.

The project ISP indicated that derogations may be required as part of the changes that were initially proposed to the connections process but this is no longer the case as the refined process will be able to operate within the existing regulatory arrangements.

The Energy Innovation Centre was initially identified as a partner however following the success in identifying innovative proposal as a result of our engagement with vendors, formal assistance will not be required to the same extent with the Energy Innovation Centre however the project will remain in contact with them should any further ideas develop which could be factored into the project.

2: Project Description Images, Charts and tables.



Dunbar Grid Site

Primary/Windfarm	Existing Generation	Proposed Generation
Aikengall	48MW	
Crystal Rig	62.5MW	
Oxwell Mains		Virador 23MW

Gala Grid Site

Primary/Windfarm	Existing Generation	Proposed Generation
Long Park	38MW	
Dun Law	29.75MW	
Bowbeat	29MW	
Corsbie Moor		18MW
Pogbie		11.9MW

Eccles Grid Site

Primary/Windfarm	Existing Generation	Proposed
Whitton		12MW
Blackhill		28MW
Brunta		23MW

Berwick Grid Site

Primary/Windfarm	Existing Generation	Proposed
Drone Hill	29MW	
Barmoor		14MW
Penmenshiel		30MW
Blackburn Farm		21MW
Future Applied		100MW

Figure 2.1: Map of Trial area

Section 3: Project Business Case

Context

From 2005 to date, in excess of £200m has been invested in distribution networks to accommodate distributed generation connections. The vast majority of this investment has been solely funded by generation developers.

Within the chosen trial area and through the analysis undertaken for the project case studies, detailed in Appendix 5, under business as usual arrangements in excess of £35m of connection infrastructure is required to accommodate the 6 generation schemes with a total generation capacity of 60MW. This investment includes £19m of transmission reinforcement which would be socialised among DNO consumers however more significantly would prevent the generation scheme connecting until 2018 at the earliest.

Through the development of the ARC trial we would forecast that i) the connection cost to accommodate the same amount of generationwith **savings of between 18-75%** in the case studies, and ii) the lead time to connection could **reduce by on average 6-12 months** realising both carbon and economic benefits to GB.

Within the SP Distribution license area alone there are a large number of locations which currently present difficulty in providing adequate generation capacity as a consequence of network constraints and where a major barrier is the effect of embedded generation on the transmission system.

Business as Usual Baseline

The existing solution to provide increased system capacity for distributed generation is to invest reinforcement schemes which can be capital and time intensive and is generally funded by the developer. DNOs are familiar with these solutions and they have served the UK's needs to date by offering a relatively low risk solution to the connection of distributed generation. However as the distribution networks becomes increasingly constrained, this investment will substantially increase resulting in projects failing to connect due to the uneconomic cost of the connection. Further, time delays will also have a significant bearing on the numbers of generation schemes connecting to the network in the future.

Drivers for Alternative Solutions

On the 18th July 2012 the ARC project held its first workshop to obtain the view and gain support as well as to immediately involve stakeholders with the development of ARC prior to the full submission of this bid. A summarised version of the workshop along with initial views from participants can be found in Appendix 7. During the workshop we undertook a SWOT analysis of the current connections process and at a high level the following key points were identified;

Strengths - connection application process was acceptable, turnaround timescales from application to receipt of offer were in general improving across DNOs, access to staff was also improving and proved invaluable in the absence of real-time system data that would enable developers to optioneer their own connection ahead of full application.

Weaknesses - connection application process differed between DNOs across the whole of GB making it more difficult to submit applications and can result in lengthier application processing times. Additionally it is the requirements of the electricity distribution licence that drives 'least cost' firm connection offers at distribution level which is perceived to limit the discussion around alternative engineering connection options.

Opportunities - consideration of alternative connection generation offers both technically & commercially, the need for a rapid response 'internet based' model for the connections process, a need for greater visibility of the network and increased involvement with the local planning departments.

Threats - local councils refusing planning applications (ARC could assist in dispelling myths and reduce infrastructure leading to improved visual environment around embedded generation sites), FiTs changes occurring quicker than planning approval is received, regulatory constraints and concerns that the small amount of applications being approved could result in bank/financiers not willing to finance projects in the future.

3: Project Business Case contd.

Business Case

In order to provide an example of the financial and time savings which could materialise from this project, the business case is presented for each of the case studies. Each one addresses a different challenge which has different time and costs for connections which is why each is considered in isolation.

In all of the case studies it is assumed that the cost of enablers is borne by the DNO as would normally be the case for any other IT system. The incremental cost for each connection is related to the extension of the ANM system to accommodate that additional generator. These costs will include the incremental communication system and ANM controller for that generator.

Case Study 1: The Exporting Grid Supply Point

This case study provides an example of wider system reinforcement being required on the transmission network to accommodate a distribution connection. The works associated with this wider network reinforcement are likely to incur a delay of at least five years before the connection can be made. The indicative cost of the connection for this generator includes the cost to the transmission network owner of £19m for the reinforcement works in addition to the connection cost of £5.6m. This case study highlights the commercial and technical issues surrounding the connection of new generation to GSPs which have reached or are reaching their export capacity under current planning regulations.

Using the methods proposed by the ARC project, an alternative solution would be to install an ANM scheme at the GSP which interfaces with existing and new generation prior to a reduced reinforcement scheme. The reduced reinforcement scheme would require upgrading of the transmission transformers only. This would cost in the order of £3m. The method would require the implementation of a link to the System Operator to allow visibility of the operation of the generation and ANM scheme. As a result of the implementation of the method, the cost of the connection would continue to be £5.6m for the assets to connect into the GSP, however the wider reinforcement cost would be reduced to c.£3m. and could be completed within the two year period in which the generator wishes to connect.

BAU Cost = £24.6m (£19m for reinforcement + £5.6m for Connection) - 5 years to connect
Method Cost = £8.6m (£3m for reinforcement + £5.6m for Connection) - 2 years to connect
Saving = £16m and time saving of 3 years. (65% saving)

Case Study 2: Multiple Issues for N-1 Contingencies

This provides the example of a new generator wishing to connect but cannot have a firm connection under various outage (n-1) scenarios. A further consequence is that their connection to the network may impact an existing firm generator connection. To address network issues, reinforcement of the circuits would be necessary to avoid tripping supply to the existing customer, at a cost of £1m in addition to a connection cost of £4.7m.

The ARC method would involve the active management of generation during n-1 conditions, which has not been explored in previous LCNF projects. The ANM scheme could perform real-time control of the 18.7MW wind farm as necessary to ensure power flows remain within defined constraint limits, overcoming the barriers of voltage and thermal issues and thus deferring the need for reinforcement.

BAU Cost = £5.7m (£1.0m for reinforcement + £4.7m for Connection) - 2 years to connect
Method Cost = £4.7m (No reinforcement + £4.7m for Connection) - 1 years to connect
Saving = £1m and time saving of 1 year. (18% saving)

Case Study 3: The Costly Firm Connection

This case study shows how SPEN explored a number of different options for the developer in order to try to find a means of connection that met the developer's requirements in terms of cost and time to connect. These ranged from an intertripping 11kV option to a costly 33kV firm connection. The connection cost for the 33kV firm connection was estimated to be £2.43M with additional reinforcement works totalling £1.64M. As a result, this cost is likely to be prohibitive for a 6MW wind farm.

3: Project Business Case contd.

The ARC method of actively managing a constrained connection will have also increased energy yield over the year in comparison to intertripping the generator which was why they were initially reluctant. The cost of connecting, with the restriction that the generator may be constrained off would be £850k for the connection and a reinforcement cost of £400k

BAU Cost = £4.1m (£1.64m for reinforcement + £2.43m for Connection) - 2 years to connect
Method Cost = £1.25m (£400k for reinforcement + £0.85m for Connection) - 1 years to connect
Saving = £2.85m and time saving of 1 year. (70% saving)

Case Study 4: Uneconomic Reinforcement
This is an example of multiple generators attempting to connect to the network however each one would have to bear the cost of significant system reinforcement. In this case the generation was deemed not to be economic as the costs we so significant for the wider system reinforcement. The total cost of connecting all of the generation was estimated to be

The ARC method would involve Advanced voltage control at the primary substation, in combination with a localised controller at the generator which could control the output depending on the system voltage.

BAU Cost = up to £0.82m - 1 year to connect
Method Cost = £0.2m - 6 months to connect
Saving = £0.62m and time saving of 6 months (75% saving)

Case Study 5, 6 and 7: Unfeasible Connections and Novel Approaches
These case studies demonstrate examples of generators attempting to connect to the network however each one would have to bear the cost of significant system reinforcement. In this case the generation was deemed not to be feasible. as the system impact was so significant.

The following methods will be explored under ARC to assess the economic viability:
- Active Management of Voltage taking cognisance of local demand;
- Assessing the role of dispatchable demand and supporting generation such as energy or heat storage;
- Locally managing demand through contracting with other parties and creating a source of load such as heat stores; and
- Making customers aware of the options in advance of developing proposals which are not feasible.

BAU Cost = No feasible solution
Method Cost = To be confirmed through the project.
Saving = To be confirmed through the project

Net Financial Benefits
The total project cost stands at **c.£8.9m**, and our analysis shows that the future cost of deploying the overall enablers such as the ANM and telecoms platform would reduce to somewhere in the region of £3-4m, which would be funded by the DNO in the future as part of the operation of the network.

Through the analysis of the case studies, savings of between 18-75% are likely to be achievable for future connections along with savings in the time it takes generators to connect.

Over the course of ED1 this would provide a significant saving for distributed generators based upon accelerating the connection lead time and reducing the connection costs to accommodate their network connection. We estimate that over the course of ED1, around 18% of GSPs will be constrained in a similar manner to case study 1 and may require similar remedial action. This translates to a population of around 16 GSPs in the ED1 period where the ARC solution could be applied in the SPD region alone, creating a benefit in the region of £260m split across developers, the distribution network and transmission network. No reliable source of the scale of this problem across GB was available however our current understanding is that this is representative based on discussions with other DNOs. Appendix details this business case and projection of benefits for SPD alone.

It should however be recognised that our proposed solution would only provide an incremental solution and there may be a future point whereby the most efficient form of investment would be to reinforce the network to increase further the availability of generation capacity. However we consider that having the ability to actively manage the network in the interim period ahead of future reinforcement will avoid the cost of constructing assets that are only required for a piecemeal solution to connect individual connections.

3: Project Business Case contd.

Additional Benefits

This project will create additional value to customers in the form of facilitating and accelerating distributed generation connections through the connection of more renewable generation sources which will offset carbon intensive generation.

Delays or prevention to development and economic growth on the network is difficult to assign a monetary value to, but these too can be substantial. This can occur when a developer does not wish to proceed with a generation scheme due to a lack of network capacity and requirement for significant cost in connection infrastructure and as a DNO we cannot speculatively reinforce the network without a firm connection agreement being in place. Reinforcement deferral has a wider benefit when considering the present value for money in an investment decision for both the DNO and embedded generation developer. By accommodating connections at a reduced cost we will be providing greater economic benefit for the generator and wider GB users through reduced DUOS.

The impact upon local communities can also be significant as to deploy traditional reinforcement methods as this may involve the installation of cables and overhead lines as well as accessing land for network equipment, furthermore by having to undertake such works this can cause disruption through road closure and plant movement.

3: Project Business Case contd.

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3: Project Business Case contd.

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3: Project Business Case images, charts and tables.

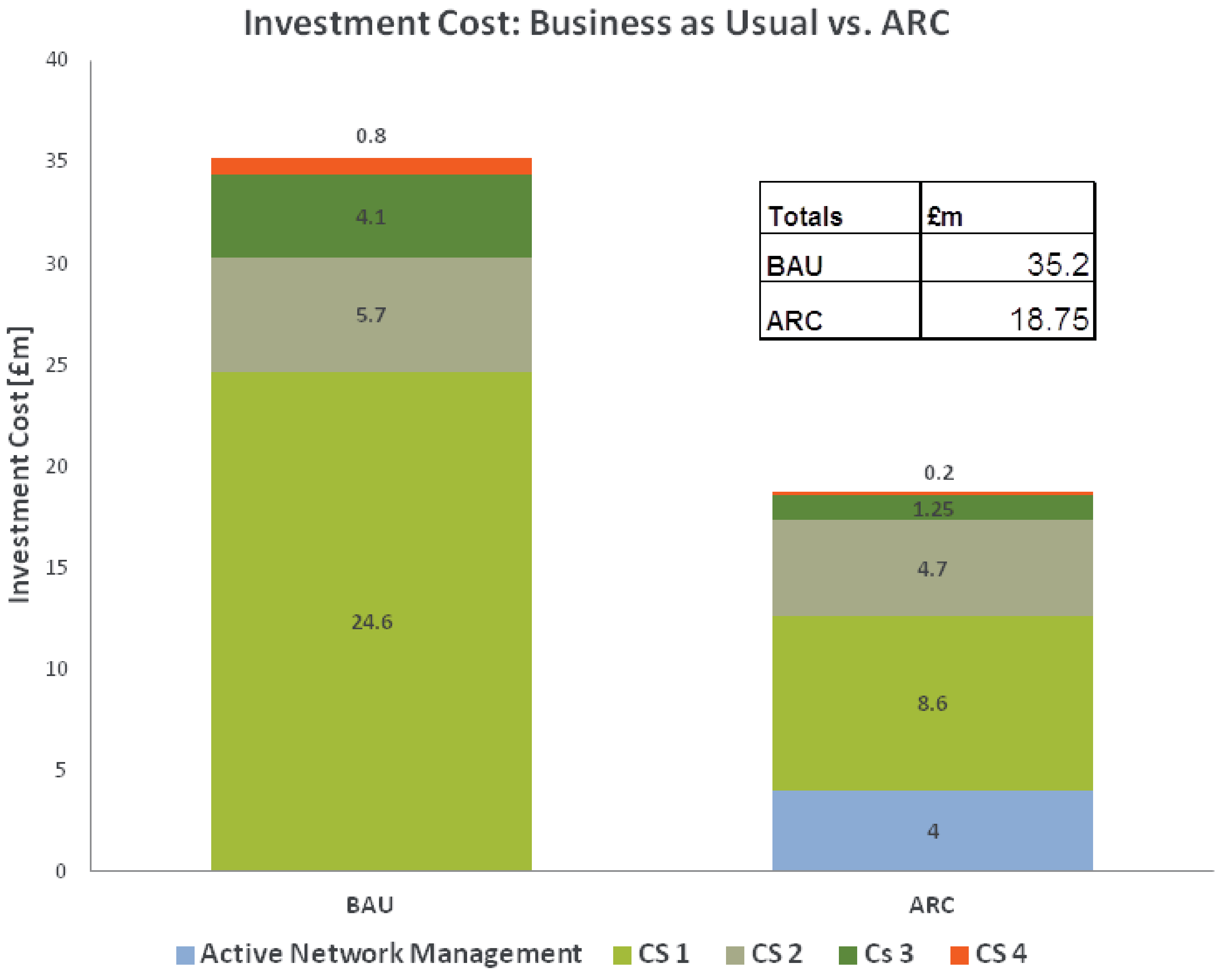

Figure 3.1: Investment Cost Comparison

Project Business Case images

Section 4: Evaluation Criteria

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

Contribution to Low Carbon Transition Plan

The Carbon Plan is committed to dramatically increasing the amount of renewable electricity generation which will have a significant impact on the distribution network. Furthermore, the Scottish Government is setting targets for at least 500MW of local and community based renewable generation by 2020. Meeting the 2020 renewables target is likely to require renewables to provide over 30% of electricity generation in 2020. Making use of some of the best wind and marine resources in Europe will help to lower emissions and the demand for fossil fuels.

SPD are seeking to remove barriers to deployment of low carbon renewable generation through the ARC project.

Improves access to the network

This project will seek to facilitate greater access to the network for customers through streamlining the connections process and making it simpler to gain connections to the network. The project will empower customers through the provision of self-serve elements that allow them to pre-assess the options and costs of potential connections before making a full application. The ARC project will also provide the customer with an improved appreciation of the capacity available on the network for connections; this will include the ability to inform them of the best location for connection of generation at the lowest cost. Non-firm capacity will be made available to customers which will allow greater utilisation of current assets and reduce the overall cost to the customer.

The clear message from the stakeholder engagement workshop was the customer desire to have access to information to identify where there is network capacity to connect generation and the likely costs. By using the information and applying their own criteria they can quickly establish the viability of any given project. The ARC project aims to achieve this by offering a web based portal. This customer accessed system will display valid network capacity, initially at 11kV through heat map presentation. The renewables connection website will clearly present the connections process, offering a range of services from simple estimation through to initiating the formal quote subject to sufficient applicant data. Through the provision of a diverse range of connection options (for example non-firm connections through improved network management techniques) we will be able to offer different connection options that better meet customer needs.

Working with our stakeholders we will further develop our relationships with the Planning and Policy groups within the Local Authorities to improve timescales in line with planning timescales. This reflects the Carbon Plan strategy, seeking to remove barriers, as per recent Government consultations on a draft National Planning Policy Framework.

Greater empowerment in the process and vision of the network capability to host generation will remove some of the barriers involved with securing a successful connection to the network.

Reduces the cost of connection

The Customer will benefit from 'self-serving' and therefore gain faster responses, indicative pricing and greater visibility of other interested parties intentions in the project area. This will help to reduce their costs (through cost sharing any network developments) and could aid their business case development and local council planning application.

This project will apply innovative solutions that will avoid the need to perform significant network reinforcements by extending the available capacity of the existing network and reducing the cost of connections.

Details of the existing connections process, and potential improvements under ARC are detailed in Appendix 8.

4: Evaluation Criteria contd.

The ARC project will take a holistic view towards the connections process and provide customers with the opportunity to consider different connection options and minimise their cost of connection. By working with stakeholders, such as locals councils, it will be possible to take advantage of local knowledge to provide customers with opportunities to implement cost saving connections for example by sharing connections with other generators. Proactive long-term planning of future demand for generation connections will allow for steps to be taken to ensure that the network will meet future connection capacity demands and reduce the cost for customers.

National Grid interface

We have recognised that National Grid as operators of the transmission network do not have visibility of the increasing levels of renewable generation connected to distribution networks, with the exception of generators greater than 30MW. SPD will work with National Grid to develop procedures and policies which are replicable across the UK to address the above issues and remove barriers to increasing renewable generation.

In workpackage 4.1, which will trial a method to resolve the power systems problem described in case study 1, National Grid proposes to reinforce the GSP such that contracted and connected generation has a firm connection under N-1 contingencies. It should be highlighted that this is currently not the case with the existing generation connected to the GSP. The resulting connection offer provided in case study 1 for the next generator is uneconomic due to wider reinforcement works required and an alternative method will be trialled in collaboration with National Grid.

This case study highlights the commercial and technical issues surrounding the connection of new generation to GSPs which have reached or are reaching their export capacity under current planning regulations. The potential exists to work towards innovative solutions which connect generation faster without negatively affecting security of supply and in timescales which are acceptable to all parties.

4: Evaluation Criteria contd.

b) Provides value for money to distribution customers

The Distributed Generation Incentive Mechanism (DGIM) was implemented in 2005. Within the electricity distribution franchise area of SPD alone, around £65m of capital expenditure has been spent on system reinforcements to connect embedded generation with an export capacity of 550MW. Nearly 100% of this investment has been paid by generation developers. The amount of required investment will continue increase in the future as more generation comes forward seeking connection to a network that is accelerating towards saturation point.

Furthermore, as additional embedded generation seeks to connect to the network the affect on the transmission system will increase requiring further costly reinforcement solutions at transmission voltage levels under the traditional methodology. Unlike the connection costs at distribution level these costs are socialised across all GB consumers. Trialling methods to resolve reduce the requirement for transmission reinforcement costs will reduce the cost to all consumers.

Small scale renewable generator customers will benefit through optimising the existing network to provide faster connections to the network that will allow them to connect low carbon generation within the timescales of planning or incentive arrangements. For smaller generators this will mean realising the benefits of feed-in-tariff arrangements that can provide significant financial benefit to small scale developers and communities. Larger developers will also see significant economic benefits to the development of their projects through quicker access to network capacity, albeit under possible non-firm capacity arrangements, and improved or more efficient connection costs.

Ultimately by accelerating the connection of renewable projects onto the distribution network the requirement for fossil fuelled generation will reduce along with the associated cost of carbon which is a cost to GB consumers. By effectively disseminating the learning from the ARC project SPD will contribute to accelerating the UK in its transition to a low carbon economy.

Partner Selection & Procurement Strategy

Our approach to partner selection for ARC has also provided financial benefits for GB consumers. SPD has, through a competitive process, selected Smarter Grid Solutions, University of Strathclyde and Community Energy Scotland. We believe that these partners will be able to help transfer the skills and knowledge that they have developed from other projects to ensure that the project delivers value for money for consumers. One of the strengths that we have in our selected partners is their experience in other LCNF, IFI and similar R&D projects. As a consequence of their involvement with ARC, they will also have the ability to reciprocate this benefit and transfer the learning from the ARC project to their activities with other DNOs, communities and industry stakeholders.

SPD has also agreed to undertake a workshop with operational staff at SSEPD engaged with the Orkney RPZ to facilitate the rapid transfer of learning and experiences to the ARC project. This event has already been agreed with SSEPD to be undertaken within year one of the ARC project commencement in order to maximise the opportunity for learning from their project to be incorporated into the ARC project and to jointly identify areas for additional potential learning.

Furthermore, SPD will ensure that the ARC project delivers value for money through our procurement strategy for the project. SPD has deliberately not included any end device technology partners in our bid submission. We have received a significant number of responses from technology providers for solutions to the typical problems within the project through an 'Expression of Interest' process. These 'Expressions of Interest' will be used to identify potential suppliers to support the project. SPD believe that value for money will best be achieved by contracting, through a competitive tendering process, for products and services through the duration of the project as and when required. We believe that by adopting this strategy we will enable further learning to be developed of the market place and by undertaking a robust tendering exercise we will ensure that the cost of the project is minimised whilst delivering solutions to address network capacity issues.

Summary

Customers will benefit from this project both directly and in-directly through:
- Network optimisation that will facilitate quicker and more cost effective connection of distributed generation
- The implementation of solutions that does not require the need for piecemeal system reinforcement that can be costly and inefficient
- Reduced environment impact for distributed generation connections i.e. construction works, visual amenity, road closures and general disruption that ultimately impact local communities.

4: Evaluation Criteria contd.

c) Generates knowledge that can be shared amongst all DNOs

The ARC project will develop network management tools and commercial arrangements that can accelerate the number generators gaining access to the network in a manner that has a positive and highly beneficial impact upon the design and operation of the distribution system.

The project will develop knowledge based on a series of real case studies within the trial area. The project will generate learning on how the deployment of alternative network and commercial solutions can form business as usual solutions to accelerate renewable generation connections onto the network.

We recognise that increasing with an increasing number of LCNF projects there is likely to be some overlap with existing projects. The ARC project will look to validate and build on any prior learning. However, the ARC is driven by customer and stakeholder group's existing concerns which are backed up by the output of Ofgem's own DG Forum making the ARC project highly relevant to deliver important industry learning. The development of alternative solutions to accommodate an increasing demand for low carbon energy generation capacity is applicable to all DNOs. By automating the systems that control generation output this will bring advantages to all DNOs and enable them to manage their network more efficiently and proactively for the future low carbon environment.

The trial area is representative of GB distribution networks, customer demographics and demand for generation capacity issues. Furthermore we have real case studies that we can commence work on immediately following successful award of funding with the enhancement of tackling this issue over all distribution voltage levels as well as exploring and developing network solutions to solve the problem of exporting GSPs that will become an increasing barrier to the connection of embedded generation as the GB network reaches saturation point. This project is not developing bespoke solutions only suitable for the SPD network and learning will be disseminated in a format that can be easily adopted and deployed by other DNOs. Contractual arrangements, information exchanges and technology measures deployed will be network tested and proven. Furthermore by informing on the policy enhancement and regulatory mechanisms required to facilitate transition to a low carbon economy, all GB DNOs will directly benefit from the learning from ARC. In recognition of the aims of this project, letters of support have been provided by SHEPD, National Grid and Scottish Renewables, as included in Appendix 6.

How will learning accelerate low carbon transition plan

The new learning from this project will be incremental which can then be applied through DNO behaviour change to achieve an increase in network generation capacity through a series of small, low risk steps that flex the constraints of the network rather than a large, high risk step.

As this project will involve some internal behaviour change, user engagement and implementation strategies i.e. policy change, commercial arrangements and contractual offering to help facilitate this will be considered specifically. This will be a key learning point for other DNOs to inform how to integrate the holistic network management approach into the larger business model.

Learning if project is unsuccessful

The diversity of work packages to be undertaken will mitigate any opportunity for an unsuccessful outcome overall. However, even if the learning outcomes of the trial area unsuccessful, this learning and other strategies can be developed both at a DNO and Regulatory level to improve investment decisions and timescales for releasing generation capacity going forward.

4: Evaluation Criteria contd.

d) Involvement of other partners and external funding

Project Partners and Funding Contribution

Community Energy Scotland

The challenges this project is seeking to address resonates with CES as they identify grid access as a major barrier for many of the community projects they work with as much of the SPD network is at capacity or access is delayed due to transmission system constraints.

CES have been working with communities on these issues since their original inception in 2002. Since then they have delivered support and advice to over 1000 communities across Scotland and are currently assisting approximately 170 projects across Scotland with a combined installation capacity of 216MW. CES have been heavily involved in ensuring access to the Orkney RPZ for the 5 community projects which are now contracted on this scheme. In the last 2 years they have been working with the Scottish Government and other industry bodies to increase and drive innovation on decentralised energy, and are now delivering the Scottish Government's Infrastructure and Innovation Fund and coordinate the Scottish Governments Community Energy DNO working group. CES wish to see more network innovation across Scotland to ensure communities can utilize their local natural renewable resources and so are very pleased to be involved in the project.

CES view that this project could have far reaching benefits in all of the work packages, and are deeply excited at the prospect of helping communities to deliver community level solutions seeking to intrinsically link community energy generation with a community's own energy needs. This project will empower a number of communities to play a much greater role in the provision of energy for and within their own localities and establish new methodologies for community energy projects that could be replicated in other areas of Scotland. CESs role in this project would be to bring the vast experience they have in working with communities to ensure capacity is built at the community level, as well as facilitate project work between Scottish Power, its subcontractors and involved communities. They also will bring a strong platform for dissemination of learning throughout the project through their membership base, website, and an national conference, as well as our engagement at policy and regulation levels in Scotland, the wider UK and Europe through a current IEE project 100% RES communities.

CES will also be seeking to help facilitate community project funding through the Infrastructure and Innovation Fund which is designed to assist communities in establishing innovative energy projects which could complement the LCNF funding. This funding has not yet been confirmed by the Scottish Government beyond 2013 but the implementation of this project will help with justifying the need for funding to be made available.

In recognition of the benefits of this project, CES will be providing a benefit in kind of **£42k** over the duration of the project management staff time to steer the project and development officer training.

Smarter Grid Solutions

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).

SGS will support SPEN in Workstream 1 and 2 by assisting with the development of methods and tools for assessing available non-firm capacity, a disaggregated generation and demand profile and heatmaps of the network loading. SGS will also trial the offline use of distribution state estimation techniques for network visibility and develop tools which aid planners in assessing network options.

SGS will provide the control platform and the active network management applications used in Workstream 3 and 4 to ANM-enable 3 GSPs in the ARC network area. These will be delivered as a managed service, in itself a commercially innovative method for delivering ANM.

4: Evaluation Criteria contd.

A partner contribution of **£250k** including:
- Project management resource (£50k);
- SGS's test environment (£50k); and
- Development of analysis tools to aid planners in assessing network options and network visibility tools using distribution state estimation techniques (£150k)

University of Strathclyde

University of Strathclyde will provide the academic oversight of the project and will in particular will be contributing through:

WP4.3 Community level connections

- State-of-the-art review and identification of options for community scale active energy management (generation and demand) within network ANM scheme through joint working with Community Energy Scotland, different types of community scale energy developers and SP [outcome: report detailing available options for community scale active energy management]
- Community scale active energy management concept(s) development with user requirements elicited from SP and community groups through forum [outcome: user requirements]
- Functional requirements, equipment procurement, prototype development hardware and software integration, laboratory testing [outcome: prototype and laboratory testing]
- Demonstration at PNDC [outcome: network demonstrated prototype]
- Assessment of community energy solutions including evaluation of the solutions implemented by communities [outcome: demonstrated community active energy management solutions; successful delivery reward criteria based on `packaged' solutions for large, medium and community scale developments]

WP5.2 Evaluation of Network
- Collation of data from ARC case studies to underpin evaluation [outcome: case study data sets for evaluation] - 1 month in 2013/14
- Development of research models and Smart Grid Forum business case models for ARC case studies at the three scales of development (transmission large, medium and community) [outcome: evaluation models of ARC case studies and smart solutions]
- Evaluation of costs and benefits of active smart solutions and comparison to network reinforcement cost, timing and enabled generation development [outcome: costs and benefits of smart solutions in case study contexts]
- Evaluation of impact of timing of smart investments and alternative trigger events (e.g. clusters of viable generation developments coming forward or response to DNO hot/cold spot information and incentives) [outcome: evaluation of triggers for smart investments; investment decision based analysis when DNOs invest in network to maximise existing generation]
- Construction of investment BaU cases for smart solutions for wider deployment through RIIO-ED1&2 (and the RIIO-ED1 mid-point review) [outcome: RIIO-ED1&2 business case inputs; proposals for structure of future generation facilitation incentives framework; successful delivery reward criteria of deployed packaged solutions to each of the ARC case studies with the evaluation of real experiences and a framework for roll forward into BaU investment within RIIO-ED1&2]

WP6.3 PNDC demonstration
- Use of PNDC facility for demonstration of network ANM and community scale active energy management solutions and PNDC technical staff time for undertaking demonstration and test activities [outcome: practical knowledge from demonstration of solutions in real but controlled environment]

Project Steering Board
- Participation at bi-monthly Project Steering Board.

4: Evaluation Criteria contd.

f) Relevance and timing

This project addresses the very immediate problem of facilitating more embedded generation onto the distribution network as a consequence of the benefits of developing low carbon generation. The Carbon Plan requires an increased contribution from low carbon generation to support the long term carbon reduction targets which has a significant bearing on the distribution network. Further, the Scottish Government has set targets for at least 500MW of local and community based renewable generation by 2020. The timeliness and cost of facilitating this generation onto the network is a key step in making this transition. However, the current perception of the connection application process from project developers is of prohibitive costs and long lead times to connect which, through stakeholder engagement, is a concern echoed frequently. The ARC project aims to address these issues by creating and demonstrating a new process for accelerating renewable connections, in a controlled manner that will avoid the real risk that the network becomes a significant barrier to the low carbon transition, to the benefit of all parties.

The network is now fast approaching saturation point whereby, as a consequence of the large volume of renewable generation that has already connected, the capacity available for future connections will be substantially constrained which, by traditional methods, would be facilitated through a programme of significant & costly network reinforcement. Furthermore, the penetration of higher volumes of embedded generation onto the distribution network is already having an impact upon the transmission system to the effect that, within some DNO areas, relatively small generation projects are now unable to connect ahead of major reinforcement being completed on the transmission system. Examples of this can be drawn upon within the proposed trial area for the project.

Furthermore the establishment of Ofgem's DG Forum and its output to date only strengthens the argument that the objectives of ARC need to be addressed now in line with both consumers expectations and Ofgem's role of ensuring that connection is provided to the distribution network that is timely and efficient and that appropriate policies have been developed to enable this to take place - ARC will inform and deliver solutions to those challenges in recognition of the fact that the connection of embedded generation is and will continue to be a key component of the energy industry now and throughout ED1.

As this will be DNO-led project, it should be possible to implement most measures rapidly without delays without waiting for input from other parties. However some aspects of industry policy change and development of alternative or improved regulatory mechanisms, should they be considered relevant, may take longer as a consequence of existing issues in driving change at these levels. Business integration strategies have already been identified for the project and a key aspect of this will be learning for network designers to improve future network planning such as identification and prioritisation of reinforcements and how deployment of active management solutions can be deployed as an alternative to reinforcement. A more holistic network management approach developed from the project would be embedded within the design team as well as the wider business. This would then be used to inform the submission for the upcoming price control review ED1 and future price reviews.

4: Evaluation Criteria contd.

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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

IPR Arrangements

This project will conform with the LCNF default IPR principals. It is not anticipated that the project will develop foreground IPR that will fall outside of the default IPR requirements.

Building on existing dissemination activities

We are intending to largely build upon the dissemination activity which we are establishing as part of our 2011 project, Flexible Networks for a Low Carbon Future. Rather than creating a new range of activity we will build on some of these platforms including:

- Practical demonstration of equipment at the Power Networks Demonstration Centre which is being developed by the University of Strathclyde, ScottishPower and SSE.
- Academic papers on the outcomes of the project by the University of Strathclyde Chair in Smart Grids which is being sponsored by Scottish Power.
- Inclusion of data in a number of PhD research projects which are already underway.
- Updating of the SP EnergyNetworks website which will provide access for any interested party to understand more about the project
- The LCNF and other industry conferences

As with the Flexible Networks Project, one of the key dissemination activities for this project will be through the Power Networks Demonstration Centre (PNDC) which ScottishPower have developed in collaboration with the University of Strathclyde and SSE. The PNDC is a world class research centre designed to accelerate the adoption of new technologies, from advanced power grids to electric cars and household appliances, through a live demonstration centre. The Power Network Demonstration Centre cost £12.5 million to develop and will be the first of its kind in Europe. The opening of the site has been delayed however construction is now almost complete and it is anticipated that the site will be opened by the end of 2012 with a formal opening in spring 2013 . The site has also been supported by Scottish Enterprise and the Scottish Funding Council and is based in Cumbernauld, near Glasgow.

This environment will allow the various aspects of this project to be deployed on a live network to trial the operation, installation process and maintenance of equipment. This will assist with de-risking some of the technology in advance of it being rolled out, but also provide a safe environment for third parties to get a hands on experience with the technology. It is intended to host events at the PNDC where other DNOs and interested parties can see the various technologies in operation and also demonstrate the practical elements such as installation processes. We believe that this will be a unique environment for other parties to find out exactly how this project can be of benefit to them.

Additional Dissemination

The project also intends to use a number of other means for disseminating learning, including:

Business and Decision Process maps

As this project has a heavy emphasis on the improvement of the connections process, the creation and publication of process maps detailing the steps which this project has developed will be on of the key learning outcomes and means of dissemination. New process maps will be designed to build on the existing information already published by SSE as part of the Orkney RPZ to ensure consistency, using the same Enterprise Architect platform.

The principal process maps which we intend to develop and publish include:
- Decision making process for top down versus incremental investment in network enablers and new technology
- Identification of trigger points for pre-emptive DNO investment to enable future DG connections as it is viewed as being in the interest of the wider customer base
- Information flows to customers to enable greater empowerment and understanding of options as part of the connections process.
- Process for interfacing with National Grid for exporting GSPs.

5: Knowledge dissemination contd.

Influencing the updating of policies and standards

From the experience of undertaking this project, key learning points will be fed into the relevant national policies and standards to ensure all parties can benefit. One of the principal learning points which will help with the dissemination will be the recommendations for a new incentive mechanism for DNOs to pro actively invest in enabling DG Connections as a replacement to the DG Incentive Mechanism. As part of the discussions to date on RIIO ED1 it has been suggested by a number of parties that the existing DG Incentive mechanism has a number of short comings which means that it is not being fully utilised.

Using the project learning and experience, and drawing from the learning of other projects, a project deliverable will be a proposal on the changes required to existing regulatory mechanisms such as the Distributed Generation Incentive Mechanism (DGIM) and how it may be used to better facilitate more proactive anticipation of network reinforcement by DNOs. Our initial thoughts are that subject to appropriate criteria, cost recovery through a mechanism such as the existing DGIM or a new DG RAV funding mechanism will be required over the course of ED1 whereby strategic investment in prospective generation rich areas takes place or where network innovative schemes are implemented to facilitate connection.

The ARC project will also develop learning on the question of "Who Should Pay" for implementation of technology and network reinforcement associated with the connection of distributed generation and consider the potential for greater 'socialisation' of connection costs. This will be facilitated by informing on the barriers of the current rules governing the apportionment of reinforcement charges that will also lead to consideration of the merits for the introduction of a shallower connection boundary for embedded generation connections going forward into the ED1 period. The ARC project will also consider the case for moving towards a greater consistency between connection charging boundaries of the transmission & distribution networks which for transmission is much shallower relative to the distribution equivalent.

This element will be delivered by University of Strathclyde and will involve analysis of other projects and how their learning has contributed to this field.

Partner Dissemination

Another less direct form of dissemination will be through the experience of our project partners; Smarter Grid Solutions, Community Energy Scotland and University of Strathclyde. Through their involvement in the project, the partners will be able to transfer the skills and knowledge that they develop to other projects which they are involved in. One of the strengths of the partners that we have selected is their experience in other LCNF, IFI and similar projects which they can bring to the project. As a result of being involved closely with the ARC project, they will also have the ability to reciprocate this benefit and transfer their learning to activity they undertake with other DNOs, communities and other relevant stakeholders.

Dissemination to customers to keep them informed of developments is detailed in Section 8 - Customer Impact

Knowledge transfer 'in' to the project

With ten LCNF Tier 2 projects now underway as well as a wide variety of LCNF tier 1 and IFI projects, ARC will be looking to build on the learning and experiences of these projects. To ensure we maximise this opportunity, we will be including a project task of knowledge transfer in to the project to ensure we maximise on the learning from of others to avoid unnecessary duplication. One of the roles of the individual responsible for knowledge transfer will be to define the current landscape of projects which complement ARC, as well as keeping an ongoing monitor of other projects as they are developed to ensure that the learning can be complementary.

In our discussions with SSEPD, we have also agreed to undertake a workshop with the operational and design staff who were engaged with the Orkney RPZ. We recognise that over and above the wide variety of material available in relation to this project, some of the less tangible learning is best shared in a workshop environment where people can talk about their experiences. This event has already been agreed with SHEPD to be undertaken within the first year of the project to maximise on the learning from their project. We will also be looking to undertake a similar activity with other DNOs where we believe there to be merit.

5: Knowledge dissemination contd.

Internal Dissemination

As detailed in our project documentation from Flexible Networks, dissemination within ScottishPower is a vital activity of this project to ensure the ongoing engagement of staff and that the outcomes of the project are adopted for future application. We will be using a similar range of techniques which have been successful to build awareness and train staff in the new approaches and processes being developed These methods will include:

- Training of staff at the PNDC on the installation and operation of equipment being trialled as part of this project.
- Inclusion of our graduate pool in project delivery as part of their accredited training scheme.
- Identifying project champions and points of contact within each business area which can be kept abreast of developments and that the customer experience is effectively managed.
- An annual internal technology conference which focuses on LCNF and IFI and is attended by up to 100 staff.

As with the dissemination of learning to external parties, we will also be using the PNDC to demonstrate and assist with the training of staff on the procedures for installing and operating equipment. This will complement our existing training facilities which we have for instructing staff on the safe and efficient methods for installing, operating and maintaining equipment. The roll out of monitoring equipment is likely to require new working procedures to be developed and the training of staff.

As part of our staff development initiatives, we will be using the positions within the project team as a development opportunity to help staff in their development through increasing awareness of innovation projects. We will also be complementing the resourcing of the project with our graduate pool as part of their accredited training programme to maximise their exposure to different activity and bring fresh perspectives to the project.

This project has a strong linkage to a number of business units including Connections, Customer Service, Control Room and Field Operations. Principal points of contact will be established within these teams to ensure all information on the project is exchanged to manage the internal process as well as for learning dissemination. As well as a project governance board which is made up of directors and senior managers from across the business, we will also be identifying project champions from each of the other business areas who will act as ambassadors and lead engagement within their business unit. This will involve providing updates and monthly team briefs and making other presentations as appropriate to keep staff informed of developments.

In 2010, we have also started to hold an annual technology conference at which almost 100 staff attend to find out about the various developments which are ongoing across the LCNF and IFI initiatives within Scottish Power and at other DNOs. This will build on the presentations made at the LCNF industry conference to inform staff of what else is happening within the sphere of LCNF activity across the industry. A broad range of staff will be invited to this from industrial staff through to managers.

We believe that this broad range of activities will provide comprehensive dissemination of the learning from this project, and that the learning will be embedded into day to day practices. Many of these processes for internal dissemination are building upon existing activities and experiences from Flexible Networks such as team briefs, while others will require additional funding which we have accounted for within the funding request.

5: Knowledge dissemination images, charts and tables.

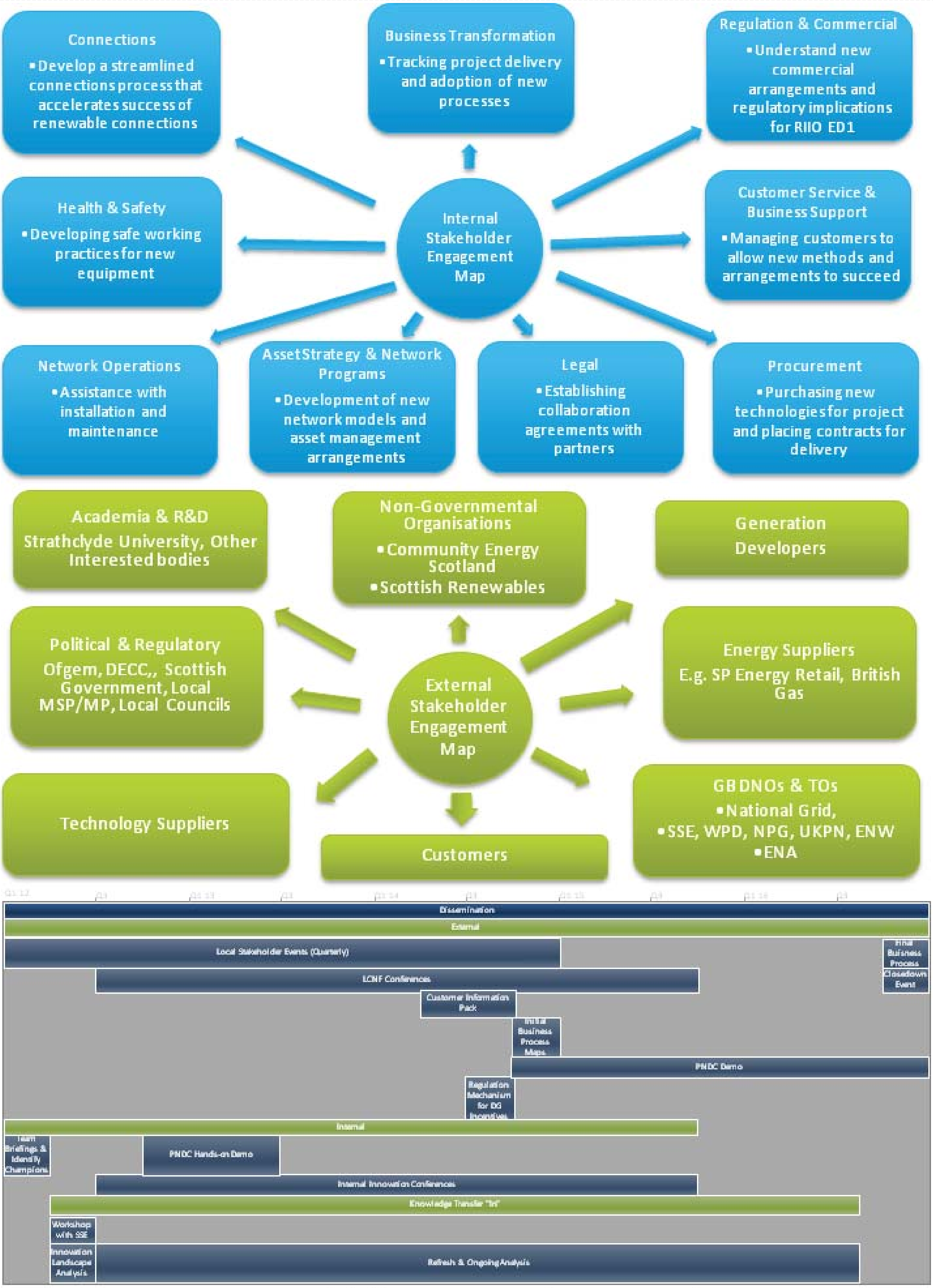

Figure 5.1: Stakeholder Engagement and Dissemination Plan

Knowledge dissemination images

Section 6: Project readiness

Requested level of protection require against cost over-runs (%). 0%

Requested level of protection against Direct Benefits that they wish to apply for (%). 0%

Pre-Submission Preparation - Stakeholder Support

In advance of submitting this proposal, the project has undertaken engagement with a number of internal and external parties to obtain feedback and views on the objectives and deliverables of the project to ensure full business buy-in. Internally this has involved close collaboration between the bid team, the New Connections team who deal with the majority of connection enquiries, Design Team who are responsible for the overall network design, Asset Management and the Commercial Department. The project has also had the endorsement of the Company Executive Team.

Events and discussions have also been held with prospective developers and other relevant stakeholders in the project. This included a workshop with a variety of renewables developers who are active within the trial area and recognised as key parties to the successful demonstration of the methods being trialled. Community Energy Scotland also attended this event and have identified 14 community projects which are currently being developed within the trial area with a total capacity of over 15MW, some of which have already received cost prohibitive quotes and many of these are in a position to be part of the project and are detailed within the case studies outlined in Appendix 5. Discussions have also been held with Scottish Renewables and a letter of support has been provided following consultation with all of their members of the 'Grids' group who are likely to have interest in the outcome of this project.

Initial discussions have also been held with SHEPD with regards to how the project aligns with the learning from Orkney RPZ and Shetland to ensure it builds upon this learning and the practical experiences of these projects can be transferred to the ARC project. It is proposed within the early phases of the project that a workshop will be held early in the project to share these experiences between SHPED, SPD and SGS.

Resourcing

The proposed project resource structure is shown on page 40. The resource structure involves the appointment of seven new dedicated staff, of which the project manager has been identified. the recruitment of these staff has been pre-approved internally on the basis of the project being successfully awarded. The formation of this team will be supported by existing resources within the Future Networks team. It is anticipated that all resources will be appointed within the first quarter of 2013. A full breakdown of the estimated resource requirement per work package is provided in Appendix 4. These dedicated resources will also be complemented by the support of our graduate trainee programme who will be involved in the project on rotating 3-6 month secondments.

Partners

From an early stage in the project the University of Strathclyde and Community Energy Scotland were identified as project partners. Community Energy Scotland in their capacity as Scotland's only national charity dedicated to supporting communities to develop renewable energy projects have an in-depth understanding of the challenges of accessing DG connections. CES also have a wealth of experience in facilitating community engagement and cohesive project management across a wide variety of stakeholders.

University of Strathclyde have been working with Scottish Power for a number of years including the development of the Power Network Demonstration centre, operation of the Scottish Power Active Research Centre as well as supporting the 2011 LCNF Flexible Network Project. The University also have a long standing relationship with Community Energy Scotland with Prof. Graham Ault being a board member of the organisation as well as undertaking research in this area. Prof. Ault will be one of the key personnel involved in the project on behalf of Strathclyde. Existing contractual relationships are already in place with University of Strathclyde and these will be updated to reflect their involvement in the ARC project.

6: Project readiness contd.

An extensive process was undertaken to identify technology partners which was outlined within our ISP and is detailed in Appendix 6. This selection process highlighted a number of interested parties with novel solutions which had the potential for deployment. Having reviewed all of the replies from organisations and undertaking subsequent discussions, Smarter Grid Solutions (SGS) were selected as a lead partner given their experience in other LCNF projects and the learning which could be transferred from these projects as well as innovative ideas and novel technology solutions which were in a position to be demonstrated.

SPEN already have a collaboration agreement in place and working history with SGS through the collaboration on a Tier 1 project - Active Network Management with Hydro Generation. An updated collaboration agreement will be implemented upon award of the project funding.

Project Governance

A Project steering board has already been identified, most of whom have been involved with the review of the full submission. The key personnel on this steering board are:

- Engineering Director (responsible for Future Networks, Asset Management, Design and Technical Services)
- Connections Director (responsible for all elements of new connections to the network)
- Head of Design
- New Connections Manager (within New Connections business)
- Network Technical Services Manager (responsible for telecoms and control systems)
- Commercial Manager (responsible for regulatory interface and commercial arrangements)
- Future Networks Manager
- SGS representative
- CES representative
- UoS representative

The Governance Board will have the appropriate organisational authority to oversee the project and ensure that appropriate action can be taken to rectify any problems which arise. The governance board will meet bi-monthly to support the establishment and to ensure that it commences effectively as well as the ongoing success of the project.

The project also has an executive sponsor who will review on a fortnightly basis:

- Project milestone progress (baseline against actual);
- Monitoring of key risks and issues, including mitigating actions and the effectiveness of their application;
- Financial reporting, including value of work against forecast and budget;
- The effectiveness of communications and stakeholder management plans; and
- Monitoring of resource utilisation, including both internal and external parties.

The project board will have the power to stop the project or take the most appropriate action and identify critical points at which the project should be referred to Ofgem if necessary.

Risk Management, Mitigation and Contingency

Risk Register included in Appendix 3.

Initial discussions were also held with SHEPD with regards to how the project aligns with the learning from Orkney RPZ and Shetland to ensure it builds upon this learning and the practical experiences of these projects can be transferred to the ARC project. It is proposed within the early phases of the project that a workshop be held with the ARC team, SHEPD staff who worked on the Orkney project and Smarter grid Solutions as a partner to both projects as a means of exchanging knowledge and practical experiences.

Project Readiness and Timeline

A detailed project plan has been developed per work package which details key elements and dependencies. This is included in Appendix 3, and is also summarised by sub work package on page 40.

In order for this project to commence in a timely manner, the early objectives for the first quarter will include: finalising collaboration agreements with partners, finalising recruitment of project team, initial discussions with developers within the trial site.

Within the first six months, an external facilitator of the stakeholder forum will be appointed and the initial meeting undertaken.

6: Project readiness contd.

Accuracy of Costing and Verification of Proposals

All elements of the project have been designed in conjunction with the wider SP Energy Networks business to ensure it is both accurate, feasible and meets the needs of both internal and external stakeholder requirements whilst still being innovative. The project steering board has reviewed the full submission and associated documentation for accuracy and all cost information is based on existing contracts/costs where available. Where no costs are available as a comparison, in particular some of the key innovation elements, these have been compared with previous LCNF/IFI projects undertaken by SPEN and compared with similar projects undertaken by other DNOs where costing information is available.

A number of other organisations were considered as part of the process to identify partners, however, we believe we can achieve greatest value for money through operating a more formal competitive process for individual solutions.

A summary of the cost breakdown and assumptions is included below.

Labour costs (Internal) - This includes engineering design and analysis, development of new tools and processes, technology assessment and costs for equipment installation for the trials. Costs for project management, staff and external stakeholder engagement and training are also included. Costs are based on estimated scope of work and timescales from the proposed work package methodology. All staff costs are based on standard costs.

Equipment costs - These have been estimated through discussion with prospective technology providers and based on experience of deploying similar technology on the network

Contractor costs - This includes provision of engineering design and analysis services, as well as assistance from project partners where this is for resourcing. Legal costs for setting up contractual arrangements with project partners are also included here.

IT - IT costs relate to the development of existing systems to improve how they can be used. Costs for enabling the trial area with an ANM system and the management of such an IT systems is also included. This is a new system for SPD and will require the appropriate testing and precautionary measures for it to be integrated.

IPR - We do not anticipate any IPR costs as any IPR development will be undertaken by the partner at their own cost which is their contribution to the project. The project is not funding the development of any technology which should create foreground IPR.

Travel and Expenses - Travel expenses have been allocated for additional travel to and from the Borders region for the purposes of this project, which would not be required for "business as usual". Also included is the cost of travel and expenses to present at key industry conferences and seminars as part of learning dissemination. There are no significant travel and expenses costs for international travel or travel to remote locations.

Payment to Users - No funding is allocated for users.

Contingency - A risk register with risk ratings, mitigation and contingency plans has been developed for this project and is provided in Appendix 3. This will be maintained and updated throughout the duration of the project. This was used to provide an indication of the level of cost contingency that will be required for each work package, broken down by cost items such as labour, equipment, contractor etc. Equipment costs were allocated a higher level of contingency due to possible prices variations in raw materials and manufacturing, an increased level of contingency was also attached to contractor costs which may be subject to change.

Decommissioning - A nominal cost for the decommissioning of equipment has been estimated for the project.

6: Project readiness contd.

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6: Project readiness contd.

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6: Project readiness images

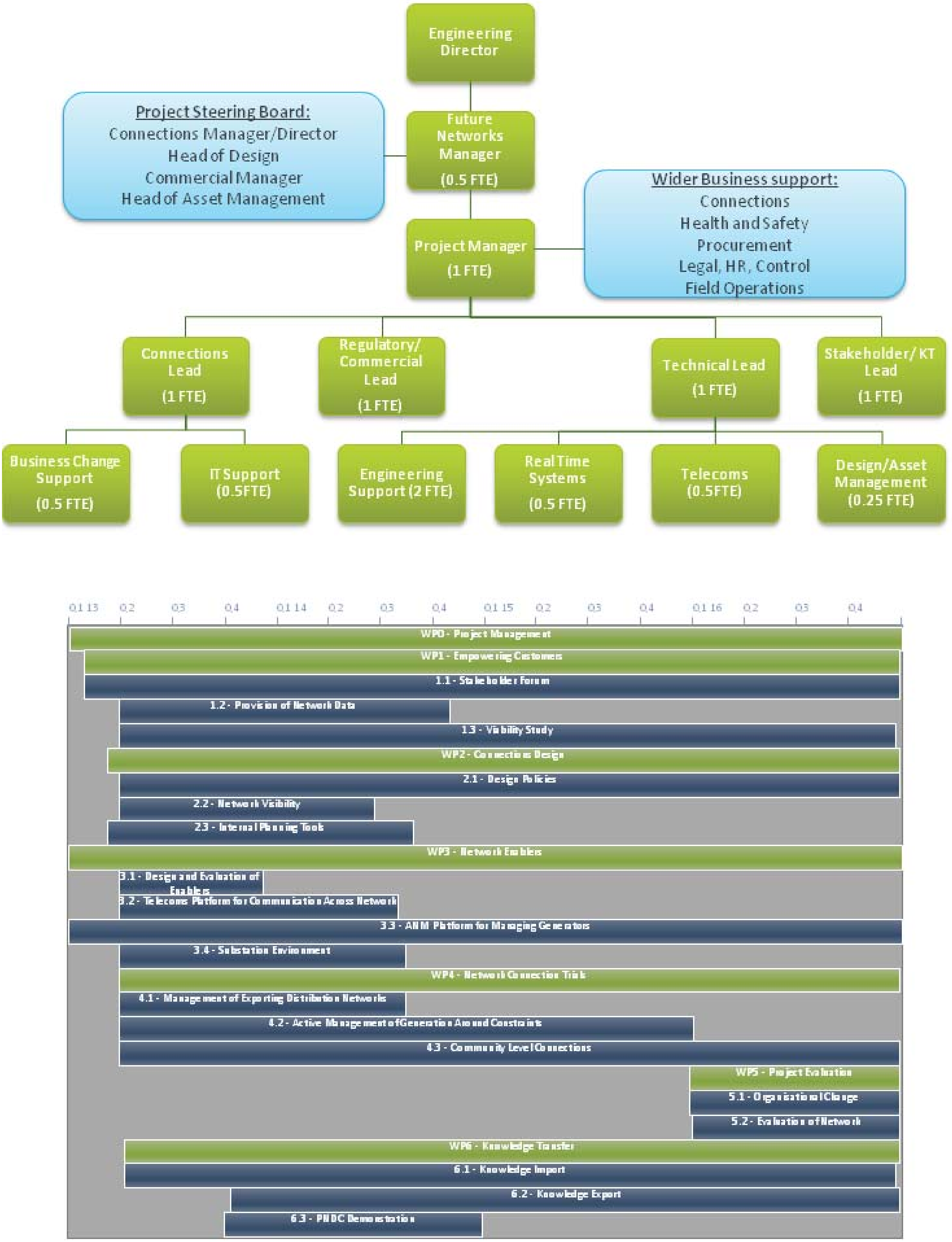

Figure 6.1: Organogram and Project Timeline

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.

Regulatory impact during the project

As a result of developing this project and its implementation during the trial period, we do not anticipate that any derogations, licence consent, licence exemptions or changes to the current regulatory requirements will be required.

Longer term regulatory impact

As the UK moves towards the development of low carbon networks, the connection of distributed generation is becoming increasingly complex. This project will inform on the changes required to existing regulatory mechanisms such as the Distributed Generation Incentive Mechanism (DGIM) and how it may be used to better facilitate more proactive anticipation of network reinforcement by DNOs. Our initial thoughts are that subject to appropriate criteria, cost recovery through a mechanism such as the existing DGIM or a new DG RAV funding mechanism will be required over the course of ED1, whereby strategic investment in prospective generation rich areas takes place, or where network innovative schemes are implemented to facilitate connection.

The ARC project will also develop learning on the question of "Who Should Pay" for implementation of technology and network reinforcement associated with the connection of distributed generation and consider the potential for greater 'socialisation' of connection costs. This will be facilitated by informing on the barriers of the current rules governing the apportionment of reinforcement charges that will also lead to consideration of the merits for the introduction of a shallower connection boundary for embedded generation connections going forward into the ED1 period. The ARC project will also consider the case for moving towards a greater consistency between connection charging boundaries of the transmission & distribution networks which for transmission is much shallower relative to the distribution equivalent.

To address those issues will require a review of how compliance with the proposed ED-1 price control is maintained and how charging methodologies will be affected.

The ARC project will also develop learning on the opportunities available to reduce the barriers that distributed generation faces, through the existing Connection Use of System Code (CUSC), in cases where distributed generation is considered to have an impact upon the transmission system. Through both our own and wider industry stakeholder engagement, it is clear that there is increasing frustration on the part of generation developers when their project is considered to have an impact upon the transmission system and a Statement Of Works is required, meaning that they are subject to significant delays in connecting their project, this has particular increasing relevance for connections in Scotland.

Furthermore as network capacity becomes increasingly limited (through traditional business as usual arrangements) distributed generation will be required to comply with increasing grid code requirements, even though a particular connection is deeply embedded into the distribution system. Developers & DNO's alike are therefore seeking improved interaction with NGET to facilitate an improved understanding on reasons for the existing process and policy requirements for distributed generation. The ARC project will address this issue.

Through our engagement with NGET on this project we will provide transparency on the key information exchanges and network visibility required to enable a greater proportion of generation to connect that would otherwise, which will inform any subsequent amendments to the existing CUSC policy & arrangements.

7: Regulatory issues contd.

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7: Regulatory issues images, charts and tables

Regulatory issues images

Regulatory issues images

Section 8: Customer impacts

Following the dramatic growth across GB in the number of embedded generators seeking to connect to the distribution network at all voltage levels, concerns have been raised by customers/developers on a number of issues relating to access to the distribution network which led to the formation of Ofgem's DG Forum in 2011. From these discussions to date, involving a number of industry stakeholder groups, a wide range of issues/concerns have emerged that include;

1. Access to information
2. Concerns over the application process
3. Transparency of costs
4. Technical issues/standards
5. Customer Service/DNO Behaviour
6. Network/Transmission issues
7. Stakeholder engagement

ARC has therefore been driven by both the output from Ofgem's DG Forum and interaction with customers. The objectives of ARC have been designed for the benefit of generation developers that will lead to improved customer service offered by DNOs. Understanding of the commercial & industry interfaces to match community owned generation with local green demand and tackle the challenge of exporting Grid Supply Points (GSPs), by exploring the relationship between embedded generation and affect on the transmission system. In addition the project will consider the potential for regulatory changes within RIIO-ED1 and beyond, associated with the existing Distributed Generation Incentive Mechanism and inform on the structure of the most suitable incentive mechanism for connection of DG. ARC will also seek to present learning on the appropriate method and process to apportion costs associated with smart interventions and how these are compatible with the well established and understood cost apportionment methods for conventional network reinforcement requirements.

We are fully committed to and recognise that effective stakeholder engagement is essential to the successful delivery of ARC which is designed to accelerate the development of low carbon generation onto the distribution network. A priority of ARC is the establishment of a comprehensive communication strategy that will be relevant, meaningful and focussed on positive engagement with all stakeholders inclusive of generation developers, local community groups, local government policy & planning authorities, transmission & grid system operators and Ofgem.

We have developed an appropriate stakeholder engagement map which identifies key stakeholders that will be directly impacted or have in interest in the learning from ARC. Analysis of the main work package objectives has been undertaken to ensure that learning from the project will be relevant to the wider GB energy network market. We have also actively engaged with Scottish & Southern Energy to capture and build further upon the learning from their ongoing Orkney and NINES projects and who subsequently have agreed to support us in the development of ARC through knowledge transfer of learning and experiences to date from their own projects.

Existing and New Generation Developers

Within the trial area, ARC will directly affect applicants coming forward seeking connection to the distribution network. In developing ARC, we have engaged with a number of developers and industry representative bodies to seek views and opinions on the requirement for and main objectives of ARC. Those representative groups include; Community Energy Scotland (CES); Scottish Renewables (SR) and a number of smaller individual developers who have all committed their support for the project and its aims as they believe that it will provide valuable learning and address a number of concerns raised through Ofgem's DG Forum.

Initial communication will be targeted towards raising further awareness of the project and its objectives and to clearly demonstrate the positive impact that ARC will have on generators and local communities and in meeting regulatory & Government targets by achieving carbon emission reductions.

Impact Upon Developers as a Consequence of ARC

In the early part of 2013, a stakeholder forum will be established within the trial area that will aim to meet 3-4 times per annum for the duration of the project. This event will be open to all stakeholders that will include both new and existing embedded generators as well as local authorities and other community representatives.

8: Customer impacts contd.

New applicants will be invited as part of the trial to undertake a 'viability study' of their proposed project ahead of going to full connection application. This will enable generators to explore all the potential options for their connection that will include non-firm, matching generation with demand in the particular area or considering the balance between requirement for overhead lines and underground cables. This will assist the develop to apply for the most cost effective and timely connection possible.

Through analysis of our existing network, SPD has identified substations in the ARC trial area which are at either capacity, nearing capacity or can accommodate additional generation. During the trial substations identified as either at capacity or nearing capacity will be ANM enabled. Within work package 3 (Network Enablers) consideration of the enabling technologies required to provide the infrastructure necessary for enabling customer connections will be identified however across the trial area an expandable communication layer will be deployed to allow interaction with new generators feeding substations to support the ANM scheme. Funding from the project will pay for the core communications between substations where none currently exists however generators wishing to connect will require to pay for additional communication required as part of the ANM scheme as these assets will be classified as sole-use under existing regulatory funding and charging arrangements. This cost however will be marginal and provide benefit to the economics of the generators scheme as opposed to a traditional reinforcement solution.

Through our communication and engagement with customers, no customer is envisaged to be disadvantaged through the development and their participation in ARC, however all developers seeking a connection to the distribution network within the trial area will have the option to have their connection application taken forward under business as usual arrangements should they decide to do so.

Delivery of Customer/Generator Information Pack
A primary delivery of ARC immediately following funding award will be the production of a Customer/ Generator Information Pack. This pack will outline the process by which SPD engage with customers/ developers throughout the project as well as provide information on the objectives of ARC and how it will affect the connection offering provided by SPD within the trial area initially. Furthermore the information pack will clarify that generators will be able to take their connection application forward under business as usual arrangements however we will seek to clarify the benefits and advantages to the developer by being part of the trial and opportunities for their respective generation projects.

Dedicated Facilities to Receive Customer/Developer Enquires
Following implementation of ARC, a dedicated resource will be identified within the business to receive enquires and be a main point of contact with generation developers for processing and providing connection applications & offers respectively.

Developers will be able to contact the ARC team through a dedicated email address and telephone number for all enquires. In addition we will host a dedicated ARC project page on the main SP EnergyNetworks website that will provide details of the ARC project, information on the trial area and key contact data as well as a list of FAQs that will be updated periodically as the project develops.

As part of the Community Level Connections work stream of ARC included within Work Package 4 (Network Connections), a Community Liaison Officer (CLO) will be employed to manage the interface between the Community Generator, DNO and individual customer groups. This person will be the key interface for the relevant community group that we will be working with alongside Community Energy Scotland (CES) and as part of the project trial this role will be funded equally by SPD & CES.

The purpose of this work stream will be to facilitate learning on the key interfaces, processes and information gathering & sharing required to accelerate local community groups to commit and develop community generation schemes but also how capacity or green demand can be consumed and managed locally in a bid to negate the requirement for expensive and timely reinforcement schemes.

Within the community where we develop the trial we will form and run a number of local community group workshops via Community Energy Scotland. A primary focus of our engagement with local community groups will be to create dialogue and seek agreements on how the community can develop local renewable generation schemes within areas that has limited export capacity availability but can still be economic through the development of processes to match local green demand with generation output.

8: Customer impacts contd.

Communication with a variety of customers will be required, directly by SPD and also via Community Energy Scotland. SPD will provide a detailed customer engagement plan as part of the project once it has formally commenced.

Our communication methods within the community will take the form of;
- Establishment of Community Development Officer (CDO) via Community Energy Scotland who will interface between DNO, Community Energy Group & Generators/Developers
- Use of web based information supported by local customer information
- Online surveys whereby we would understand how customers have engaged with the Community Generation objective and what benefits/disadvantages there are from matching community generation with local green demand
- Local community groups & individual customers would also have direct access to the CDO for any enquiry throughout the project

We do not foresee that this project will require any supply interruptions to domestic customers.

Within the local community for the trial of the community generation scheme, vulnerable customers will be clearly identified prior to commencement of the project however we do not consider that there will be any alteration from business as usual service that they currently receive as a consequence of this project.

Wider Stakeholder Engagement

A number of indirect stakeholders will have an interest in the development of the project. Those stakeholders are shown on page 32 who will be involved with the dissemination of knowledge and include academic institutions, regulatory bodies, consumer & trade groups, technology & equipment manufacturers as well as network operators.

We have provided below a list of additional stakeholder groups and their relevance in the ARC project and how we propose to engage with them.

Local Government & Regional Development Agencies - Local government planning authorities and policy departments will be impacted by the learning that we hope to achieve from ARC as there is a direct link between the implementation of Active Network Solutions and requirement for consents for generation and network equipment within local planning authorities. By disseminating the learning and communicating the objectives from the project we hope to provide information of how ARC will affect future development of renewable generation going forward. We have already engaged with East Lothian and Borders Council who have provided numerous information that has been used to understand likely penetration of renewable generation within the trial area.

National Renewable Generation Trade Associations - Renewable trade bodies will have a significant interest in the project. To date we have held a number of discussion regarding the requirement and objectives of ARC with both Scottish Renewables & Renewable UK who have both highlighted their support and recognise that the learning from ARC will address a number of the concerns raised by their members on the barriers they face in obtaining cost effective and timely access to the GB distribution network. Through continued liaison with both representative bodies we hope to develop learning on how better we can work with developers to offer them solutions that enables connection to the network and satisfies the requirements of their stakeholder such as banks, landowners and company investors.

Banks & Finance Institutions - From our stakeholder engagement to date the issue of what Finance Institutions require from developers in relation to securing a viable network connection has been raised a number of times. Through ARC we will also seek to engage with the Banking & Finance sector to firstly understand how access to network capacity affects developer access to funding for their project and how the learning from ARC and other LCNF projects to date can provide those institutions with a level of comfort as to network availability albeit being delivered through an alternative network solution than full reinforcement.

Academia & NGO's - The project will be supported by University of Strathclyde (UoS). We believe that having UoS as a partner in the project is key in providing impartial analysis of ARC such that the outcome of the project can be verified and recommendations made to the future adoption of the various tools and networks techniques that can be adopted to accommodate increasing levels of embedded generation. In addition however throughout the project we will seek further engagement with organisations who we consider will complement the aims of the project.

8: Customer impacts contd.

8: Customer impacts images, charts and tables

Customer Impacts images

Section 9: Succesful Delivery Reward Criteria

Criterion (9.1)

Project Budget

The project will be delivered to budget in accordance with the Tier 2 full submission. A 5% variance will be acceptable between work packages but the overall project will be delivered in line with this submission in order to demonstrate effective cost control.

Evidence (9.1)

Ongoing cost reporting to monitor progress and publication of a final report to Ofgem will identify costs incurred per work package to assess compliance with the Tier 2 submission. Project completion date of December 2016.

Criterion (9.2)

Project Timeline Delivery

The project will be delivered in accordance with the timelines outlined in the Tier 2 submission to ensure timely learning can be disseminated and adopted in advance of RIIO-ED1 commencing. Delivery in accordance with these timelines, and in line with budget as per criterion 1 will demonstrate effective project management.

Evidence (9.2)

Ongoing project reporting and formal reports to Ofgem will identify the how well the project is being delivered in accordance with the time lines set out within this submission. Should individual work package time lines deviate from plan, a lower reward weighting may be appropriate as long as the overall project is delivered on time. Completion date December 2016.

9: Succesful delivery reward criteria contd.

Criterion (9.3)

Demonstration of alternative solutions as detailed in case study 1

Implementation of the Active Network management system and interface with National Grid as outlined in Case Study1 of the appendices for the exporting GSP site.

Evidence (9.3)

Implementation of the ANM system at a GSP, demonstrating one of the alternative solutions highlighted in Case Study 1. Evidence will be the publication of a revised case study evaluating the traditional solution versus the alternative solution which has been deployed detailing cost, time and operational benefits. Learning and details of the processes and technology involved to achieve an interface with NGET and the impact of this on the statement of works process will be included within this publication. Completion date December 2016.

Criterion (9.4)

Demonstration of alternative solutions as detailed in case studies 2,3 and 4

Implementation of the Active Network management system and alternative arrangements as detailed in either case studies 2, 3 or 4. Each of these case studies are based on real examples within the trial area which provides us with a high degree of confidence that it will be possible to demonstrate and document the learning from at least one of these examples.

Evidence (9.4)

Delivery of **at least two** connections which utilise the alternative solutions detailed in case studies 2, 3 or 4 of the appendices. Evidence will be the publication of a revised case studies evaluating the traditional solution versus the alternative solution which has been deployed detailing cost, time and operational benefits. Learning and details of the processes and technology involved to achieve such a connection will be detailed. Completion date December 2016.

9: Succesful delivery reward criteria contd.

Criterion (9.5)

Creation of community energy generation scheme & model for community level generation
Delivery of a minimum of one community level generation scheme to facilitate a new generation connection onto the network and thereafter production of achievements and learning developed through identification of options for community scale active energy management (matching generation with green demand at a local level). In addition ARC will delivery at least one community level generation demonstration project facilitated through the PNDC that will be used to disseminate knowledge to industry stakeholders.

Based upon the pipeline of community projects identified by CES in the trial area, it is believed that this will be achievable as 14 projects have already been identified.

Evidence (9.5)

Publication of a report detailing the available options for community scale active energy management to facilitate the matching of available generation to local green demand. This will include a review by Community Energy Scotland and a selection of community groups. This will be enhanced through the delivery of a PNDC demonstration event that showcases at least one community energy solution.

Furthermore ARC will deliver at least one community energy generation model that facilitates a new generation connection and publish an account of experiences and processes as a follow-up report Criterion 9.5 to be used and adopted by other communities throughout GB. The delivery of this SDRC will involve a presentation to a interested and relevant stakeholders where an opportunity for questions, information gathering and challenge will be provided.

Criterion (9.6)

Demonstration of top-down Active Network Management
Delivery of and deployment of Active Network Management top-down enabling technology at a minimum of two substations within the trial area as well as associated communication and control system platforms in order to evaluate the benefits of the adoption of this innovation vs. incremental investment plan.

Evidence (9.6)

Delivery of Report on ANM
Publication of report detailing the learning and experience of the deployment of ANM and delivery of a Cost Benefit Analysis (CBA) of the top-down strategy vs. traditional business as usual solutions, based upon project objectives - Delivery December 2016.

9: Succesful delivery reward criteria contd.

Criterion (9.7)

Detailed publication and dissemination of learning from project

Effective dissemination of project learning and business processes to ensure that other DNOs and stakeholders can benefit from the delivery of this project.

Evidence (9.7)

Publication and dissemination of project learning including:
- detailed business process maps for the alternative approaches adopted in the project;
- proposals for structure of future generation facilitation incentives framework;
- evaluation of triggers for smart investments; and
- investment decision based analysis when DNOs invest in network to maximise existing generation;
- Learning and technical documentation to support the technology demonstrated and how this is reflected in design policies.

Completion December 2016

Criterion (9.8)

Improved generation connections experience

Improved overall experience for customers connecting within the trial area through:
- empowering customers through the facilitation of more information,
- alternative options for connections, and
- improvements to the time and cost to connect through these alternative options.

Evidence (9.8)

Stakeholder survey will be undertaken within the first year of the project to determine the baseline of perception of the connections process, time to connect and overall experience - completion date of August 2013.

Stakeholder survey will be repeated in 2016 to determine the improvement that has been experienced by customers within the trial area. All surveys will be undertaken by an external agency and a summary of the results made available - completion date of December 2016.

Section 10: List of Appendices

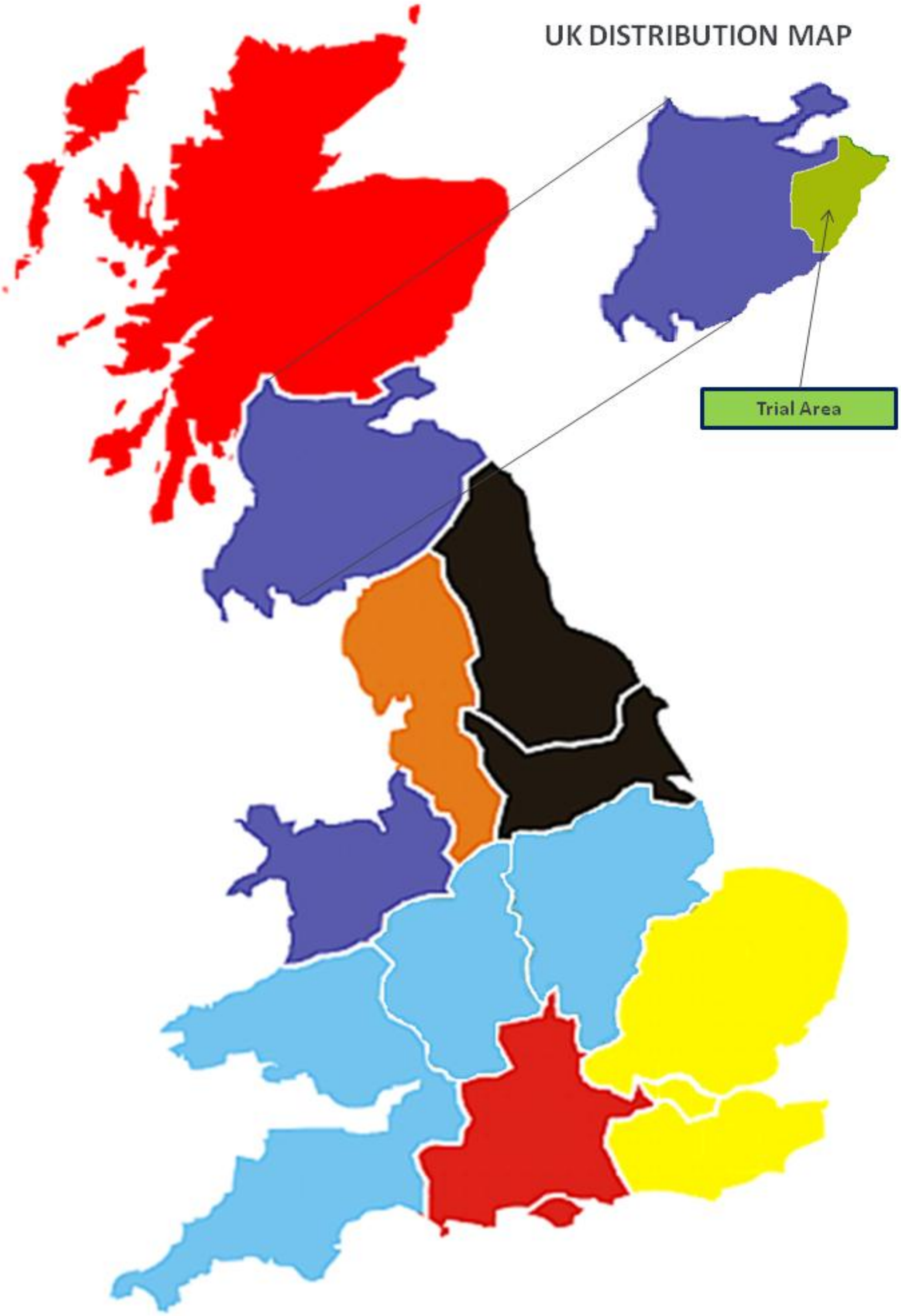
LCNF Tier 2
Accelerating Renewable Connections

Appendices

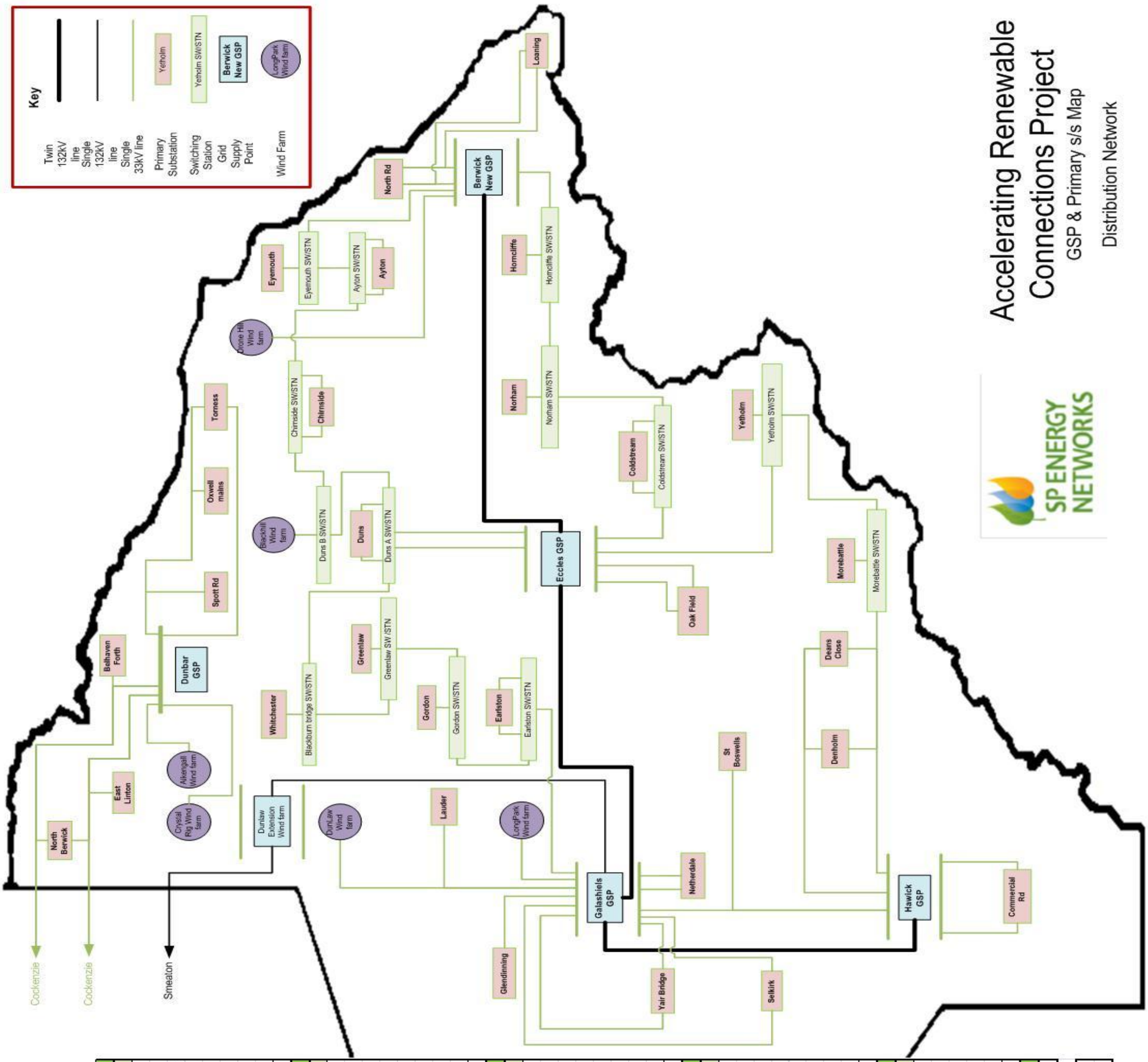
Appendix 1: Budget

Additional financial information is provided separately in the attached spreadsheet.

Appendix 2: UK Map of DG and Highlighted Trial Area



Trial Site Plan



DUNBAR GSP		
Primary S/S	No. Of Secondarys	Customers
TORNESS	155	850
EAST LINTON	138	1510
OXWELL MAINS		LaFarge Cement
SPOTT ROAD	41	2062
BELHAVEN	116	2656
North Berwick	159	5417
Crystal Rig W/F		
Aikengall W/F		
Totals	609	12495
BERWICK GSP		
Primary S/S	No. Of Secondary	Customers
NORTH ROAD	75	3460
EYEMOUTH	72	2460
AYTON	197	1479
COLDSTREAM	205	2373
NORHAM	79	789
HORNCLIFFE	107	670
LOANING	276	5607
Drone Hill W/F		
Totals	1011	16838
ECCLES GSP		
Primary S/S	No. Of Secondarys	Customers
CHIRNSIDE	108	1202
DUNS	223	2577
BLACKHILL W/F		
WHITCHESTER	80	295
GORDON	149	835
GREENLAW	51	495
OAKFIELD	338	5872
YETHOLM	71	624
Totals	1020	11900
GALASHIELS GSP		
Name	No. Of Secondarys	Customers
NETHERDALE	234	8949
YAIR BRIDGE	55	660
SELKIRK	293	4029
GLENDINNING	79	2388
LAUDER	215	1720
LONGPARK W/F		
DUNLAW W/F		
EARLSTON	124	1338
Totals	1000	19084
HAWICK GSP		
Name	No. Of Secondarys	Customers
MOREBATTLE	116	629
DENHOLM	198	1150
DEANS CLOSE	268	3474
COMMERCIAL ROAD	334	9153
ST BOSWELLS	179	2071
Totals	1095	16477
Dun Law Extension GSP		
For Connection of Dunlaw Extension and Toddleburn W/F		
Totals	Secondaries	4735
	Customers	76794

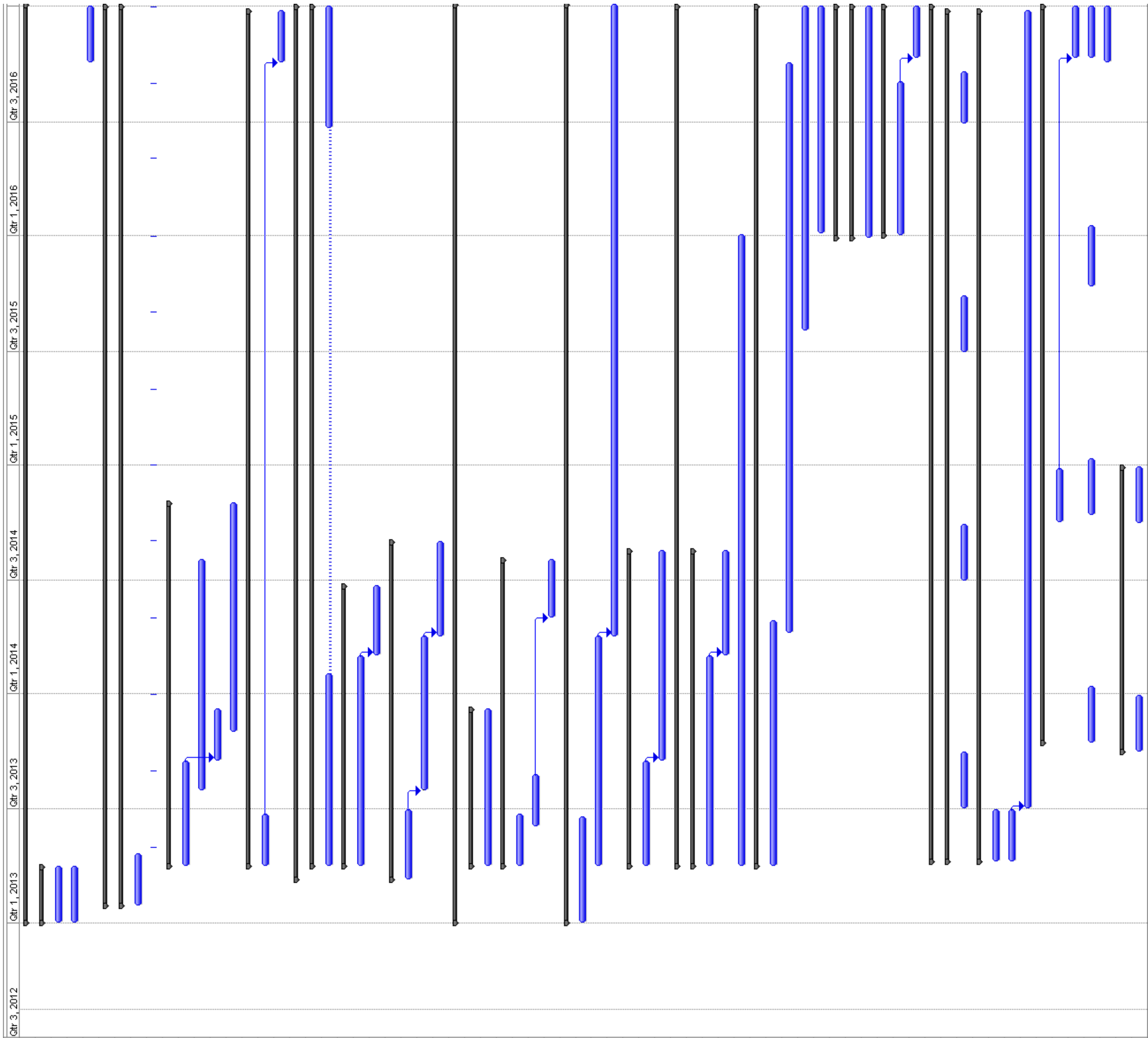
DG Connected in SPD

Existing Distribution Generation Totals in SPD and Trial Area excluding LV

	Installations in SPD	Capacity in SPD (MW)	Installations in Trial Area	Capacity in Trial Area (MW)
Connected Generators	92	942.3	10	255.7
Construction in Progress	21	425.7	2	54.5
Offers Accepted	27	507.9	1	23
Offers Issued or in Preparation	40	653.1	5	110.1
Offers Allowed to Lapse or Withdrawn	158	2113	23	357.1
Feasibility Study Requested	10	286.5	2	54
Enquiries/Concept Development	114	5718.2	28	775.8

Appendix 3: Project Management

Project Gantt



ID	Task Name	Duration
1	**WP0 - Project Management**	**1046 days**
2	**0.1 - Project Management**	**65 days**
3	Recruit Staff	3.25 mons
4	Agree Partner Contracts	3.25 mons
5	0.2 - Decommissioning	3.25 mons
6	**WP1 - Empowering Customers**	**1025 days**
7	**1.1 - Stakeholder Forum**	**1025 days**
8	Forum Creation	3 mons
9	**Stakeholder Forum**	**959 days**
22	**1.2 - Provision of Network Data**	**414 days**
23	Network Data Assessment	6 mons
24	Development of GIS Access System	13.1 mons
25	Develop Network Heat Maps	3 mons
26	Web Portal Development	13 mons
27	**1.3 - Viability Study**	**975 days**
28	Initial Business Process Maps	3 mons
29	Final Business Process Maps	60 days
30	**WP2 - Connections Design**	**995 days**
31	**2.1 - Design Policies**	**980 days**
32	Review & Update Design Policies + Commercial Framework	18 mons
33	**2.2 - Network Visibility**	**320 days**
34	Assess Current Network Data Available	12 mons
35	Develop Optimal Network Data Arrangements for Customers	4 mons
36	**2.3 - Internal Planning Tools**	**385 days**
37	Design Tools Assessment	4 mons
38	Data Sources Integration	8.7 mons
39	Testing and Validation	5.45 mons
40	**WP3 - Network Enablers**	**1045 days**
41	**3.1 - Design and Evaluation of Enablers**	**180 days**
42	Design of Enabling Technology	9 mons
43	**3.2 - Telecoms Platform for Communication Across Network**	**349 days**
44	Specify Telecoms Arrangements	3 mons
45	Implement	3 mons
46	Develop Telecoms Platform	3.25 mons
47	**3.3 - ANM Platform for Managing Generators**	**1045 days**
48	Specify ANM Platform	6 mons
49	Deploy & Integrate	13.1 mons
50	Demonstrate New ANM Functionality	35.95 mons
51	**3.4 - Substation Environment**	**360 days**
52	Identify Necessary Equipment to be Replaced	6 mons
53	Perform Replacements	12 mons
54	**WP4 - Network Connection Trials**	**980 days**
55	**4.1 - Management of Exporting Distribution Networks**	**360 days**
56	Define National Grid ANM Requirements	12 mons
57	Develop Grid Boundary Interface for ANM & Generation	6 mons
58	4.2 - Active Management of Generation Around Constraints	720 days
59	**4.3 - Community Level Connections**	**980 days**
60	Develop Community Led Small Scale Models	14 mons
61	Implement Models in Community Level Projects	32.5 mons
62	Review of Community Solutions	18.5 mons
63	Review & Evaluate	13 mons
64	**WP5 - Project Evaluation**	**265 days**
65	**5.1 - Organisational Change**	**265 days**
66	Organisation Change Mapping	13.25 mons
67	**5.2 - Evaluation of Network**	**261 days**
68	Identify Network Upgrade Triggers	8.7 mons
69	Towards BAU Analysis	3 mons
70	**WP6 - Knowledge Transfer**	**975 days**
71	**6.1 - Knowledge Import**	**970 days**
72	**Internal Innovation Conference**	**840 days**
77	**Knowledge Transfer "In"**	**970 days**
78	Workshop with SSE	3 mons
79	Innovation Landscape Analysis	3 mons
80	Refresh & Ongoing Analysis	45.5 mons
81	**6.2 - Knowledge Export**	**840 days**
82	Initial Business Process Maps	3 mons
83	Final Business Process Maps	3 mons
84	**LCNF Conference**	**840 days**
89	Closedown Event	3.25 mons
90	**6.3 - PNDC Demonstration**	**325 days**
91	**PNDC Demo**	**325 days**

Risk Register

A detailed risk register has been prepared for this project in order to identify and manage risks, and prepare appropriate mitigation and contingency plans, as shown. This will be maintained and updated throughout the project by the project manager and reviewed on a regular basis by the executive sponsor and project steering board. The risk register provides guidance for the level of cost contingency used for each work package. The work package/s associated with the risk item is indicated in the register.

A risk rating (**RR**) has been calculated for each risk item by allocating a probability (**P**) and a consequence (**C**) rating, where 1 is low, 2 is medium and 3 is high, and multiplying to get the overall risk rating. This enables identification of significant risk items and development of suitable mitigation and contingency plans.

No.	WP	Risk Description	P	C	RR	Mitigation	Contingency Plan
1	WP 1.3	Developers unwilling to trial new commercial and connections arrangements	1	3	**3**	External party to maintain high level of contact with developers ensuring benefits are understood by developers	Work closely with local authorities and existing applicants to develop new procedures
	WP 1.2	Dynamic network constraints and sheer data volumes could lead to IT issues	1	3	**3**	Ensure tools, resources and data meets the needs of connections customers	May prove too complex due to volume
2	WP 2.1	The development of new tools and processes for connections design involves some complexity and time/cost risk.	2	2	**4**	SPD has engaged technology partners to develop up to date tools and processes for connections design	Utilise internal IT support and resources
	WP 2.2	Increased visibility of network may have an impact on the available network headroom	2	1	**2**	Traditional design headroom has been conservative	Utilise learning gained from Flexible Networks project on headroom available
	WP 2.3	Integrating existing data sources and tools is not successful due to incompatibility	2	1	**2**	SPD will engage technical experts to conduct integration of data and tools into a single streamlined solution	Expand on previous IFI trials
3	WP 3.2 WP 3.3	There are communication issues with telecom platform meaning that some areas cannot be covered by ANM	3	2	**6**	SPD will carry out site surveys and specify telecoms that will meet the needs of the trial area	Resort to BAU e.g. laying fibre cable
4	WP 4.1	Failure to establish SPD/NGET processes and policy	2	2	**4**	Discussions with NGET. These have commenced and concept has been favourably received	ANM scheme can still be deployed without National Grid interface
	WP 4.2 WP 4.3	There is a risk that procurement of technology and software tools to facilitate trials could hold project back	1	3	**3**	SPD has already carried out an EoI process with technology providers already selected, allowing for procurement process to be advanced	BAU
5	WP 5.2	Network evaluation finds that generation triggers are difficult to categorise	1	3	**3**	Academic partner to carry out analysis and report	Work with planning authorities
6	WP 6.1	Knowledge import from other projects	1	1	**1**	Assign resource to implement	Review learning through DNO websites , publications & site visits
	WP 6.2	Knowledge dissemination	1	1	**1**	Host learning conference	Regular updates to website

	WP 6.3	PNDC demonstration of technology	1	2	**2**	Selected technology does not function as specified	ANM has been successfully implemented elsewhere
7		Changes to renewable incentives which change developer landscape	1	2	**2**	Project needs to accommodate uncertain landscape	Number of projects already identified within trial area for inclusion in the project

Sub Work Package	Activity	Specific Learning	Reference points in other projects	Benefit to ED1	Costs excluding resources	Resources
WP0 – Project Management						
0.1 – Project Management	Overall project management and coordination	-	-	-	**£65k** Legal (£50k) and audit (£10k)	800 MD (PM) 400 MD (FNM)
0.2 - Decommissioning	Decommissioning of equipment at end of trial if necessary	-	-	-	**£30k**	40 MD (Tech)
WP1- Empowering Customers						
1.1 – Stakeholder Forum	Creation of a forum for relevant parties to discuss generation connections issues within the context of this project.	How can improved dialogue between DNOs, developers and other parties such as local authorities and planners help with the connections process. Feedback from Stakeholders on the project progress	None	Stakeholder engagement in improving the connections process.	**£100k** External agency to coordinate and facilitate Forum	160 MD (SM)
1.2 – Provision of Network Data	Provision of network data including more frequent LTDS and network heat maps to allow well informed connection enquiries to be developed.	Understanding what information and how this is best presented to help inform customers of network capabilities for new generation to empower them to make well informed and quality applications. Provide a view of alternative connection options	Orkney RPZ design process	Informing customers in order to improve the overall experience through greater self service	**£315k** Creation of a web portal which details network information and access to geographic information	80 MD (SM) 80 MD (CL)
1.3 – Viability Study	Introduction of a `Viability Study' option whereby SPD can work with the developer prior to making a formal application to help them look at the potential options for their connection.	Develop process maps for information flows to customers to enable greater empowerment and understanding of options as part of the connections process.	Orkney RPZ design process	Improved customer service by allowing customers to explore options for connections	**£60k** External assistance and facilities to undertake constrain analysis	400 MD (CL)
WP2 – Connections Design						

2.1 – Design Policies	Review and update policies to accommodate ARC proposals Develop commercial framework to support new arrangements	Commercial framework required to support new connection arrangements (e.g. Application of Last in, first off for constrained areas). How can Business as Usual design accommodate active network management? Connection of DG to alternative points on the network.	Orkney RPZ, Flexible Plug and Play	Alternative arrangements for offering a connection Updated policies are fully developed for deploying in ED1	**£25k** External technical support	320 MD (Tech) 80 MD (CL) 80 MD (Reg)
2.2 – Network Visibility	Use of existing data sources, learning, models from other LCNF projects and off-line state estimation to provide visibility on the operation of the network	Use of off-line state estimation compared to deployment of further monitoring on the network. Application of learning from other LCNF projects	LV Templates, Low Carbon Hub, Flexible Plug and Play	Optimised monitoring approach Improved understanding of network power flows	**£30k (+£50k)** External technical support, and creation of a off-line state estimation tool (£50k BIK from SGS)	320 MD (Tech) 160 MD (CL)
2.3 – Planning Tools	Integration of PI, GIS and design software to improve design process	Streamlining of design process for faster turnaround of designs	SPD IFI project on data integration	Improved turnaround of connection designs	**£525k** IT modifications to integrate data sources and apply new tool	320 MD (Tech)
WP3 – Network Enablers						
3.1 – Design and Evaluation of Enablers	Study of the optimal level of investment in top down enablers compared to incremental. Study of who and how these enablers should be paid for in future.	Analysis and developing methodology for the deployment of top down opposed to incremental deployment. Building on the analysis undertaken by Smart Grid Forum WS3 activity	SGF WS3 report identified this as an area requiring further study	Influence investment decisions on enabling technologies	**£55k** Design and specification of enabling technology	200 MD (Tech) 80 MD (Telecoms) 80 MD (RTS) 80 MD (Reg)
3.2 – Telecoms platform for communicating across network	Establishment of a expandable telecoms platform across the trial area for communication with ANM and other technology as required to	Potential technology for establishing such a network which is proposed for ED1	Flexible Plug and Play comms module SPD IFI work on radio comms	Improved understanding of telecoms requirements	**£565k** Specification and establishment of communications across trial area with a limited number of end points	320 MD (telecoms) 160 MD (Tech)

3.3 – ANM platform for managing generators	Establishment of an ANM platform such that it is interfaced with PowerOn for any generators to join as required	Development of ANM platform and demonstrating new ANM functionality not previously developed	SPM ANM of Hydro in North Wales Orkney RPZ Flexible Plug and Play	Build confidence in the deployment of ANM as a BAU solution	**£1050k**	800 MD FTE (Tech) 240 MD (RTS)
3.4 – Substation Environment	Replacement of auxiliary equipment where necessary including tap changers and protection relays to facilitate ANM.	Level of modernisation required when retro-fitting new technology	None	Understanding of upgrades required in future to accommodate ANM	**£400k** (£250k equipment, £100k contractors, £50k Contingency)	80 MD (Tech) 80 MD (Eng)
WP4 – Network Connection Trials						
4.1 – Management of Exporting Distribution Networks	Define the National Grid requirements for visibility of ANM to the TSO Develop an interface which allows for visibility of generation and ANM across the grid boundary through Inter Control Centre Protocol Link The use of ANM as an alternative to multiple individual inter-tripping schemes to provide coordinated management and enabling/disabling of generation.	How is DG managed across the Grid boundary? Alternative solutions for exporting Grid Supply points which normally require statement of works. Facilitating additional generation at an exporting site which would normally be constrained.	WPD Interconnection of SCADA systems	Management of GSPs which are increasingly exporting. Visibility of generation for National Grid in the distribution network.	**£300k** SGS £150k Internal IT £100k	160 MD (Tech) 80 MD (RTS)
4.2 – Active Management of Generation Around Constraints	The use of ANM to manage non-firm connections and facilitate more DG to be connected. The use of advanced voltage control to manage the voltage at substations The use of novel generator control to manage power flows around constraints.	Active management of N-1 thermal and voltage constraints. Use of fast acting and novel controls at generator. Commercial arrangements for constrained connections. Alternative network technologies which assist with DG connections.	SPM ANM of Hydro in North Wales Flexible Plug and Play Orkney RPZ	Confidence in the use of ANM for future connections.	**£350k** £150k (SGS) £150k (Deployment of Advanced Voltage control)	400 MD (Tech)

4.3 – Community level connections	Development of a community led solution to smaller scale generation. Use of Community level end point technology to maximise output of generators. Engagement with communities to explore demand led solutions such as contracting with load to off-take excess generation. Use of conversion of excess power to heat as off-take solution.	Develop a number of Community level models which demonstrate solutions to expensive or infeasible small scale generation. Use of Community end point technology.	SPM Ashton Hayes Village SSE NINES project WPD BRISTOL WPD Hooknorton	Alternative community led solutions for connecting DG which are lower cost Community engagement to better understand the future requirements of the network.	**£1,076k+UoS+ CES** Other End point technology (£540k) CLO Full time (£240k) UoS (£146k) SGS (£150k) Commercial arrangements and assistance from CES. Other external technical assistance	160 MD (Tech) 60 MD (SM)
WP5 – Connections Design						
5.1 – Organisation al change	Understanding and detailing organisational changes that are required to adopt the project learning Mapping of business processes for dissemination	How other organisations can utilise the learning from this project.		Adoption of project learning	**£50k** External technical Assistance	80 MD (Reg) 160 MD (BC)
5.2 – Evaluation of network	Identification of triggers based on generation installed and constraints for network upgrades Analysis of how solutions being deployed can be used in BAU	Proposals for structure of future DG incentive Decision based analysis when DNOs invest in network to maximise existing generation		Future incentive mechanism for investing in the network to maximise generation potential	**£150k** UoS Assistance for independent evaluation.	160 MD (Tech)
WP6 – Knowledge Transfer						
6.1 – Knowledge Import	Ensure learning from other projects is adopted in this project and updating of policies as required	How do apply learning from other projects to maximum effect	All other LCNF/IFI/RPZ projects	Application of learning developed by other DNOs	**£10k**	80 MD (Tech) 80 MD (SM)

6.2 – Knowledge Export	Dissemination of learning to other DNOs and interested parties	Dissemination		All DNOs benefiting from learning	**£85k** Website (£15k) Other dissemination inc LCNF Conference (£70k)	160 MD (SM) 80 MD (Tech)
6.3 – PNDC demonstrati on	Demonstration of key network technology components at the PNDC	Practical demonstration of technology	SPD/SSE IFI for PNDC SPD Flexible Networks		**£50k**	40 MD (Tech)

SP ENERGY NETWORKS

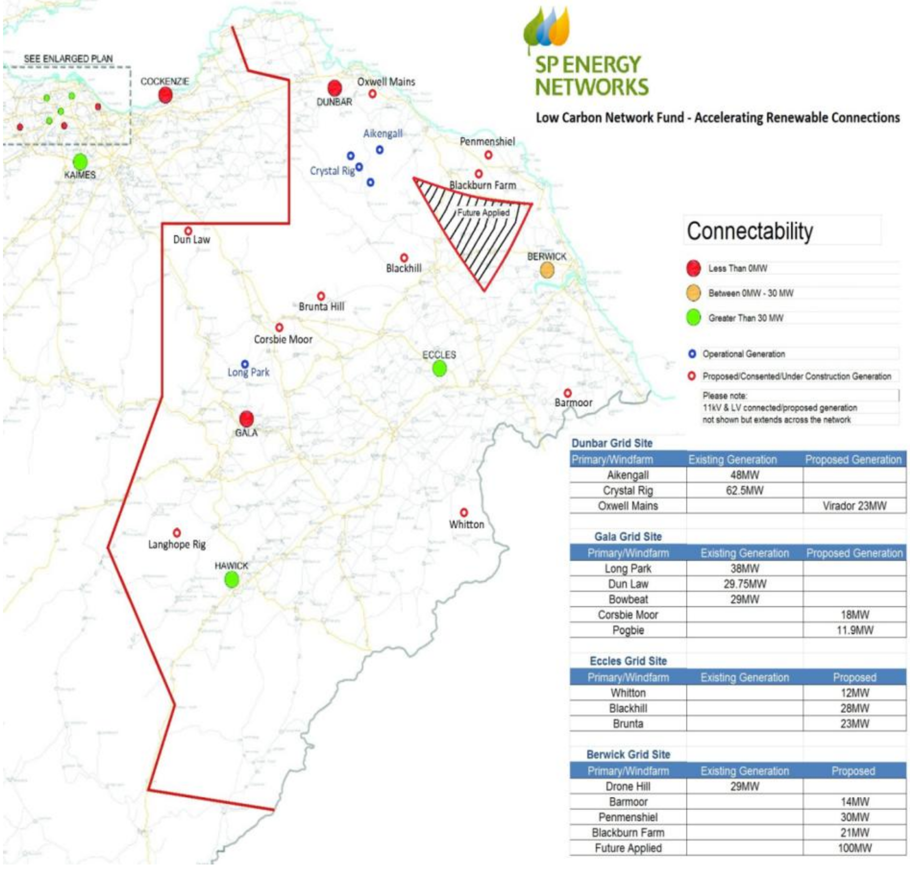
Appendix 5: Connection Case Studies

Introduction

The following seven case studies describe the network issues that exist within the Accelerating Renewable Connections (ARC) trial area. Five of the seven case studies are reflective of recent connection applications to SPD whereby the applicant has not pursued their connection application beyond the offer stage. The suspected reasons are surmised and alternative network solutions that could be explored through ARC are highlighted. These alternatives are for illustrative purposes and do not form an exhaustive list. In addition, two further illustrative examples highlight further network issues that are known on the SPD electricity network. The seven case studies are:

- Case Study 1: The Exporting Grid Supply Point;
- Case Study 2: Multiple Issues for N-1 Contingencies;
- Case Study 3: A High Cost Firm Connection due to Thermal Constraints;
- Case Study 4: High Cost Firm Connections due to Voltage Rise;
- Case Study 5: The Infeasible Application;
- Case Study 6: The Small Scale Community Scheme; and
- Case Study 7: Impact of Small Scale Generation on the Exporting GSP.

For each case, an alternative network solution has been proposed that will form the basis for LCNF learning as part of the ARC trial. SPD has selected a trial area that is supplied by five GSPs within the Scottish Borders.



Dunbar Grid Site

Primary/Windfarm	Existing Generation	Proposed Generation
Aikengall	48MW	
Crystal Rig	62.5MW	
Oxwell Mains		Virador 23MW

Gala Grid Site

Primary/Windfarm	Existing Generation	Proposed Generation
Long Park	38MW	
Dun Law	29.75MW	
Bowbeat	29MW	
Corsbie Moor		18MW
Pogbie		11.9MW

Eccles Grid Site

Primary/Windfarm	Existing Generation	Proposed
Whitton		12MW
Blackhill		28MW
Brunta		23MW

Berwick Grid Site

Primary/Windfarm	Existing Generation	Proposed
Drone Hill	29MW	
Barmoor		14MW
Penmenshiel		30MW
Blackburn Farm		21MW
Future Applied		100MW

Figure 1: ARC Network Area

For each case study, the network issues and/or commercial barriers are described along with the nature of the original connection offer provided to the developer and a comparison made with the options currently under consideration as part of ARC.

For each case, the following information is presented:

- The barriers to connect;
- Alternative accelerating options to be explored through ARC; and
- LCNF learning that will be developed by trialling alternative network solutions.

Case Study 1: The exporting Grid Supply Point

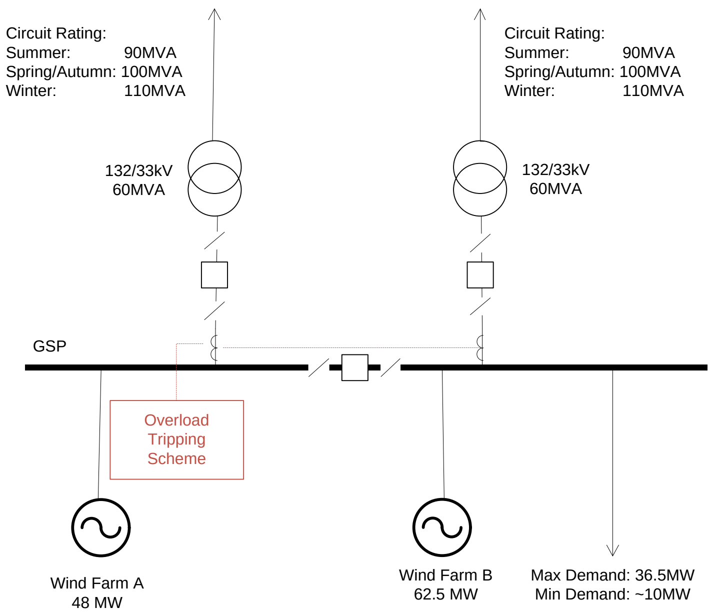


Figure 2: Exporting GSP with limited remaining export capacity

Case study 1 centres on a Grid Supply Point (GSP) (Figure 1). Two wind farms are currently connected to the GSP at the 33kV busbar (**Error! Reference source not found.**):

- Wind Farm A - 48MW (50.5MVA)
- Wind Farm B - 62.5MW (65.7MVA)

The maximum demand at the 33kV busbar is 36.5MW. The minimum demand is approximately 10MW.

An overload-tripping scheme is in place so that if either the transformer or circuit is overloaded, Wind Farm A is tripped. SPD would then allocate a proportional share of the remaining capacity to each wind farm during a network outage. A third developer has applied to connect a 27.5MW (32.4MVA) plant via the same GSP. The developer wishes to connect within a 2 year period.

Network Problem

The GSP in this case study does not have sufficient export capacity to support the firm connection of the third generator with the network fully intact. During the worst-case scenario, with respect to export capacity, i.e. maximum wind farm output and minimum demand, there is less than 15MVA of available firm capacity. During the loss of a transformer or one of the 132kV circuits, the GSP would not be able to support the export capacity of the existing generators at maximum output with minimum local demand.

Connection Options

To accommodate the new generator, SPD proposed the following works:

- The replacement of the existing 60MVA transformers with 90MVA transformers (Figure 3).

The overload-tripping scheme would remain in place, tripping Wind Farm A if either of the transformers was overloaded due to the loss of the other or 132kV circuit. In a similar manner to existing arrangements, the remaining capacity would then be shared on a fair and equitable basis amongst the three generators whilst the outage was in effect.

The proposed maximum net export from the GSP would be approximately 128MW with a new limitation of 90MVA export under a circuit or transformer outage. The amount of DG required to be constrained during an outage would be marginally less than the existing situation at the GSP.

A Statement of Works to National Grid Electricity Transmission (NGET) was required. NGET sought a solution that would offer all three generators a firm connection resulting in a requirement for the following reinforcements:

- The installation of two additional 90MVA 132/33kV transformers at the GSP;
- The installation of a second 33kV busbar at the GSP; and
- Upgrading of the two 132kV circuits to provide a minimum summer rating of 160MVA pre-fault.

The reinforcements shown in Figure 4 are based on NGET making a requirement for the firm connection of the third distributed generation developer under an unplanned/planned outage. This differs from the situation for the two existing contracted generation schemes at this GSP.

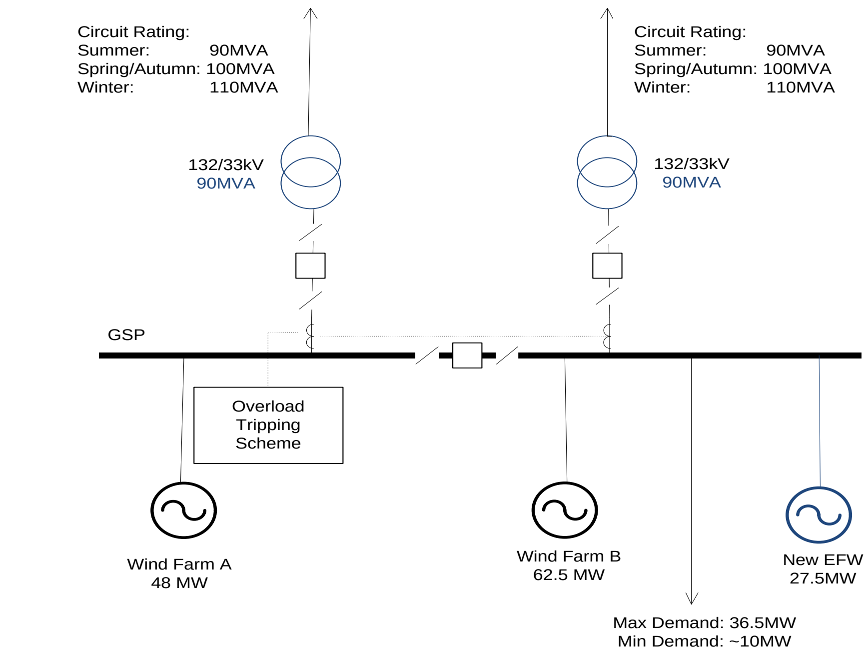


Figure 3: SPD Proposed Solution

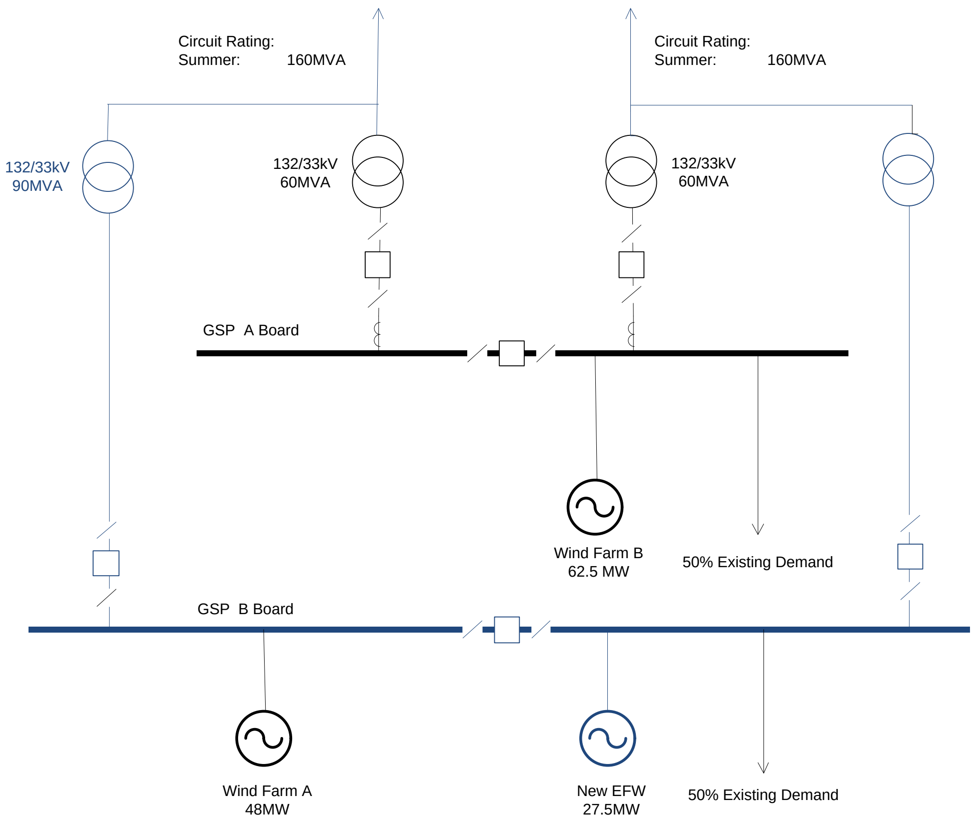


Figure 4: NGET Proposed Solution

Barriers to connection: Time to connect

The developer wishes to connect within the next 2 years. However based upon current reinforcement timescales it is considered that the reinforcement works proposed by NGET will not complete within the timescales the developer wishes as a consequence of the need to obtain the requisite planning consents and wayleaves.

NGET proposes to reinforce the GSP such that contracted and connected generation has a firm connection under fault condition contingencies. It should be highlighted that this is a higher requirement than currently exists for existing distributed generators connected to the GSP.

This case study highlights the connection policy and commercial issues associated with exporting GSPs and issues within the current connection process.

Potential Accelerating Options under ARC

Alternative options to be considered under ARC are:

- **The negotiation of alternative reinforcements and the use of Active Network Management (ANM) with NGET, which would facilitate faster connections**. A dialogue with NGET would be required to explore the possibility of alternative/accelerating options in this case;
- **The use of ANM to actively manage all connections during SPD proposed reinforcement works**. An ANM scheme would be used for the 9 week outage to manage the connected generation and increase energy yields whilst the transformers were being replaced; and
- **The use of ANM to actively manage all connection for planned/unplanned outages after the completion of agreed reinforcement works**. The platform deployed during the reinforcement works would be used to manage connected generation during fault conditions as an alternative to intertripping.

  Benefits include:
  - Greater energy yield from the connected generation;
  - An extensible solution to managing connected generation under outages at exporting GSPs and below; and
  - The possibility of releasing additional non-firm capacity for future connections at exporting GSPs.

Potential for LCNF Learning

This case study highlights the commercial, System Operator policies and technical issues surrounding the connection of new generation at exporting GSPs which have reached or are reaching their export capacity under current planning regulations.

The potential exists to work towards an innovative solution which enables generation to connect faster without affecting security of supply.

Key points of learning to be explored are:

- **Collaboration with NGET in developing alternative, cost effective and timely solutions to connecting additional generation to exporting GSPs**;
- **The creation of a new process for dealing with exporting GSPs, possibly in the spirit of connect and manage**; and
- **Understanding the requirements for technical solutions at the transmission/distribution network boundary**.

  In the case of ANM, this may include:
  - **Understanding the TNO/TSO requirements for actively managed GSPs**. It is not currently known what different stakeholders at the Transmission Network Owner /Transmission System Operator boundary would require in order to allow exporting GSPs to be actively managed;

- **TNO/TSO visibility of ANM operation**. This would involve using an inter control centre protocol (ICCP) link to make operational data from ANM available to the TNO/TSO. Whilst the use of ICCP between a Distribution Network Operator's (DNO's) Distribution Management System (DMS) and NGET's Energy Management System (EMS) has been investigated in a Western Power Distribution (WPD) IFI project, ARC would focus on understanding what sort of data would have to cross the boundary as well as the technical/process challenges in creating such an interface.

Case Study 2: Multiple Issues for Fault Contingencies

Case Study 2 concerns an application to connect an 18.7MW wind farm to Substation D (Figure 5).

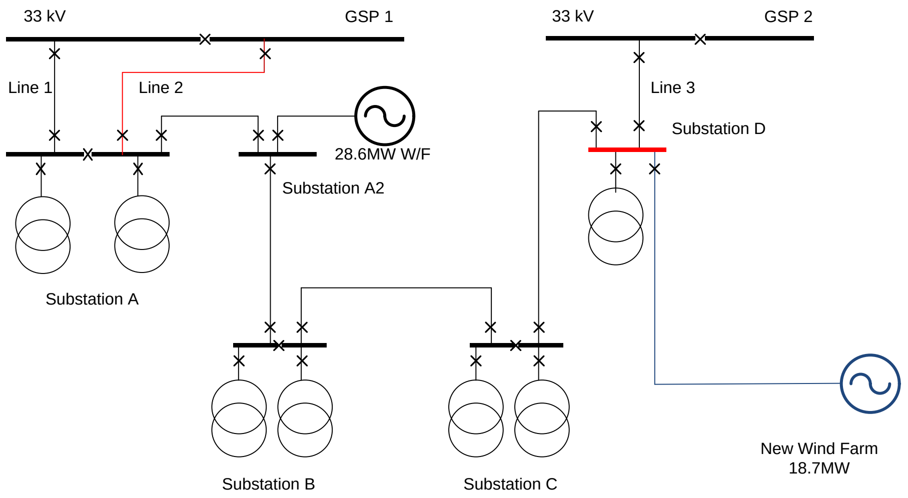


Figure 5: Network Diagram for Case Study 2

An application was made by the developer to explore a connection into the 33kV Primary (Substation D) as an alternative to connecting to GSP2 which is a further 14km away.

An existing 28.6MW wind farm is already connected at Substation A2. An overload tripping scheme is in place that disconnects the existing wind farm if either Line 1 or Line 2 is overloaded, e.g. for the loss of either line during maximum output of the wind farm and minimum local load.

Studies undertaken by SPD conclude that the connection of the new wind farm at Substation D would result in two different types of power system problem:

- Thermal constraints during fault contingencies; and
- Voltage step-change during fault contingencies.

Power System Problem 1: Thermal Constraints During Fault Contingencies

Substation D is on a closed 33kV circuit between GSP1 and GSP2. The connection of the new wind farm at Substation D influences the circuit loadings for Line 1 and Line 2 during normal operation and outages.

Studies undertaken by SPD highlight that the loss of Line 1 would cause an overload capacity of 156.2% on Line 2 if both the existing wind farm and the new wind farm were at maximum output and the local load was at its minimum. The existing overload protection would trip the existing generator in such a situation. Given the size of the overload, tripping of existing generation during an outage is more likely when the new wind farm is operating.

Power System Problem 2: Voltage Step Change During Fault Contingencies

Under fully intact network conditions, the loss of the new wind farm would not cause any voltage issues. If the new wind farm is operating, it does not exacerbate the existing voltage step issue associated with the loss of Line 3. However, studies show that loss of the new wind farm during a Line 3 fault causes a 15% step change in voltage at Substation D (shown in red Figure 5).

Offered Connection

In order to reduce the potential overload under fault conditions to approximately 105%, it was proposed that Line 2 be rebuilt with a capacity of 19.7MVA. The cost of the reinforcement would be £1m with the developer meeting 50% of that cost.

In order to avoid voltage-step-change, the new wind farm would be ramped down and disconnected following a planned or fault outage of Line 3. The developer was offered the option of installing a dynamic voltage device but the offer was declined.

In order to ensure that the existing wind farm was not adversely affected, the new wind farm would be ramped down on loss of either Line 1 or Line 2. This reduces the probability of the existing 28.6MW wind farm tripping off due to circuit overloads.

Barriers to Connection: Reinforcement Costs

In this case, the developer already had a connection offer. SPD assumes that the additional costs associated with the reinforcement of Line 2, in order not to increase curtailment of the existing wind farm, is the primary reason that this offer was rejected.

Potential Accelerating Options under ARC

Potential accelerating options in ARC are:

- **ANM for Power Flow Management under fault contingencies**. The potential overload of the Substation A to GSP1 circuits identified in the connection offer occurs with load set at 40 % of diversified peak demand and only under outage conditions. This network configuration and loading are the worst-case conditions for network performance. As an alternative to reinforcement, it may be possible to manage the power flow through the circuits. The ANM scheme could perform real-time control of the 18.7MW wind farm as necessary to ensure power flows remain within defined constraint limits on the two circuits from Substation A to GSP1. The ANM scheme would continuously monitor the power flows though the Substation A to GSP1 circuits. New set-points and limits would be calculated for the 18.7MW wind farm with sufficient rapidity to ensure constraints are resolved within a defined time. Through the use of suitable margins this would also ensure the existing 28.6MW wind farm is not adversely affected by the new 18.7MW wind farm; and
- **Active management of voltage step issues**. In order to secure against the voltage step issue at GSP2, the ANM scheme could monitor the circuit between GSP1 and GSP2. Should a fault develop on this circuit the ANM scheme will automatically ramp the new 18.7MW wind farm export down to zero. In the future this may be extended by the addition of a voltage management scheme,

which will calculate set points for the new wind that will allow it to meet the voltage step criteria under N-1 conditions.

Potential for LCNF Learning

The active management of generation during fault conditions has not been explored in previous LCNF projects or the Orkney RPZ. ARC offers the opportunity for learning of how ANM can offer an alternative to intertripping schemes. Potential learning in this case study includes:

- **Active management of fault thermal and voltage constraints**. To date, ANM has not been used to manage fault conditions. Thus there is scope for learning in this area; and
- **Use of fast acting controls at generator site**. Depending on the nature of the generators control system, there is the possibly of exploring a tighter coupling between the ANM scheme and the generator's control system to make use of the generator's ability to offer voltage support in a range of situations. This would require development and testing of an appropriate interface between generator control systems and any active network management solution.

Case Study 3: The Costly Firm Connection

An application was received to connect a 6MW Wind Farm via the existing circuits GSP1 (Figure 6).

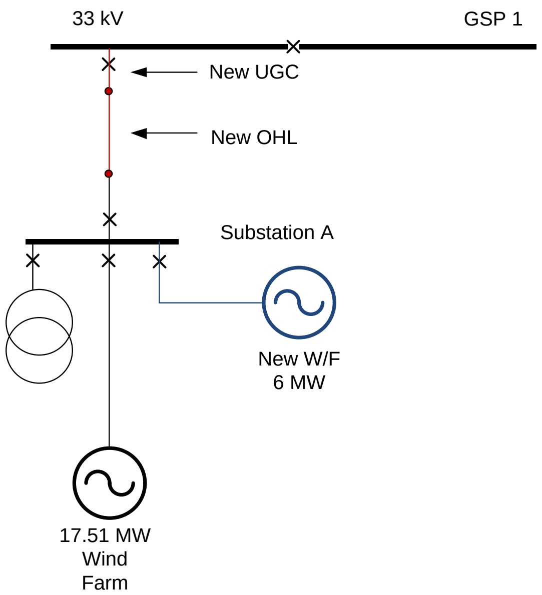


Figure 6: Network Diagram for Case Study 3

Power System Problem: Insufficient Network Capacity

Studies by SPD determined that the connection may only be permitted after reinforcement of the Substation A to GSP 1 33kV Circuit (Shown in Red). This would require reinforcement of approximately 10km of overhead line and 1.1km of underground cable.

Connection Offer

The existing line circuit from GSP1 to Substation A comprises 1.1km of underground cable with a continuous rating of 20.9MVA and an overhead line with a summer rating of 19.7MVA. The presence of an existing wind farm rated at 17.51MVA leaves a spare firm capacity of 2.19MVA. There are no voltage or fault level concerns associated with the new connection.

The developer had previously rejected a direct connection to the 33kV system at GSP1 due to a desire to avoid having to obtain new overhead line consents. The developer was looking for an offer that would allow an earlier connection.

The developer was also offered a constrained connection to the 11kV system. This was potentially the lowest cost option. The constrained connection would not be actively managed. Instead, the developer would be allowed to generate up to 2.7MW during the summer months (May-August) and up to 4MW for the rest of the year. The transformer at the primary would be replaced to allow the requisite reverse power flow capability for the constrained connection. This option was rejected by the developer.

An 11kV underground cable connection to another primary substation in the area was also investigated by SPD. Whilst the other primary substation had sufficient capacity to connect the wind farm, it was ruled-out because of voltage rise issues.

Barriers to Connection: Cost/Time to Connect

The total cost for the supply and installation of the underground cable was £750k and the cost of the overhead line reinforcement was £911k. The total cost of the reinforcement works were £1.66m. The total reinforcement & connection cost was £2.43m. This cost would likely impact the economics for a 6MW wind farm.

Whilst cost was perceived to be the reason for the developer rejecting the offer, the application itself was motivated by the developer's desire for a connection offer that would allow generation to be connected sooner.

Alternative Accelerating Options under ARC

This case study shows that SPD explored a number of different options for the developer in order to try to find a means of connection that met the developer's requirements in terms of cost and time to connect.

SPD recognised that a constrained connection may offer the least cost connection and the possibility of connecting generation earlier. However, the constrained connection was not actively managed; limits on generation were set on a seasonal basis rather than by network conditions. Studies were not carried out to illustrate to the developer what the energy yield of a wind farm connected under that basis was likely to be. Only the headline figures for capacity were given to the developer. Figures on energy yield may have made the constrained connection more attractive.
Active management of the constrained connection may have also increased energy yield over the year in comparison to merely setting seasonal limits on generation. As a result, potential accelerating options under ARC are:

- **Actively managed connection at 33kV**. The network capacity was calculated with the minimum load at Substation A, this is the worst-case condition for the network. It may be possible to offset the local load and using a non-firm connection increase the energy export from the new wind farm. As an alternative to reinforcement, it may be possible to manage the power flow through the circuits from Substation A to GSP1. The ANM scheme could perform real-time control of the wind farm as necessary to ensure power flows remain within defined constraint limits on the overhead line from Substation A to GSP1. New set-point and limits will be calculated for the wind farm with sufficient rapidity to ensure constraints are resolved within a defined time.

- **Actively managed connection at 33kV with real-time ratings**. Dynamic Line Ratings could be investigated for increasing the headroom on the overhead line section of the circuit from Substation A to GSP1.
- **Actively managed connection at 11kV**. The rejected constrained connection offer at 11kV was not actively managed. Under ARC, the connection process could offer an actively managed constrained connection in that case using similar methods as the actively managed constrained connection at 33kV.
- **Actively managed connection at 11kV with real-time ratings**. Dynamic Line Ratings could also be investigated for increasing the headroom on the 11kV overhead line, and thus increasing the energy yield from the wind farm.

Potential for LCNF Learning

The options above have been explored in earlier Registered Power Zones (RPZs) and other LCNF projects. Integrating these options within the new ARC connections offer process would build on that earlier innovation.

Currently, the barriers to offering such connections are, in part, the lack of experience of the required type of analysis to offer such connections within SPD. This is exacerbated by the lack of industry network design tools to support such analysis. Key learning from ARC, and the roll out of such solutions, would relate to changes to the connection application process and their use over a wider area of network than the previous trials.

Outputs could be:

- **New process for offering these types of connection;**
- **The creation of tools and analysis techniques to support these types of connection;**
- **An understanding of the data and IT requirements for offering these types of connection; and**
- **Integrating the solutions above with other point solutions, such as energy storage and voltage management solutions, if required.**

Case Study 4: Voltage Rise requires Uneconomic Reinforcement Works at 11kV

This case study considers three recent applications to connect sub-1MW generators to the 11kV network. In each case reinforcement works would be required to keep voltage within statutory limits.

Each connection can be seen in Figure 7:

- Connection 4.1: A proposed 500kW wind turbine to the remote end of an 11kV feeder;
- Connection 4.2: The connection of a new 275kW wind turbine. There is also a separate proposal for a further 500kW of generation elsewhere on this site. In the first instance the customer has requested connection of a generating capacity of 275kW (wind turbine). The new connection will be provided at 11kV; and
- Connection 4.3: This application concerns the connection of a 330kW wind turbine and a 250kW Anaerobic Digester at the remote end of an 11 kV feeder.

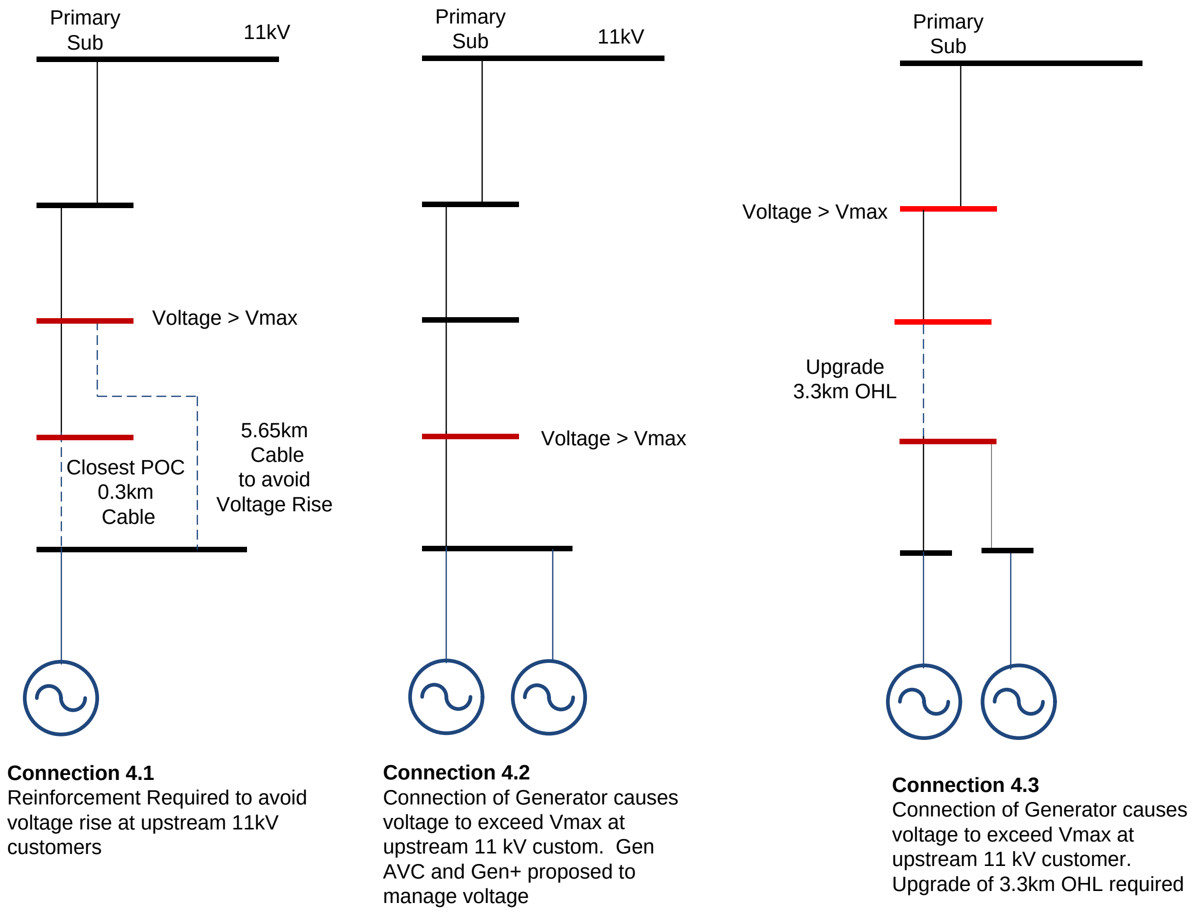


Figure 7: Case Study Connections with Voltage Rise Issues

Power Systems Problems: Voltage Rise

The critical constraint for any connection to the 11kV system is the upper voltage limit of 11.25kV at the Point of Connection and 11.66kV at the generator terminals. For each of the connection applications, assumptions have been made for the minimum loading on the 11kV network. In each case, connection to the closest point of the network would have resulted in voltage rise above the upper voltage limit.

Connection Offers

In each case reinforcement works were required:

- Connection 4.1: Whilst the closest point of connection was only 0.3km away, in order to maintain the voltage for the existing customer on the 11kV network, the connection assessment determined that connection via a new 5.6km cable to a point of connection closer to the primary substation was required to ensure the voltage remained within limits. In addition, this connection is highly likely to compromise further connection offers over the entire circuit length without further major works.
- Connection 4.2: Studies showed that reinforcement works would be required. The existing overhead line (1.8km) and a section of cable would have to be replaced. However, the customer suggested the use of a Senergy GEN+ voltage control system to limit the voltage at the generator to a level specified by SPD. SPD accepted this proposal intended to trial the use of the GenAVC system.

- Connection 4.3: Studies showed that reinforcement works would be required to connect the full amount of generation order to ensure the voltage limits are maintained. An alternative was proposed to restrict the output of the wind turbine. With the wind turbine operating at full output (unity or 0.95 leading power factor), the voltage on the 11kV line will be above the acceptable limit of 11.25kV. Only by restricting output to 110kW, will acceptable voltages be maintained under all conditions. Similarly, the Anaerobic Digester would have to be limited to 130kW.

Barriers to Connection: Cost of Reinforcement Works

In each case the cost of reinforcement works was a barrier to connection:

- Connection 4.1: It is assumed that this offer was rejected due to the cost associated with the reinforcement;
- Connection 4.2: Evaluation of the GEN AVC device was not possible as the device in question was not commercially available. The 275kW turbine has been installed but the further 500kW of generation cannot be installed until an alternative to GenAVC can be found; and
- Connection 4.3: To allow the full output from the generators, network reinforcement would be required. An upgraded 3.3km section of overhead line is required, with an approximate cost of £461k. This cost is prohibitive.

Alternative Accelerating Options under ARC

The limiting effect of voltage rise on the connection of Distributed Generation to 11kV networks is well understood. As a result, a number of different technical solutions are available. These solutions include: point solutions which limit output of generators based on the measured voltage at the generators terminals; AVC schemes which manage voltage at the primary based on additional measurement for the affected feeder or managed output of the generator.

The following solutions would be explored under ARC:

- Active Management of Voltage: In all three applications, the voltage rise has been calculated at summer minimum worst-case load conditions. The minimum load condition is temporary and further capacity will be available to the generators under other loading conditions. As part of the ARC deployment, the voltage constraints could be monitored in real-time to ensure that the voltages do need exceed the calculated maximum. As an alternative to reinforcement, the power flow through the 11kV circuits could be actively managed to ensure the voltage limits are respected.

Potential for LCNF Learning

Voltage rise is a common barrier to the connection of distributed generation at 11kV. Whilst there has been some activity in the UK, e.g. GenAVC or investigations into the use of D-SVCs, the possibility for trialling alternative solutions still exists. SPD's pre-bid invitation to express interest in the project and promote technology solutions elicited a number of different proposed solutions managing voltage rise.

Tackling voltage rise issues under ARC, offers the following possibilities for learning:

- Trialling a range of options for managing voltage rise, drawing on existing LCNF learning and comparing novel technologies/new solutions to those benchmarks;
- Understanding how estimates of minimum load affect the calculation of worst-case voltage rise during planning; and
- Understanding how currently available solutions should sit in the range of connection options offered under ARC.

Case Study 5: The Infeasible Application

This case study centres on a community scheme wishing to connect in the Borders region. The community developer submitted an application to connect a 10MW wind farm to the local GSP. The proposed site of the wind farm was 10km from the GSP. In this case it was clear to the design engineers that the least cost connection offer they were developing was unlikely to be taken up by the customer.

Power System Problem: Cost of Connection Works

The wind farm was to be sited nearly 10km from the GSP, requiring substantial overhead line and underground cabling works. At the GSP itself, if one of the transformers is switched out under outage, under minimum load maximum export conditions the reverse power rating of the transformer would be exceeded. Traditional options would include:

- Installing an operational inter-trip scheme that would disconnect the wind farm during the loss of either GSP transformers; or
- Altering and augmenting the existing transmission protection scheme to allow the wind farm to stay connected during an outage. This would require transmission works.

Connection Offer

A connection was offered that included: the overhead line and underground cabling works; the additional switchgear at the GSP; and the requisite protection, automation and control equipment. The cost of the connection to the developer was £2.8M.

Barriers to Connection: Cost

The reason that the connection offer was not taken up was the cost. The connection was not economically suitable for the developer. The developer now intends to resize the project for connection into a local 33kV substation. Whilst there is less capacity at that substation, the cost of connection should be more economic with respect to the size of the wind farm.

Potential Accelerating Options under ARC

The high cost of connection was clear to the design engineers from an early stage during preparation of the connection offer, however, under current regulations, the least cost connection offer had to be developed on receipt of the application.

This case study highlights an area where the connections process should be improved through self-service on the customer's part, allowing the customer to size their application appropriately given available capacity and enable them to optioneer there proposed connection prior to moving to a full connection application. In this case the similar outcome of a smaller wind farm connected at a point in the network which reduces the connection costs and renders the project economic could have been arrived at sooner.

Potential for LCNF Learning

This case study highlights the potential benefit of a more customer-focused connections process.

Case study 6: Insufficient Capacity for Small Scale Community Scheme

This illustrative example highlights the issues surrounding small scale community schemes where there is insufficient network capacity.

Power Systems Problem: Insufficient Capacity

A community developer wishes to develop a small renewables project sized at 300kW at a location where the network can only accommodate an additional 250kW of generation without triggering costly reinforcement works due to thermal and voltage constraint.

Barriers to connection:

The cost of reinforcement is the main barrier to connection.

Potential accelerating options under ARC could include:

- **Allowing community and small scale schemes to match export, which cannot be delivered by the network, to local demand, e.g. heating of a community asset.** Community schemes would be responsible for managing the export from behind that constraint. Technical solutions may include:
  - The deployment of point solutions in the form of small scale storage technologies such as heat storage and battery storage; and
  - The use of low cost ANM to manage community generation and load behind given constraints.

Potential for LCNF Learning

The potential for LCNF learning includes:

- **Working with communities to understand how such options could be exercised and the difference in perceived benefits to the community;**
- **A greater understanding of the technical and commercial options that could be offered in order to facilitate such community schemes; and**
- **An understanding of the economics of sizing such options and including them in the new ARC connections process.**

Case study 7: The Impact of Small Scale Generation at higher voltage levels

Case Study 7 concerns the impact of small scale generation at lower voltage levels on the firm capacity of the exporting GSP.

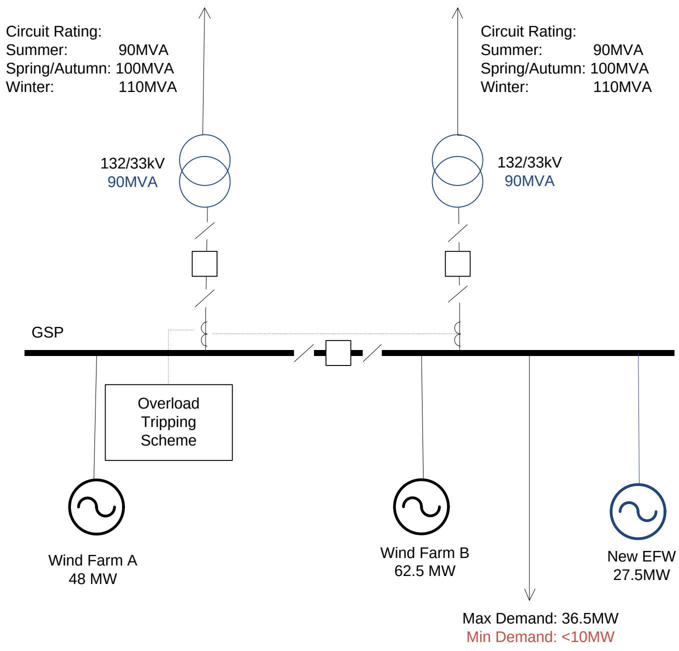


Figure 8: Impact of Smaller Scale Generation at Lower Voltage Levels on the Exporting GSP

Power Systems Problem

The firm capacity of the GSP is the rated export capacity plus the minimum network demand. As more small scale generation is connected at lower voltage levels, it offsets demand, reducing the minimum demand seen at the GSP (Figure 8). This additional generation can potentially invalidate minimum load design assumptions

Barriers to Connection

The example has been experienced in the Orkney RPZ. Large deployments of unmanaged small-scale generators reduce the non-firm capacity previously available to larger developers with non-firm connections. The expected aggregated capacity of the small scale connections on Orkney is approximately 2MW.

Alternative Accelerating Solutions under ARC

Active management of generation across voltage levels may mitigate the effect of smaller generators further down the network which are eating into the capacity of larger generators nearer constraints at higher voltage levels.

Point solutions, such as smaller scale energy storage, may have a role to play in such situations. The solutions discussed in Case Study 4 may have a role to play in mitigating the effect at higher voltage levels. This leads on to the requirement for the potential choreography/coordination of such point solutions by the ANM scheme across the GSPs

Potential for LCNF Learning

Potential LCNF learning points include:

- **The exploration of potential solutions to the problem of smaller scale generation at lower voltage levels negatively affecting non-firm capacity at higher voltage levels**; and
- **Active management of constraints across voltage levels**. To date there have been no attempts in the UK to actively manage constraints across voltage levels.

Conclusions and Summary

This appendix describes seven case studies which highlight the barriers to connection experienced by customers. Many of the technical problems are well understood; such as voltage rise and thermal constraints when the network is intact (Case studies 3 and 4).

As a result, there is an opportunity to leverage existing RPZ and LCNF learning to solve these issues. It should be noted that the voltage rise solution that SPD intended to use as a business as usual solution, was previously trialled as part of an RPZ, however is no longer on the market. Hence, a new solution is sought.

Case studies 1 (The exporting GSP), 2 (Multiple Issues for fault contingencies), 6 and 7, identify cases where new innovative technical solutions are required. Technical solutions to these cases will build upon existing LCNF, RPZ and IFI learning but need the scope of the use of specific technologies to be extended, e.g. the use of ANM to manage constraints during falt conditions and the management of constraints across voltage levels.

Case study 1 (The exporting GSP) offers significant opportunity to address the technical and commercial challenges associated with exporting GSPs. The commercial and technical requirements for actively managing exporting GSP are not well understood, hence, this problem offers significant scope for learning and is a significant problem on the Scottish distribution networks of both SPD & SSE.

Case study 5 illustrates an area where changes to the connections process rather than innovative technical solutions would result in better service for customers.

Table 1 summaries each case study in terms of: the business as usual outcome of the application; the potential for innovative solutions and the savings they may accrue; an estimate of how much sooner customers may be able to connect; and comments of potential LCNF learning.

Case Study	Case Study Descriptor	Power System Problem	BAU Solution	Potential ARC Solutions	Potential Savings*	Time Saving	Reference to previous learning	Potential LCNF Learning in tackling this type of case
1	**The Exporting GSP**	GSP approaching firm capacity. Thermal constraints under N-1 on TX and OHL. Proliferation of intertripping schemes. Multiple generators are already connected; new connection must not adversely affect contracted or connected generation.	TX upgrade proposed by SPD. Statement of Works to NGET. NGET propose alternative reinforcements to guarantee firm connection to all generators under N-1. Connection cost £5.6M, infrastructure costs £19M	Apply "Connect and Manage" principles to distribution connected generation that feeds into a transmission network constraint. Active Network Management of Generation connected to the GSP to release non-firm capacity for network-intact and N-1.	With current cost apportionment rules there is no obvious saving to the customer; however substantial reinforcement works could be deferred. Upgrade grid transformers to 90MVA £3m. May release additional non-firm capacity.	The generator wishes to connect within 2 years. ANM enabled could connect in 2 yrs, saving 3 years.	Leverage learning from Orkney RPZ, UKRN FPP, UKPN LCL, and NPG CLR (GUS). Leverage learning on ICCP link with NGET from UKPN Tier 1. Interconnection of WPD and NGC SCADA systems.	Process for collaboration between DNO and TSO in developing cost effective and timely solutions to connecting addition generation at GSPs approaching capacity. Understanding the TNO/TSO requirements for actively managed GSPs. Active Management of N-1 Thermal Constraints.
2	**Multiple Issues for N-1 Contingencies**	Thermal constraints under N-1 conditions. Voltage-step-change under N-1 conditions. Multiple generators are already connected; new connection must not adversely affect contracted or connected generation. Existing Overload Intertripping scheme means new connection can not be easily accommodated.	Reinforcement of OHL at constraint location to avoid tripping existing customer. Additional cost of £970k, 50% apportioned. Ramping down of new generator under N-1 conditions where a voltage step-change would occur if the generator is disconnected. Connection cost £5.2M	Active Network Management of Generation connected to the GSP to release non-firm capacity for network-intact and N-1.	Avoids/defers OHL reinforcement.	Reinforcement works no longer required. Generator can connect sooner. 6 months	Leverage learning from Orkney RPZ, UKRN FPP, UKPN LCL, and NPG CLR (GUS).	Active management of N-1 constraints. Active Management of voltage-step-change issues. Understanding of novel options within the ARC connections process

Case Study	Case Study Descriptor	Power System Problem	BAU Solution	Potential ARC Solutions	Potential Savings*	Time Saving	Reference to previous learning	Potential LCNF Learning in tackling this type of case
3	**The Costly Firm Connection**	6MW WF connection. Thermal constraint triggers requirement for reinforcement for connection to existing 33kV network.	Reinforcement works of £1661k. Rebuild 9.5km OHL. Connection cost £2.43M	Offer of alternative actively managed connection at 33kV or at 11kV via a closer primary substation. Use of RTR/DLR to increase headroom on 11kV OHL connection.	Avoids/defers 33kVOHL and cable reinforcement works. 33/11kV transformer upgrade for reverse power flow, £400k. 11kV constrained connection offer £860k mn cost. Savings £1.57M	Reinforcement works no longer required. Generator can connect sooner. 6-12 months	Leverage learning from Orkney RPZ, UKRN FPP, UKPN LCL, and NPG CLR (GUS).	The creation of Tools and Processes for developing this type of connection offer. Understanding of novel options within the ARC connections process
4.1	**Voltage Rise Requires Uneconomic Reinforcement works at 11kV**	500kW Wind Turbine Connection. Voltage rise issue at closest POC.	New 5.66km Cable at a high cost. Connection cost £820K.	Active Management of voltage rise or installation of other point solution. Enable ANM solution, connection offer £195k	N/A. Without an alternative solution the connection is uneconomic under BAU. ANM enabled £625k	N/A. Without an alternative solution the connection is uneconomic under BAU. ANM enabled connection	WPD LCNF Tier 1 D-SVC. Martham RPZ.	Trialling a range of options under ARC and comparing with other benchmark solutions. Understanding how estimates of minimum load affect the calculation of worst-case voltage rise. Understanding how the range of potential solutions sit in the options offered under ARC.

Case Study	Case Study Descriptor	Power System Problem	BAU Solution	Potential ARC Solutions	Potential Savings*	Time Saving	Reference to previous learning	Potential LCNF Learning in tackling this type of case
4.2	Voltage Rise Requires Uneconomic Reinforcement works at 11kV	275kW Wind Turbine and 500kW Anaerobic Digester connection. Voltage rise issue at closest POC.	SPD attempted to install GEN+ and GEN AVC under BAU. Connection cost £240k + device	Active Management of voltage rise or installation of other point solution. Enable ANM solution, connection offer £205k	N/A Without an alternative solution the connection is uneconomic under BAU. ANM enabled 35k	N/A Without an alternative solution the connection is uneconomic under BAU. ANM enabled connection	WPD LCNF Tier 1 D-SVC. Martham RPZ.	Trialling a range of options under ARC and comparing with other benchmark solutions. Understanding how estimates of minimum load affect the calculation of worst-case voltage rise. Understanding how the range of potential solutions sit in the options offered under ARC.
4.3	**Voltage Rise Requires Uneconomic Reinforcement works at 11kV**	330kW Wind Turbine and 250kW Anaerobic Digester connection. Voltage rise issue at closest POC.	3.3km OHL upgrade. Cost to generator is ~£461k.	Active Management of voltage rise or installation of other point solution. Enable ANM solution, connection offer £213k	N/A Without an alternative solution the connection is uneconomic under BAU. ANM enabled £248k	N/A Without an alternative solution the connection is uneconomic under BAU. ANM enabled connection	WPD LCNF Tier 1 D-SVC. Martham RPZ.	Trialling a range of options under ARC and comparing with other benchmark solutions. Understanding how estimates of minimum load affect the calculation of worst-case voltage rise. Understanding how the range of potential solutions sit in the options offered under ARC.
5	**The Infeasible Application**	10MW community scheme over 10km for nearest POC with the required capacity	Connection uneconomic due to cost of OHL to POC. Cost £2.82M	Improved connection process allows customer self-service and appropriate sizing of projects.	N/A Without an alternative solution the connection is uneconomic under BAU.	N/A Without an alternative solution the connection is uneconomic under BAU.		Improved connections process.

Case Study	Case Study Descriptor	Power System Problem	BAU Solution	Potential ARC Solutions	Potential Savings*	Time Saving	Reference to previous learning	Potential LCNF Learning in tackling this type of case
6	**Insufficient Capacity for Small Scale Community Scheme**	Sub 1 MW connections with insufficient export capacity.	Connection uneconomic due to required reinforcements.	Allow customers to explore solutions which match local demand to unavailable export capacity.	N/A Without an alternative solution the connection is uneconomic under BAU. None, Storage may enable generation	N/A Without an alternative solution the connection is uneconomic under BAU.		A greater understanding of the technical and commercial options that could be offered in order to facilitate such community schemes. An understanding of economics of sizing such options and including them in the new ARC connections process. An understanding of perceived community benefits of such schemes.
7	**Impact of Small Scale Generation at the GSP**	Small scale generation at lower voltages offsets demand and eats into firm capacity at higher voltage levels.	N/A	Investigate methods for actively managing the impact of small scale generation.	N/A	N/A	Orkney RPZ.	The exploration of potential solutions to the problem of smaller scale generation at lower voltage levels negatively affecting non-firm capacity at higher voltage levels. Active management of constraints across voltage levels.

Appendix 6: Project Partners

Project Team

Details of the project team are given in the organogram, provided in Section 6 of the FSP.

Partners

The University of Strathclyde, Community Energy Scotland and Smarter Grid Solutions have all been engaged as partners in this project. The number and scope of partners is felt to be acceptable for a project of this magnitude to provide sufficient industry commitment and relevance whilst not impacting programme delivery due to overly complex management and contractual negotiations. Further details of the partners are provided below, as required for the LCNF bid governance.

A relationship diagram is provided in Section 6 of the FSP indicating the contribution of the various partners and external contractors to the project work packages.

University of Strathclyde

Relationship with DNO

University of Strathclyde (UoS) is an educational institution and a charitable body registered in Scotland, number SC015263. It is independent of the DNO.

Type of Organisation

University of Strathclyde is a research-led educational institution. The Department of Electronic and Electrical Engineering has a wide and well-established portfolio of research with clients and collaborators from industry and government in the UK and beyond.

Role in Project

The team at Strathclyde will contribute knowledge of the area of smart grid, active network management and community energy solutions. They will develop conceptual models and test community led solutions to network constraints. They will also evaluate the investment decisions associated with novel solutions for accelerating renewable connections such as active network management and community led solutions involving energy storage and demand management – this will contribute to the RIIO-ED1 and DG incentive debate. Use of the Strathclyde led Power Network Demonstration Centre (PNDC) to test and demonstrate the solutions will provide a significant acceleration of the maturity and readiness of the outcomes of the early stages of this project. Finally, the team will contribute to the reporting and dissemination of results and learning outcomes.

What Partner will add to Project

University of Strathclyde have provided resources to assist with the development of this project and will provide a conduit to specific relevant research activities on smart grids, active network management and community energy. Two research fellows will work on this project mainly in the first two years but with some evaluation activity later in the project. Additional researchers in related publicly funded projects and further academic staff with specific expertise will contribute throughout the project. The University will also provide sharing of knowledge from other investigations and make available undergraduate, MSc and PhD students to work on problems related to the Project. University of Strathclyde will be contributing a benefit in kind of £33k in form of a discount on research services and attendance at project steering group.

Prior Experience

The Advanced Electrical Systems Group at Strathclyde has worked with electricity network operators on a wide variety of applications for more than 20 years. This includes power system operation, active network management and condition monitoring. It is both the principal investigator and management hub for the largest publicly funded research initiative on highly distributed energy futures and low carbon distribution networks ('HiDEF') contributing in respect of demand side management and distribution network operation. It is also a leading in a number of ongoing and recent active network management projects including Aura-NMS (with Scottish Power) and the Autonomic Power System project. Its expertise is recognised internationally and the Department is among the highest rated in the UK. The team participating in this project have strong existing links with other partners in the project including Community Energy Scotland and Smarter Grid Solutions and this will aid significantly in the development of effective and productive working relationships with these partners.

How Funding relates to benefits from Project

University of Strathclyde will benefit from a continuation and expansion of a longstanding and fruitful relationship with Scottish Power, the maintenance of industrial relevance in both teaching and research and the opportunity to develop new active network management and community energy solutions that promise to benefit the migration to lower carbon networks. Using existing publication expertise, the team will be able to disseminate outcomes and contribute to learning not only in the UK but internationally. The funding in this project will provide excellent opportunities for university academics and researchers to further their participation in the ambitious low carbon transition in the UK distribution networks.

Community Energy Scotland (CES)

Relationship with DNO

Community Energy Scotland is a registered Scottish Charity and has been in operation since 2008. It is independent of the DNO.

Type of Organisation

CES are dedicated to raising the capacity of community groups so they can bring forward their own sustainable energy projects from micro to megawatt scale to deliver real, tangible and long term benefits within their communities. CES achieves this by delivering detailed, independent and ongoing locally based support for all aspects of community energy project development. Community Energy Scotland has over 300 community members and the experience of having worked with over 1000 clients. CES also acts a collective voice for community energy projects in Scotland and we work to promote the development of, and remove barriers to, community energy in policy, regulation and legislation arenas. CES currently delivers service contracts across Scotland including the Scottish Governments' Community and Renewable Energy Scheme Loan Fund (CARES) and the Big Lottery's Growing Community Assets (GCA) fund, as well as regional contracts.

Role in Project

To achieve the work required at community level in the ARC trial area it is proposed that CES dedicate a team member to work solely on Project ARC activity for the lifetime of the project. From the experience of CES, having a local dedicated Development officer is the best method of supporting locally based activity and community liaison. The current staffing structure is a network of locally based Development officers working across a range of programmes and with a wide number of communities. Given the novel and innovative nature of the work under the ARC project it is anticipated a full time

Development officer dedicated to this project would be required to fully deliver and achieve significant innovation at community level.

What Partner will add to Project

In recognition of the benefits of this project, CES will be providing a benefit in kind of £42k over the duration of the project management staff time to steer the project and development officer training.

Through working with the Scottish Government and highlighting the issues faced by communities in terms of limited grid access we are now administering an Infrastructure and Innovation fund. This fund is currently operational during 2012-2013, and it is hoped will continue given the interest from the community sector in the fund and its ability to assist with:

- Piloting of practical measures such as energy storage and active network management to more closely link local energy demand with local renewable energy generation;
- Supporting and developing working commercial models for community owned generators to deliver renewable heat and electricity to local consumers;
- Delivery of Feasibility /investigative studies for communities wishing to review innovative connection, energy storage or commercial arrangements for their energy needs.

It is hoped that this fund will continue beyond April 2013 and could leverage additional activity for communities within the project timeframe of the ARC project

Prior Experience

CES have delivered support and advice to over 1000 communities across Scotland and are currently assisting approximately 170 projects across Scotland with a combined installation capacity of 216MW as well as been heavily involved in ensuring access to the Orkney RPZ for the 5 community projects which are now contracted on this scheme. In the last 2 years they have been working with the Scottish Government and other industry bodies to increase and driveinnovation on decentralised energy, and are now delivering the Scottish Government's Infrastructure and Innovation Fund and coordinate the Scottish Governments Community Energy DNO working group. CES wish to see more network innovation across Scotland to ensure communities can utilize their local natural renewable resources and so are very pleased to be involved in the ARC project. From this experience, CES will be providing unique expertise in wokring with communities to allow them to fulfill their aspirations and develop novel approaches to network connections for future community energy projects.

How Funding relates to benefits from Project

CES will also contribute to the project with significant management time input, training and expertise from the rest of our team and learning established through our other work on decentralised energy.

Smarter Grid Solutions (SGS)

Relationship with DNO

SGS is a small-medium enterprise. It is independent of the DNO.

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

SGS will support SPD in Workstream 1 by developing methods and tools for assessing available non-firm capacity for a 'live' LTDS and heatmaps. In Workstream 2, SGS will trial the offline use of distribution state estimation techniques for network visibility and develop tools which aid planners in assessing network options.

SGS will provide the control platform and the active network management applications used in Workstream 3 and 4 to ANM-enable 3 GSPs in the ARC network area. These will be delivered as a managed service, in itself a commercially innovative method for delivering ANM.

What Partner will add to Project

A partner contribution of £250k including:

- Project management resource (£50k);
- SGS's test environment (£50k); and
- Analysis tools to aid planners in assessing network options and network visibility tools using distribution state estimation techniques (£150k).

Prior Experience

SGS has unique understanding of the technical and commercial issues involved in the deployment of ANM solutions to manage grid constraints through our deployment of the world's first multiple constraint and multiple generator ANM scheme on Orkney. SGS is a partner in: UKPN's "Low Carbon London" LCNF Tier 2 project; UKPN's "Flexible Plug and Play" Tier 2 project; SSE's "Northern Isles New Energy Solutions" project; and ELIA and ORES's "Belgian East Loop" project.
SGS will bring the experience from these projects and others undertaken with other UK and European Distribution Network Operators (DNOs) to enhance the learning generated by the project.

How Funding relates to benefits from Project

SGS will benefit in a number of ways including:

- Demonstration of new ANM applications. ARC has already identified a number of areas where the scope of ANM could be extended to support the connection of more renewable generation to distribution networks;
- Trials of the use of our SGse as an offline tool to aid network planners;
- Industrial learning in terms of new commercial arrangements of delivering ANM as a managed service;
- Deployment of our platforms in a configuration not previously trialled to demonstrate the management of constraints over different voltage levels;
- Demonstration of the use of ANM as an alternative to complex intertripping;
- Demonstration of how ANM can be deployed on a larger scale using a "top-down" approach rather than in an incremental fashion, as identified in Worskstream3 of the Smart Grid Forum

EoI Process and Partner Selection

Project Partner Identification Summary

This section details the method adopted to ensure the selection of the most appropriate project partners.

Background

To ensure a high degree of project visibility and interest to potential partners, SPD wrote to over 200 organisations via the ENA LCNF database; Smart Grid GB members, Intellect Smart Grids and Smart Metering Group and Utilities Group.

Notice of Interest Documentation

Each potential partner received a copy of the Notice of Interest Documentation which contains the necessary details on the project to produce an appropriate submission. The content of the Notice of Interest Documentation included:

Information on LCNF

- Background information on LCNF including its funding mechanism and purpose

Information on the Project

- Information on what the project will address including the co-ordinated connection**s** application process, the delivery of novel commercial arrangements and the rollout and trial of innovative technology & engineering tools

Details of the current problems faced by DNO's

- Explains the current and future shortcomings of existing technologies and policies associated with the connection of distributed generation including; the effects on connection rates of distributed generation, the adverse effects on our transmission and distribution network and the general lack of visibility of the network.

Information on what is desired

- Interested parties brought forward innovative solutions that they consider could be deployed by network design engineers. These aimed to connect a greater capacity of renewable generation to the existing distribution network without the need for traditional reinforcement solutions. The proposal had to satisfy at least one of the following criteria:
    - A specific piece of new (i.e. unproven in GB) equipment (including control and communication systems and software) that has a direct impact on the Distribution System
    - A novel arrangement or application of existing distribution system equipment (including control and communication systems software)
    - A novel operational practice directly related to the operation of the distribution system

Technical Issues to be overcome

- Lists the technical issues that this project needs to address and solve

The following timescales were stated:

Submission of Notice of Interest from interested parties:	**5th June 2012 (Latest)**
Shortlist of Applicants Notified:	**WC 11th June 2012**
Shortlisted Applicants Invited to Present Solution:	**WC 18-30th June 2012**
Notification of Successful Applicants:	**WC 2nd July 2012**
Second Tier LCNF Bid Preparation & Submission:	**July - 17th August 201**
Decision on Second Tier Project Funding by Ofgem:	**30th November 2012**

Submissions

Each submission was to address the following points:

- Company Information
- Technical, Commercial or Operational Practice Proposal
- Technology Readiness Level
- Novelty of solution
- Indicative Costs & Investment
- Other Relevant Information

Outcome

Over 40 responses to the Notice of Interest Documentation were received. After evaluation, 8 proposals were shortlisted and further discussion led to Smarter Grid Solutions being selected as project partner.

This process highlighted a number of other organisations who will be considered as the other elements of the project are developed and equipment/services are procured.

Appendix 7: Stakeholder Engagement

DG Forum Summary

Introduction

Our primary stakeholders in the ARC project are the commercial developers and community groups seeking to connect renewable generation to our network in the trial area.

This document briefly describes our initial stakeholder workshop, and sets out plans for further workshops throughout the period of the project.

Initial Stakeholder Workshop

The initial stakeholder workshop took place on 18 July 2012, at SPEN's training centre in Cumbernauld, Lanarkshire.

The purpose of the workshop was to gain insight into the experiences of developers and community groups seeking to connect renewable generation to our network.

The workshop was facilitated by SPEN personnel, in collaboration supported by consultants from Engage Consulting Limited (Engage), and included representatives of both commercial and community energy developers.

The workshop was helpful in clarifying views of the issues faced by developers, and some of the reasons why a high proportion of applications for generation connections come to nothing.

Proposed Stakeholder Forum

It is our intention to conduct further stakeholder workshops during the course of the ARC project. We consider that it is important to engage with community energy groups. To this end our partners, Community Energy Scotland, will act as a conduit to the many community groups developing, or considering developing, community energy schemes. Such groups are likely to develop one-off generation schemes, will be relatively inexperienced, and need particularly close support.

We will also work closely with commercial developers, who are likely to provide the majority of the new generation capacity within the trial area.

The workshops will be interactive, with the focus being to facilitate open discussion of issues and concerns, and the two-way flow of information. It is expected that the workshops will yield information that will help refine our approach as the ARC project progresses and inform of development being made throughout the course of the project.

We will develop the content of the workshops in association with external workshop facilitators, and plan to utilise our partners, Community Energy Scotland, wherever appropriate. Each workshop will focus on development within the project and the experience of generators as they develop their distribution connections, and later workshops will seek feedback on the impacts of changes made to the connection regime in the ARC trial zone. We will also seek to ensure that interested stakeholders groups such as Local Authorities, Financiers and other interested parties are also represented throughout the process.

In developing the workshops we will adhere to the following best practice approach:

Facilitation of workshops

- Ensure that there is clarity about the purpose of each workshop and the desired outcomes with an appropriate range of SPD stakeholders.
- Issue an agenda, clear objectives of the workshop, and simple background material to attendees in advance to ensure that all participants are clear on the purpose of the meeting and what is required of their participation.
- Facilitate each workshop to ensure that the key topics are covered in a structured manner and that stakeholder views are obtained as effectively as possible.

Depending on the number of attendees, and structure of the output required we will:

  - Consider breakout sessions where stakeholders have particularly areas of interest or specialisms that may lend themselves to focussing on a specific question or agenda item; or
  - Conduct the workshop in a single session where more general feedback and/or input is required.

In either event it is good practice to have at least two independent facilitators present to ensure good chairmanship, with supporting resource to capture notes and feedback.

- Factors that are key to effective workshop facilitation include: ensuring capture of differing views, respectfully seeking to ensure that everyone's opinion is obtained and ensure that any potential conflict is managed appropriately.
- In collecting feedback, and questioning we will seek to distil common themes or views – judging the importance participants attribute to each topic and the depth of feeling.
- Facilitation materials – such as whiteboards, post-it notes etc. are used as appropriate to aid the process – taking into consideration the nature of the participants and the facilitation style that is likely to be most effective.
- We will always seek feedback on the workshop so that subsequent workshops can be improved and to re-enforce the message that participants' views matter.
- We will record detailed notes and take away completed materials to support subsequent analysis, documentation and facilitate the dissemination of learning from ARC to industry stakeholders. These will be used to produce a record of each workshop ensuring that key points are captured. Each set of records are reviewed by another resource who attended the workshop.

Workshop Records & Reports

- We will design workshop data recording templates at the start of the process to ensure that the information recorded from each stakeholder event is consistent and lends itself to ready distillation of the key information / themes.
- We will design the structure of a final report document in advance of the completion of the process and gain agreement from all interested parties on its appropriateness and that it is fit for purpose to ensure that it covers the purpose, proposals, findings, common themes, issues, conclusions and recommendations.
- We will use the output from the workshops to produce a final report and will adopt an appropriate style, mindful of the need for independence and impartiality.
- The project stakeholders will review the final report in advance of it being submitted as a final document and a final workshop will be held prior to publication with all interested stakeholders to present the key content, outcomes and learning.
- Production of a report following each workshop will enable:
- The project team and stakeholders to track changing views and outcomes throughout the delivery period of the project;
- Provide an appropriate format to inform or act as items arise to disseminate learning from the project to other DNOs and interested stakeholders.

Minutes of Stakeholder Workshop

Introduction

The primary stakeholders in the ARC project are the generation developers and community groups seeking to connect renewable generation to our network in the trial area as well as GB DNOs and National Grid. A workshop supported by Engage Consulting was held on the 18th July 2012. This document describes the initial stakeholder workshop and key findings.

Agenda

- Introductions
- Objectives of Workshop
- SP Connections Proposal
- SSE Learning – What does/does not work?
- Developers Views and Experience

Attendees

- Martin Hill – Scottish Power Energy Networks
- Euan Norris – Scottish Power Energy Networks – **Workshop Host**
- Dave Darracott – Engage Consulting – **Workshop Support**
- Andrew Neves – Engage Consulting – **Workshop Support**
- Ross McLaughlin – Ili Energy Ltd
- Lynn Wilson – Stakeholder Engagement & Communications Manager SPEN
- Felix Wright – Community Energy Scotland
- Angela McIntosh – SPEN Connections
- Tony Callan – Scottish Power Power Systems
- Ken Hunter - MEG Renewables
- Martin Wright – Scottish Power Energy Networks
- Andy Maybury - Community Energy Scotland
- Catherine Birkbeck – Scottish Renewables
- Alan Gooding – Smart Grid Solutions
- Jim Sharpe – VG Energy
- David Ireland – 3R Energy
- Karina Walker – 3R Energy
- Simon Maden – Maden Eco
- Craig Baird – TGC Renewables

SWOT Analysis

The SWOT analysis was completed to understand what the attendees thought of the current connections process managed by Scottish Power Energy Networks.

Strengths

- Timescales are improving but could be better in respect of the connections process
- Customers get money back if the planning application fails
- Average of 42 applications per week shows high level of interest in this area
- The process is straight forward and easy to follow with no risk to the developer as no fee is charged
- Website shows indicative costing
- Informal conversations with SPEN are helpful and valuable
- SPEN are available for regular meetings
- There is a good relationship between SPEN and developers
- Early conversations are held to highlight potential issues/solutions early on

Weaknesses

- Developers don't understand the network constraints and submit applications that end up clogging up the process as there is no cost in doing so
- There needs to be more flexibility around different voltage connections
- The 'last in' method makes investors more nervous around non-firm connections
- Price varies based upon who signs up in the same area (re connections) due to where they are in process
- Process could be clearer around forfeit costs/deposits
- Ability to phase payments does not exist for lower cost connections
- Policy drives the least cost firm connection offer and prevents discussion around other options
- It takes a long time to turn around applications

Opportunities

- Include learning / liaison officer for planning department (planning dept.)
- Allow 100-500kW priority to fill capacity
- Allow 10-15kW (i.e. smaller sites) to top off substations and approve planning quicker
- Apply FITS against planning application
- Investigate smarter solution for 33kV lines
- Rapid response for initial quotes (i.e. internet based model)
- League table of developers for priority service based upon applications vs. deposit
- Provide a monthly/fortnightly update regarding network capacity/design
- Ability to be able to view how the network could look (i.e. a preview page) before formal application is made. This could be fed into the planning application (local gov)
- Demonstrate potential issues describing the impacts of additional capacity
- Show on feasibility report the list of other developers (etc.) involved in the same area
- Provide more information on pricing to enable budget planning
- Connect with local authority (and developers) to determine preferred areas to invest network growth
- Create a (6 monthly?) customer survey to understand where the developer interest lies to support pre-emptive network design

Threats

- Local councils refusing planning applications based on aesthetics rather than understanding the network side of the request
- FITS are banded by generator capacity, changes frequently and is generally out of date on the application when approval is granted
- There are regulatory constraints on SPEN (and the other DNOs)
- Capacity reserved before application /planning is granted and can affect costs massively
- Showing potential connections points could make the process worse by having increased applications based on the 'free space'
- Small amount of applications getting through could result in banks not wanting to finance these types of projects in the future
- There are too many choices (assume confusing?) available regarding build options

Generator/Developer Requirements

The attendees were asked to define the requirements that they have or would like to have as part of the connections process. These were categorised as follows:

1. Connection Offer or Feasibility Study

- Communication with DNO is working
- Connection offer is better and allows you to calculate your own budget

- Feasibility is never accurate and cannot be used as a basis for funding
- Valid application acceptance (i.e. deposit paid) is around 10-15% on connection offers
- Both are required at different stages of the project lifecycle
- Connection offer should be based on having planning application in place
- Offer firm connection with non-firm on top to cope with maximum output

2. Firm Capacity

- Offer firm connection with non-firm on top to cope with maximum output
- Trading Capacity between generators (i.e. 1 has lots and sells part of it to the newcomer)
- Many 850s running at 500 could be a trigger point for SPEN to invest in network re-enforcement and get approval from Ofgem

3. Batched Connections

- Ability to share cost of connection
- Connections could include use of a battery
- Ability to opt out of the new process

4. Shared Capacity

- Collaborative working between operators of renewable schemes (e.g. operating at night vs. daytime) – not allowed to fluctuate output based upon financier requirements
- There are already large scale generators operating on constrained capacity

5. Timely Connection

- Keep history connection applications and make them available to support new connection applications
- Quick turnaround of connection offer is appropriate where planning is already obtained

6. Entire Generation Output capacity

- Re-take capacity back from developers that are not using it after a set period of time
- E.g. 500 capacity is being supplied by an 850 generator

7. Other Thoughts

- More knowledge transfer from SP to developers
- Adopt same forms across UK – currently a massive headache managing them
- Ability to unlock booked capacity that has not progressed after a set period time

Letters of Support

Letters from external stakeholders have been received in support of the project:

Appendix 8: Connections Timeline

Connection Stage	LV Connection	11 kV Connection	33 kV Connection	Post Project Improvement
Pre-Connection Application				Improved network visibility and option to use viability studies
Formal Connection Application	45 days	3 months		Reduced connections timescales due to increased customer visibility
Planning	Dependant on planning authority OHL- 6 months (section 37)			Business as usual
Quote Acceptance	3 months			Business as usual
Wayleaves	1 week to 6 months	4-12 months	6-12 months	Lower asset requirements reducing timescales
Project Start	up 12 months	OHL -24months U/G – 12 months		Improved timescales due to shorter wayleaves requirements
Network Build	1 day to 6 months	6 to 12 months	12 to 18 months	Lower asset requirements reducing timescales
Outages	none	2-4 weeks	Apr - Oct	Reduction in need for 33kV outages
Commissioning	1 day	2 day	1 week	Business as usual
Energisation	Energisation			Business as usual

Note: All timescales indicated are maximum allowed times and may be less in reality

- : SPEN
- : Developer
- : Government
- : National Grid
- : Land Owner
- : Local Authority