ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

Project Code/Version Number:
SPD/EN/01

1. Project Summary

1.1. Project Title	EVOLUTION
1.2. Project Explanation	EVOLUTION will deliver the UK's first trial of the Distribution System Operator concept: demonstrating how operating a localised balancing market can reduce customer bills through efficient provision of services and optimised network performance while facilitating cost effective growth in local generation, demand side response and energy storage services.
1.3. Funding licensee:	SP Distribution
1.4. Project description:	*1.4.1. The Problem(s) it is exploring* The role of the GB System Operator (SO) is to balance supply and demand as cost effectively as possible. Historically, this has been manageable with substantial levels of transmission connected generation coupled with predictable demand. The emergence of low carbon technologies and intermittent distributed generation is changing this paradigm. Most distributed generation connects outside of the Balancing Mechanism and is invisible or uncontrollable by the SO. Micro-generation, particularly PV installations, has increased dramatically and makes demand far less predictable. The consequence is that the SO requires access to greater resources to help balance the system at the same time that they are reducing. It is neither practical nor feasible for the SO to directly manage these resources and the current licence model does not support the DNO performing this function. As a result there continues to be significant discussion across the industry globally about the development of a new entity known as a Distribution System Operator (DSO). The DSO will adopt the responsibility of local management of the network, bridging the gap between the current SO and customers connected to the distribution network. *1.4.2. The Method(s) that it will use to solve the Problem(s)* EVOLUTION will deliver the UK's first DSO trial by adopting a whole system approach of how consumers, distribution networks and system operation can work together to enable a more robust and affordable future energy system. EVOLUTION will develop new commercial relationships between DNOs and customers and between the DNO and SO as well as exploring the technical means by which the transmission to distribution interface can be best managed.

	1.4.3. The Solution(s) it is looking to reach by applying the Method(s) EVOLUTION is seeking to transform 3 Grid Supply Points (GSPs) into a source of dispatchable capacity with the DSO operating a local market for grid capacity and system services. *1.4.4. The Benefit(s) of the project* EVOLUTION will open the balancing market and its income opportunities to significantly more participants whilst reducing system operation costs.

1.5. Funding

1.5.1 NIC Funding Request (£k)	*£6,057.09*	*1.5.2 Network Licensee Compulsory Contribution (£k)*	*£684.07*
1.5.3 Network Licensee Extra Contribution (£k)	*£0*	*1.5.4 External Funding – excluding from NICs (£k):*	*£0*
1.5.5. Total Project Costs (£k)	*£6,840.74*		
1.6. List of Project Partners, External Funders and Project Supporters	National Grid Elexon CGI Smart Grid Consultancy Vodafone Global Energy Advisory		

1.7 Timescale

1.7.1. Project Start Date	1st April 2016	*1.7.2. Project End Date*	31st March 2020

1.8. Project Manager Contact Details

1.8.1. Contact Name & Job Title	Euan Norris Senior Project Manger	*1.8.2. Email & Telephone Number*	*euan.norris@spenergynetworks.co.uk* *0141 614 1964*
1.8.3. Contact Address	SP Energy Networks, Future Networks Dept 3rd Floor, Ochil House 10 Technology Avenue Hamilton International Technology Park Blantyre Glasgow G72 OHT		

1.9: Cross Sector Projects (only include this section if your project is a Cross Sector Project).	
1.9.1. Funding requested the from the [Gas/Electricity] NIC (£k, please state which other competition)	N/A
1.9.2. Please confirm whether or not this [Gas/Electricity] NIC Project could proceed in the absence of funding being awarded for the other Project.	EVOLUTION could not proceed in the absence of support provided through the NIC funding mechanism. The principle reason for this is that it requires the support of industry stakeholders and electricity regulatory Ofgem to be taken forward. At this point a Distribution Network Operator does not have the mandate to test and propose new market rules.

Section 2: Project Description

2.1. Aims and Objectives

EVOLUTION aims to address the current regulatory and grid code barriers to greater interaction between the transmission and distribution system to deliver whole system benefits.

The objective of EVOLUTION is to successfully demonstrate how the use of a Distribution System Operator (DSO), as a neutral market facilitator for Distributed Energy Resources (DER) can:

- Offer market access to currently locked out consumers
- Improve overall visibility and control for system operation; and
- Reduce system operation costs throughout GB

The Problem to be Addressed

The UK energy market is complex in its construction and relatively fractured due to being unbundled and operating with vertically integrated separation. This means that various parties have specific responsibilities over aspects of the complex electricity supply chain but don't necessarily interact with each other in a 'smart' manner. This has created many new challenges in terms of operating the network efficiently. Historic rules and processes associated with the old centralised infrastructure are not fit for purpose as it becomes more distributed. One of the potential remedies to this is to separate responsibilities for operating the network efficiently and effectively using clear demarcation points such as Grid Supply Points (GSPs), creating a system of distributed responsibilities and control. Based upon the existing structure the most obvious separation is at the interface between transmission and distribution.

The operation of the electricity system for the GB System Operator (SO) is dramatically changing. The unprecedented rise of intermittent distributed generation and micro-generation is moving a significant proportion of the UK's generation mix from a few large transmission connected generators to thousands of devices scattered throughout the distribution network. While a few of the larger distribution connected generators require Transmission Entry Capacity (TEC) and join the Balancing Mechanism a significant proportion do not. The cost of integrating a small generator to the Balancing Mechanism is exactly the same regardless of size and this represents a significant barrier to participation.

With less of the generation capacity visible and controllable to the SO at a time when demand profiles are changing, reducing and becoming less predictable due to micro-generation the challenge of system operation is increasing. The challenges are well documented in National Grid's System Operability Framework and are felt in increasing system operation costs. This is a consequence of greater system services being required but available from an ever decreasing population of the generation mix.

EVOLUTION will improve visibility and controllability to the SO by **democratising the balancing services market** to a wider group of consumer participants and DER developers. By introducing a neutral market facilitator, a DSO, the cost of Balancing Mechanism participation will be reduced opening the market and local grid management challenges on the distribution network, including the interaction which Active Network Management (ANM) and non-firm connections can be addressed.

Creation of a new control hierarchy through a DSO is an essential development in the future energy market within the UK.

To provide some context, it is worth considering the state of the art technology in this area and the smaller practical issues that this has identified. For example, the existing SP Energy Networks (LCN Funded) Accelerating Renewable Connections (ARC) project, one of the first to demonstrate coordination across the transmission-distribution boundary, has investigated how the T-D boundary can be managed through tri-lateral contracts between the Transmission Owner (TO), SO and DNO. The ARC project, building on previous Active Network Management (ANM) projects, has demonstrated to date how distribution connected generation can be successfully managed, technically and commercially, to manage technical constraints simultaneously on the transmission and distribution network. However, the ARC project had identified a case where one of the distributed generators who can benefit from an ANM connection has already registered as a BMU. This means that they can be called upon by the SO to provide emergency response however, when they are curtailed by the SO spare capacity locally could be released which will be filled by other existing Non-Balancing Mechanism Units thus failing to achieve the original objective. This and other Balancing & Settlement Code (BSC) related issues are discussed in the Elexon report 'Actively Managed Distribution Generation and the BSC'.

National Grid and SP Energy Networks have worked through this example together and it is being resolved through normal business to prevent any delay to ANM rollout. However, it highlights how a seemingly simple change at one part of the network can have a consequential affect elsewhere.

The challenge becomes greater when the control actions become required for wider constraints and system services with wider commercial implications. It is these challenges that EVOLUTION aims to address, not just for generators but also aggregators, storage developers and consumers. The need for wider system thinking is supported by the IET Power Network Joint Vision group in their report 'Transforming the Electricity System: How other sectors have met the challenge of whole-system integration'. Therefore EVOLUTION is critical to explore these issues and provide guidance as to how the future electricity system in the UK should develop to properly integrate renewable generation into the mix at minimal cost to consumers.

Over recent years there has been extensive discussion about the expected transition of a DNO to a DSO. This has even been a major topic within the Smart Grid Forum's Work Stream 6 and 7 industry groups. In spite of this, there has been little work carried out by UK DNOs to determine the benefits and impact assessment of full DSO capability;

- Scope of responsibilities
- Operational challenges
- Inter-industry dependencies
- Legal and regulatory requirements (systems and processes)
- Staffing and skills
- Stakeholder engagement

The Project Methods

EVOLUTION will develop a DSO concept as a method by converting normally uncontrolled GSPs into a dispatchable source of capacity for the SO. The DSO will register the GSPs as a Virtual Balancing Mechanism Unit (VBMU) or enrol in ancillary services and will contract with the SO to provide a range of system services. The DSO will recruit participants (generators, consumers, energy storage developers and aggregators) for services which they will then dispatch and instruct in order to deliver the response required by the SO. In doing so, the DSO will ensure that technical network constraints on the local network can be kept within operational limits. It is the requirement to deliver licence conditions requiring visibility of the local network

conditions why the DNO, as opposed to an unregulated participant, must perform the DSO role.
Where there are existing Balancing Mechanism participants behind a GSP, offering services as BMUs individually or via an aggregator, the project will look to incorporate them into the local DSO market. This will allow a market for local, distribution level services to also be developed whilst coordinating the demand for system services across the transmission-distribution operators. Where a BMU without an ANM connection wishes to continue a direct relationship with the SO then that will be accommodated but they will be unable to benefit from non-firm connections and local balancing market services being facilitated by the DSO as a neutral market operator.

As the general principles of the trial are largely commercial rather than technical, much of the methods will involve stakeholder engagement and consultation to establish what is feasible and acceptable to current market actors. This is expected to include Ofgem itself due to the regulatory interaction between system operation and industry regulation.

There will however be some operational aspects and systems that will require to be developed. A significant learning outcome from EVOLUTION will be the requirements of the BMUs at the GSPs to link into National Grids expected Energy Balancing System (EBS) to facilitate automation of signals and response or participate within non-BM ancillary services. Due to the uniqueness and innovativeness of EVOLUTION, lack of prior precedent and predominant association with commercial factors, any innovative technology testing will relate to systems development and integration.

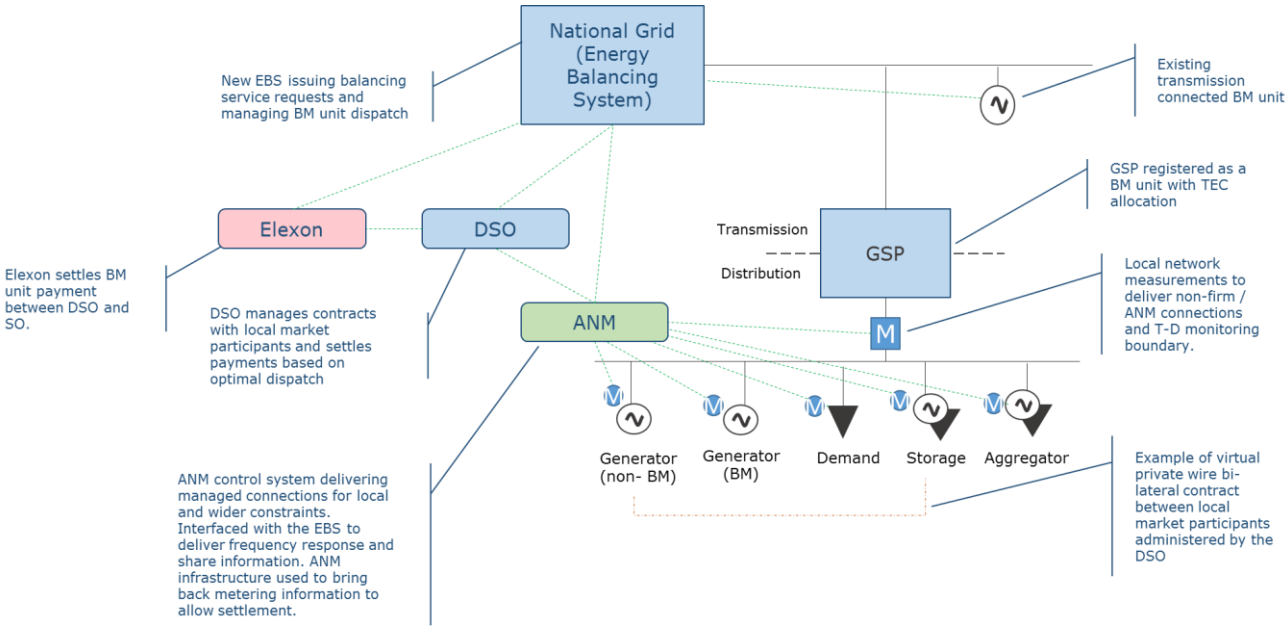

Figure 1. Technical Method for EVOLUTION Trial

The diagram (Figure 1) above describes the proposed technical method for the trial. ANM is used as the control and data infrastructure to enable the market by delivering ANM connections, interfacing with the SO control room and the DSO. The ANM system will pass on dispatch signals generated by the DSO and ensure that delivery is coordinated with emergency actions initiated by the SO and local network constraints. The ANM system will meter the response from participants allowing the DSO an audit trail of the response to dispatch signals and for settlement. The EBS will issue the DSO, as a VBMU or Ancillary Services Aggregator (ASA), with service requests and the DSO will have bid to provide those services along with other market participants. The

metering via the ANM system will be fed back to the DSO in order for Elexon to settle the payment for the SO service request.

The project will also consider how more local balancing markets can be delivered through community schemes, bi-lateral contracts (sometimes known as virtual private wire) and energy storage. The DSO would become the local market facilitator and would meter and settle the services as contracted.

The commercial methods to be trialled using the DSO concept and required by the SO will be:

- Turn down services
- Turn up services
- Frequency response
- Reactive power management
- Outage management (which may be physically delivered as turn down or turn up services)
- Virtual private wire
- Local balancing to a dynamic TEC

To deliver the proposed model a raft of new commercial contracts will be required between the SO and the DNO/DSO and between the DSO and local participants. We believe that this approach is most consistent with the industry and market structure within the UK and we do not believe that this will have any detrimental effect on existing market operation. We believe that any effect will be positive through the enablement of additional competition.

By carrying out EVOLUTION, SP Energy Networks will develop new relationships with the customers connected to the distribution network with a view to understanding their needs and how they can potentially participate in a 'smarter network' operation. In some cases this could result in working directly with sites and service providers including aggregators to reduce energy consumption, modify behaviour and optimise the efficiency of the network operation. By pragmatically doing this across the full supply chain from the overall system operation, through transmission, distribution and finally connected customers it is expected that the trial will achieve a greater positive impact than if a single stakeholder were to attempt to implement unilateral changes.

As the electricity supply networks become more active there is a necessity to consider how the control hierarchy should be developed in order to ensure that they are operated in a 'smart' manner. In order to carry out a comprehensive trial that reflects the complex nature of the current arrangement and avoids over simplification the SO and TOs must be involved.

The Solution

The solution that the methods are attempting to achieve in 'simple' terms is the devolution of certain aspects of system operation to the DNO, operating as a DSO by controlling assets connected at distribution voltage levels to assist in overall system operation. The DSO, with unique understanding of the local network and access to the distributed customers is no longer merely an asset management organisation but one that operates as a neutral market facilitator ensuring that a much larger base of customers and resources can participate in a wider market.

EVOLUTION is seeking to identify the critical aspects of the current system structure, both technically and commercially, that require to be altered in order to establish a transition to a new topology where the DSO takes responsibility for aspects of the live operation and balancing of localised markets. The local market will be operated in order

to achieve the greatest possible efficiency, driven by known and well understood system services, allowing the DSO to operate as a far more commercial entity than when only fulfilling DNO licence obligations.

Such a solution will ultimately open up new revenue streams for market participants of multiple scale and ultimately reduce network costs to consumers.

2.2 Technical Description of Project

A detailed breakdown and technical description of the project is provided in Appendix C. The Technical Description document holds information on related LCNF projects, project background and details of the proposed trial.

2.3 Description of Design of Trials

Work Package 1: Market & Technical Design

WP 1 is focussed on developing a Market and Technical Design Report identifying beneficial new control and financial hierarchical systems that enhances the current arrangements for National balancing services, whilst taking into account transmission and distribution network operations and energy trading. It is the intension of the project to develop an open architecture that will allow the DSO systems to be tailored to ensure broad deployment in different locations and customer mixes. Also detailed was the need for a new low cost, high reliability inter-participant communications system which will be developed with our strategic communications provider (Vodafone). Critical to such a deliverable is the ability to interface directly with customer assets or aggregators' in order to provide visibility of participant sites and execute any dispatch and cease instructions.

The report will seek to explore and develop the following areas over the implementation of a distribution system operator;

- Agree design of process, communication and financial flows with TO & SO to delegate decision, dispatch and financial settlement of assets to DSO.
- Participate in National Grid's industry engagement and share knowledge to inform proposed service revision and new service design activities.
- Identify and engage key customers and aggregators with DSR participation potential. Develop customer proposition and financial benefits analysis.
- Agree design of process, communication and financial flows with DNO / Control Room for network optimization services, including coordinated assessment with the proposed upgrade to NGET EBS - Energy Balancing System (due for release 2017).
- Support to Technical Architect in development of systems to integrate with
    - Downstream customers via Vodafone communications solution
    - Upstream systems with TO / SO and DNO
- Support Technical Architect in the design of
    - Customer monitoring and dispatch systems
    - Back office (performance assessment and financial settlement)
- Authoring of bilateral contracts to detail and agree relationship responsibilities and performance expectations between parties involved in DSO trials.
- High level design of customer monitoring and dispatch systems

- High level design of 'Back office' (performance assessment and financial settlement)
- Establish technical requirements for integration with external systems
    - Customer assets
    - SO / TO Legacy systems
    - SO / TO systems / service updates
    - DNO control room / ANM systems
    - Proposed energy trading facilities

The diagram in Figure 2 demonstrates the market design process. The outcome of the trial is likely to suggest improvements or alterations that can be made to the market design before future rollout.

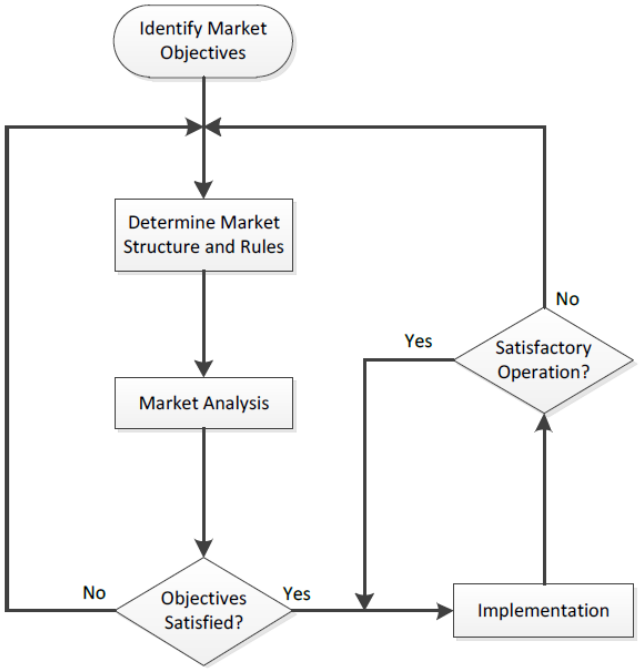

Figure 2. Market Design Process

The market design will be analysed using computation techniques commonly used in the electricity industry to test the design and identify any issues which may arise during market operation. This will allow the market design rules to be changed if required in order to further improve the DSO market.

Work Package 2: Stakeholder Interface

WP 2 will involve engaging with key representatives from industry stakeholder groups relating to generation, aggregators, suppliers, storage providers, distribution network operators and energy trading companies to gather views and any concerns relating to the potential impacts of trialling the DSO model in the UK energy sector. The Stakeholder Interface Report will also seek to bring together key industry group members including OFGEM on a quarterly basis who will review the activity of the market design work package (SDRC 1) and provide feedback on its development.

The project team will deliver a Stakeholder Interface Report addressing the following concerns raised by the Expert Panel;

- Any likely conflicts or synergies between market actors and the magnitude of expected actions.
- Assess the appetite for change that allows access for distribution connected customers to participate in a new market mechanism for trading rather than through exiting parties
- How any trading proposal will relate to other changes that are already confirmed and will be taking effect including P306 and the capacity markets?
- Who are the winners and losers?
- Identification of the appetite for distributed energy resource wishing to connect within the identified trial area of East Kilbride

To address these concerns, the project team shall actively engage on the following areas to inform the Stakeholder Interface Report;

- Engage with the UK National System Operator (NGET), transmission / distribution network owners, major energy users, traders and suppliers to consult on proposals
- Engage Elexon in high level design of processes and system / market developments necessary to facilitate energy and local balancing.
- Provide detailed feedback of views and in particular any concerns raised in relation to market impact and expressions regarding 'winners and losers'
- Support Technical Architect in the design of an open interface to facilitate actions in collaboration with external energy trader systems.
- Carry out market analysis of P305 impact on existing market impact and provide professional view of any influence this may have on DSO service proposals.

Work Package 3: Ofgem Consultation Report 'Funding Gate'

WP 3 will commence upon completion of WP 1 & 2, a report shall be produced consolidating the key outputs from each report. The purpose of WP 3 shall be to provide OFGEM with a holistic and detailed needs case, supported by a broad and diverse range of industry representatives around the DSO model, including but not exclusive of market platform, technical specifications and payments hierarchy.

Work Package 4: Identify Service Providers

WP 4 will identify service providers for the DSO market. Based on the outcome of WP 1 and 2, a procurement process will identify participants in the DSO market.

Key tasks in this work package include:

- Implementing processes from Work Package 2 to recruit market participants that may have been identified as an output from Work Package 1.
- Identify which market participants are willing to participate in which elements of the balancing services e.g. turn up, turn down, frequency response, reserve etc.
- Implementing processes from Work Package 2 for solicitation services to National Grid Energy Balancing System (EBS)

Work Package 5: Build and Test

WP 5 will pull together all elements of the first four work packages and implement all designs into the trial area. Tests will be carried out before the DSO market is permitted to go live. Continuous improvements will be applied to processes based on customer feedback during the trial.

Key tasks in Work Package 5 include:

- Implementing designs for alternative responsibilities, financial and data flows incorporating DSO
- Implementing designs for new systems incorporating DSO, SO and customers
- Engaging with customers within trial area
- Establishing operational services capability in conjunction with SO
- Testing National Grid Interface
- Testing external interface to distributed assets / participants
- Go-Live
- Establish

Work Package 6: Evaluation and Dissemination

WP 6 will provide evaluation of the trial, knowledge dissemination to wider industry and provide recommendations to industry based on trial results.

Key tasks included in this work package include:

- Monthly performance reporting in parallel with operational phase
- Knowledge dissemination
- Producing comprehensive reporting of impact analysis
- Closedown report and recommendations to industry

2.4 Changes Since Initial Screening Process

Since the submission of the ISP, we have engaged with a number of stakeholder and market participants. National Grid and Elexon were approached in order to establish their involvement and support within the project as this was critically important in order to be able to develop workable systems and support for alternative control and commercial arrangements to customers within the trial zone.

A letter of support from NG as well as a further letter confirming that they do not see any critical regulatory issues that prevent the trial proceeding have been provided and are included with the submission.

Elexon have confirmed their role as a key stakeholder within the project definition stages and as a participant in the later stages where there is increased likelihood that a DSO service will require to incorporate financial settlement.

Vodafone were approached to take on responsibility for development of a new M2M communications solution that will enable low cost communication to sites that will serve as active participants within the DSO trial operations.

Section 3: Project Business Case

3.1 Context

The cost of balancing the electricity system will continue to rise if the SO continues to operate within an environment where it has limited visibility and rising uncertainty over GSP load profiles coupled with insufficient resources under its influence to deliver the required balancing and ancillary services. One solution to this problem could be to extend the role of the SO. However, an expansion of direct SO influence into the distribution system, beyond its present arrangements, is not desirable as it could at times impede the DNO from fulfilling its obligations, leading to financial penalties.

The more appropriate alternative is the creation of a new market mechanism, administered by the DNO, which continues to allow the DNO to meet its licence obligations, but also provides the SO with greater visibility and influence over GSP import and export energy transfer. EVOLUTION will register 3 GSPs as a VBMU or ASA and will provide balancing and ancillary services to the SO. Service provision will be achieved through the procurement of similar services from resources connected downstream of the GSP by the DNO. A fair and transparent local distribution services market will be designed during the project so as to allow the DNO to act as a neutral DSO across the trials zone and eventually across multiple GSPs in its licence area.

EVOLUTION will;

- Demonstrate the collective benefits that local and coordinated wider system balancing will deliver to GB plc
- Quantify the market size for local balancing and network services
- Align with SP Energy Networks RIIO-ED1 business plan and longer term strategy
- Facilitate market penetration of energy storage and demand side response services for all market participants.

The project is a first of its kind in the UK and is therefore highly innovative for the UK. The success of this project could potentially accelerate the most significant progression of the energy industry since privatisation.

3.2 Balancing Services Market

The table shown below (Figure 3) has been extracted from the Monthly Balancing Services Summary published by National Grid in April 2015. What it shows clearly is that the balancing and services market value is close to £1 billion annually. This market therefore represents a significant opportunity to new participants. The size of the market that could be captured by a single BMU will depend greatly on its locational and temporal characteristics.

Ability to earn revenue from constraint payments is largely down to a BMU's location on the network, capacity and therefore its ability to solve a location specific problem. There have been a number of high profile examples where this has resulted in BMUs in heavily congested areas of the network receiving large constraint payments because of limited competition for provision of those services in that particular area. Other temporal characteristics such as speed of response and coincidence of availability with problem times of the day also significantly impact on potential revenue.

There is the very real possibility within a competitive market of being continually outbid by less expensive alternatives, this is where EVOLUTION seeks to drive benefit and value to GB plc through development and operation of a local balancing and services market. Therefore any new revenue streams for both DSO market participants and DNO should be treated as supplementary to primary sources of revenue, as should be the case for

existing BMUs. However, having a DSO opens up a market at appropriately located GSPs to a much greater number of participants located under each GSP and will result in more competitive supply of services.

Simply having this increased competition and therefore greater supply of service providers should drive down system balancing costs, which is of major benefit to all customers. The variety of resources at the disposal of the VBMU/ASA could eventually make it the most competitive source of balancing services available to the SO. Ultimately, due to its nature, it is very unlikely to result in payments being concentrated amongst one or two market participants based solely on size and location of resource.

2015/16 £m	A. Year to Date Total Cost	B. Year To Date Target	C. Year to Date Latest Cost Forecast	D. Year to Date Initial Target Forecast	E. Projected Total Cost for Year (Cost Outturn + Latest Cost Forecast)	F. Projected Scheme Target Total (Year 1)	G. Initital Forecast for Year
Energy Imbalance	-£14.0	£0.0	-£4.4	-£14.3	-£47.8	£0.0	-£94.0
Operating Reserve	£5.9	£0.0	£4.9	£16.9	£86.8	£0.0	£174.8
BM Startup	£0.0	£0.0	£0.0	£0.5	£2.7	£1.9	£4.8
STOR	£2.9	£0.0	£4.4	£6.5	£62.1	£0.0	£82.8
Constraints - E&W	£5.9	£0.0	£14.2	£58.5	£296.1	£0.0	£610.9
Constraints - Cheviot	£3.0						
Constraints - Scotland	£4.8						
Footroom	£0.3	£0.0	£0.7	£0.2	£10.2	£0.0	£15.6
Fast Reserve	£8.6	£0.0	£11.0	£11.8	£124.6	£0.0	£148.9
Response	£15.6	£0.0	£14.5	£18.6	£177.7	£0.0	£213.4
Reactive	£6.7	£0.0	£6.7	£7.1	£72.2	£0.0	£87.8
Minor Components	£4.2	£1.7	£3.0	£3.8	£40.6	£21.4	£51.8
TOTAL	£43.9	£1.7	£55.0	£109.5	£825.2	£23.2	£1,296.8

Figure 3. National Grid "Monthly Balancing Services Summary 2015/16", April 2015

3.3 New Revenue Streams

Revenues generated by the VBMU/ASA will in the first instance go towards settling payments to DSO market participants for services provided. This will open up an entirely new revenue stream for a greater majority of Distributed Energy Resources (DER). Some DER do participate in the balancing services market today, chiefly Short Term Operating Reserve (STOR), however this is severely limited in terms of overall balancing services market share, as quantified above in Figure 3.

Most DER are prohibited from directly participating in the balancing services market due to their lack of scale. In Scotland there are large generators already connected to the

distribution network under a contract with the SO called a BELLA. Under the terms of the BELLA contract, those generators elect not to participate in the Balancing Mechanism due to the high cost of participation. Having the DNO/DSO administer this local DSO market at the GSPs allows for aggregation of smaller units and the cost burden of enrolling as a VBMU/ASA to be borne initially by the DNO and then socialised across market participants over time. This represents the removal of another significant barrier to market entry making a stronger business case for DER to participate.

Customers participating in this market will have the opportunity to capture the full value of their DER and the benefits it can provide to system operation. This additional source of revenue for the DER provider should also lead to a reduction in the reliance on subsidies for low carbon technologies entering the energy sector.

A key learning from EVOLUTION will be to understand how the DNO, by performing this DSO role, would expect to receive compensation commensurate with the value of the service it is providing as the market facilitator. How the DNO conducts its market trades, the mark-up applied to services which it is buying and selling, cost recovery over time and any profits extracted from this new market participant will be the subject of scrutiny during the execution of the project, in addition to the benefits it realises for DER providers.

3.4 Continuation of Active Network Management Rollout and Enhancement Through New Distribution Balancing Services

DNOs have already, principally through Low Carbon Networks Funded projects, invested a significant proportion of customer money in the development of Active Network Management (ANM), the benefits of which in lowering carbon emissions through facilitating cheaper and faster connection of renewable generation are now very well understood. However the advent of ANM and how it interacts with the existing Balancing Mechanism is something which must be considered as DNOs seek to develop ANM on a much wider scale across the distribution network.

As it is predominately low carbon technologies that connect to the distribution network through an ANM connection, curtailment has a quantifiable cost to society in terms of lost CO_2 reduction as well as lost revenue to the owner of the generation unit. In addition to ANM connected generators under a GSP, there are non-ANM connected generators who can also be parties to the Balancing Mechanism. These units can be curtailed for long periods of time so as to allow DNOs and Transmission Owners (TOs) to take outages on their network. These outages are critical to the ongoing maintenance and operation of the national infrastructure however the resultant lost CO_2 reduction and lost customer revenue is becoming so significant as to warrant greater investment in finding a resolution.

Anticipating that in future the situation will become unacceptable to customers or that DNOs may be required to compensate curtailed generation now is the time to investigate ways to reduce this potential impact. By going to the effort of investing in the creation of a DSO market to facilitate the VBMU, the DNO creates significant opportunity to expand this to new distribution network focussed balancing services. Or, use the infrastructure to administer bi-lateral contracts between disparate DER, in a virtual private wire arrangement e.g. a wind farm could procure energy storage to avoid or limit curtailment during a network outage or at times of low demand.

The expected result of EVOLUTION is therefore, further additional revenue for DER, reduction in lost revenue to generators and increased CO_2 reduction. The DNO would similarly expect compensation for facilitating this service and the SO would have greater visibility of assets connected under a GSP.

3.5 Case Study: East Kilbride South GSP

East Kilbride South GSP has been chosen as one of the three to host the EVOLUTION trial because it is presently at full capacity under normal design conditions as a consequence of the large volume of renewable generation connected and contracted. The GSP has over 80MW of connected generation with an additional 26MW contracted to connect. The penetration of embedded generation on the distribution network means relatively small generation projects are unable to connect ahead of major reinforcement works being completed. No reinforcement works are planned and therefore no more capacity will be released at this time. The export profile of East Kilbride South GSP in 2014 is shown in Figure 4. The maximum generation exported from East Kilbride South GSP was 59MW on 11th August at 3am. The maximum demand imported at the GSP was 14MW on 2nd July at noon.

The network which is fed from East Kilbride South GSP offers a good mix of urban and rural areas as well as suitable variety of industrial and commercial premises. It is also significantly different from the adjacent GSPs, East Kilbride and Strathaven which combine to make up the trial zone. We consider that this area offers greatest potential to facilitate growth in demand side response by engaging with local industrial customers some of whom have already been identified.

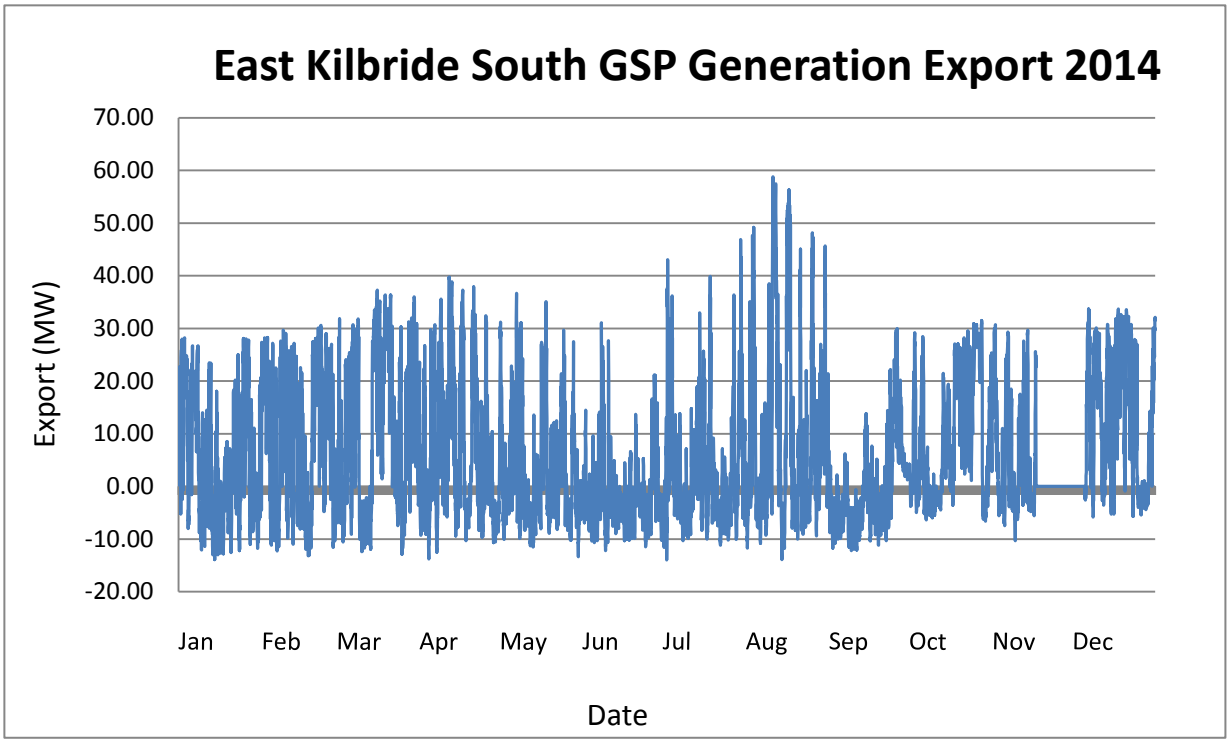

Figure 4. East Kilbride South GSP Export Profile 2014

A full overview of the East Kilbride trial area is provided in Appendix G.

To allow essential maintenance to the network, there are a number of outages scheduled for East Kilbride South and the electrically connected Strathaven GSP in 2015 which will require up to two generators connected under East Kilbride South to be constrained to around 10MW each. These wind farms will be constrained for at least 65 days in 2015 and this will continue to rise in each of the following years during the trial. Having reviewed the last three years of wind data it is estimated that the affected wind farms could see a potential loss of revenue due to these constraints of between £300k - £400k

in 2015. Once further wind farms connect, constraints at East Kilbride South could result in projected loss of earnings to customers of at least £1million every year.

It is our view that the diversity of customer type and infrastructure within the trial zone will provide results that will be applicable throughout the other DNO regions across the UK, offering a valuable opportunity to the entire industry.

Benefits

EVOLUTION will seek to deliver the platform for a local energy market model that will make significant contributions towards the overall system operation efficiency, reducing cost to consumers whilst generating new income for market participants from provision of new services. These could include participation in the National Balancing activities which are currently the responsibility of suppliers trading activities, up until trading ceases at 'gate closure' when the final adjustments are made by the GB System Operator (SO).

Current participants in 'system balancing' activities do so for commercial gain and receive a combination of payments for different services that are provided to support SO activities. There are existing procurement mechanisms for 'ancillary services' that in many cases exist between suppliers, SO and distribution network connected assets. By migrating to a Distribution System Operator (DSO) model it is expected that many of these ancillary service arrangements would be devolved and the DSO would undertake the responsibility of both local market balancing and upstream interactions to support the national network balancing. By introducing the increased understanding and operational control of an active local network/market, it should be possible to minimise conflicting actions that currently occur through autonomous operations whilst opening up the market to provide services to a new group of participants locked out of current arrangements.

The major benefits of EVOLUTION are expected to be:

- Reduced cost of UK system operation through more efficient balancing and elimination of conflicting actions
- Facilitation of increased connection capacity of distributed/renewable generation
- Reduction in constraint management and inter-tripping of distributed generation
- Reduction in cost of operating distribution networks
  - Reduced system losses
  - New commercial service opportunities for distribution connected consumers and generators
  - Improved response times for outage restoration
- Increased system resilience
  - Reduction in outages
  - Improved response times for outage restoration

An important benefit of undertaking EVOLUTION is that it will provide a focal point for critical learning required for the future of the UK energy industry, informing the debate on topics such as to how a DSO model would require to operate be licenced and incentivised. Some questions that EVOLUTION would seek to answer include:

- What commercial arrangements and contracts need to be put in place:
  - Between SO/DNO?
  - Between SO/TO/DNO?
  - Between DNO and service providers (consumers, aggregators, communities)?
  - Between consumers and service providers underneath a GSP?

  For the following system services:

  - Reactive power control
  - Turn up
  - Turn down
  - Frequency response
  - Local system balancing

  To help with issues such as
  - Outage management
  - Boundary congestion
  - System balancing
  - Virtual private wire (where local contracts are struck within communities to create demand when renewable generation output is highest or constrained)
- What price should a DSO pay for these services?
- How would a DSO be technically delivered? For example
  - What the mechanism should be for metering/settlement?
  - What should the hierarchy of control be for a system of systems?
  - How can better coordination between entities improve outage management?
  - What should happen with existing BMUs under a GSP? Should they novate to DSO control from direct SO control?
  - How predictable can GSPs be as a dispatchable VBMU/ASA?
- What changes would be required to the grid code to enable DSO implementation?
- What would be the licence implications for the SO and DNO?
- Where should the boundaries of regulated and unregulated entities lie (noting the recent Eurelectric Conclusion Paper on the Future Role of a DSO, 13 July 2015)?
  - For example, how could the existing SO licence, obligations and incentives be adapted for application to a DSO?
  - How should the costs of a DSO be recovered?
- What distribution level services could supplement the marketplace?

Section 4: Benefits, Timeliness and Partners

4.1 Summary of Benefits

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

EVOLUTION will, through the deployment of its innovative solutions and development of a local market for DSO services, have a positive impact on both SO and Network Licensees. Benefits include:

- Opening up the balancing market to allow a larger number of smaller customers to participate. This will democratise the balancing market and allow generators to not just sell energy, but services as well.
- Increasing the number of participants in the balancing market will introduce greater competition, bringing down the cost of services. This will reduce system operation costs and ultimately provide benefit to customers.
- Participation in the balancing market will allow distributed generators to capture the full value of their offering and further promote low carbon technologies. This will reduce reliance on subsidies to be profitable and strengthen the business case for low carbon technologies.
- Increasing the number of participants in the balancing market will provide more levers for the SO to manage the system. This will ultimately reduce risks to system operation by ensuring a higher degree of controllability.
- The creation of a market offering balancing services at distribution level can provide more options to generators when the DSO is managing outages. This can have benefit for generation customers and increase production from low carbon technologies.
- Ensure that managed connections can be adopted on a wide scale. This will provide the opportunity for more low cost and accelerated connections for distributed generation that are subject to technical network constraints.

Due to the nature of EVOLUTION, there will be no direct benefits to SP Distribution during the trial. The project focuses on wider system operation and aims to provide valuable industry learning which will assist in future facilitation of low carbon connections and meeting renewable energy targets.

The Carbon Plan is committed to dramatically increasing the amount of both renewable generation and low carbon technologies. This is having a significant impact on distribution networks throughout GB. Additionally, in Scotland alone, the Scottish Government has set out targets for at least 500MW of local and community based renewable generation projects by 2020. The UK is also facing the challenge that a significant proportion of its existing power station capacity will reach the end of its operating life by 2020.

Decarbonisation policy demands rapid and substantial increases in low carbon and renewable energy generation. The very nature of this type of generation presents sizable and new technical and commercial challenges to the UK system. Whilst clean and environmentally friendly, renewable generation is generally less flexible, more intermittent and often independently operated by comparison with traditional centralised electricity generation. This makes renewable energy harder to manage within the overall structure of the existing centrally controlled system, and balance the level of electricity demand with supply. In addition, the UK will see certain sectors, in particular heating and transport becoming more reliant on electricity, thereby potentially increasing overall demand and demand model volatility.

The smartening of distribution networks will bring significant benefits to network operators and customers connected to them. The UK is now at the critical stage where considerably greater effort is required to enable those advances in technology to operate within localised economic energy markets. Distribution networks now have many more critical points to be monitored and managed with several objectives that can be in conflict with each other. These include the safe operation of the networks, maximising renewable generation, minimising capital investment and planning for future requirements. Distribution networks connect the majority of customers, large industrial and commercial energy users, as well as distributed generation; therefore the advent of the DSO is now critical to manage the many drivers as well as interaction at a local level between customers and national system operation.

EVOLUTION will facilitate further growth in the connection of renewable generation and create an economic led market for energy storage and demand side response services at a distribution level as part of the UK's long term commitment to reducing the emission of greenhouse gasses and meeting EU 2020 renewables directive.

National rollout of the DSO model across GB is expected to reap substantial environmental and financial benefits to GB customers through the continued avoidance and deferment of network reinforcement and reducing system losses. Greater balancing of local systems using innovative commercial techniques will minimise the need for unnecessary network reinforcement and lead to more targeted DNO and TO investment.

A DSO controlled local balancing mechanism will reduce connection costs in areas of intermittent network constraint, typically caused by correlated distributed generation. Applying local balancing between generation, demand and energy storage under a VBMUwill provide a cost efficient solution to maintaining a fit for purpose electrical system without the need for significant investment in new infrastructure.

Building upon SP Distribution's successful Accelerating Renewable Connections (ARC) project, we recognise that National Grid in their role as GB System Operator (SO) does not have visibility of actions taken by existing Active Network Management (ANM) schemes. Operating at distribution voltages, the ANM systems see available network capacity and release to those connected under a GSP. This leads to National Grid taking additional actions and paying additionally for that service. Whilst ANM has been successful in accelerating access to the grid, managing generation and demand based upon physical network constraints, it alone will not benefit the UK's transition to a low carbon economy in the longer term. This is just one example of the type of issue that can occur when the SO or TO bypasses the distribution network control to carry out actions bilaterally.

EVOLUTION is the natural next step to build upon the success of ANM and will enable the movement of power and balancing of generation and demand based upon economic market signals as opposed to just physical network capacity constraints. Furthermore EVOLUTION will seek to develop the principles, processes, operating policies and overall foundation to develop a DSO model within the UK that has full balancing responsibilities for the energy market under a GSP, to enable delivery of wider energy system benefits. This will bridge the gap and improve visibility of constraints that currently exists between distribution networks and the SO.

EVOLUTION will harness the cumulative effect of small scale generation, industrial loads and penetration of low carbon technologies connected to the distribution network to deliver social, environmental and economic benefits at the local level. This will not been done in isolation, but whilst supporting and offering services to National Grid in its national balancing and outage planning obligations.

4.2 Value for Money to Electricity Customers

Response to (b) Provides value for money to electricity distribution customers

EVOLUTION is seeking to create a new localised energy market by delivering new processes and commercial structures; where the benefits realised from EVOLUTION will be both qualitative and quantitative. Development of a DSO model will not detract from the current DNO licence obligations of focussing on maintaining a safe, reliable and resilient network. It should also bring with it, associated benefits from improved efficiency throughout the operation of the GB energy system as a whole.

- Local market management will be coupled with improved visibility of the local conditions and enhanced forecasting. By doing so the local arrangements should eliminate some of the expensive contingency measures a centralised GB System Operator requires to procure. National Grid has limited data for distribution connected assets and individual demand patterns so are therefore required to over procure services to manage this uncertainty.
- Future requirements for increased balancing services capacity will create an unnecessary competitive market between DNO and TO/SO if there is no alteration to current arrangements. Ancillary services and general access to demand side capacity is contracted on an exclusives basis, meaning use only for DNO, TO or SO due to contractual restrictions. By placing the asset under the management of a DSO and allowing them to then serve contracts to other parties it will eliminate unnecessary competition and enable cost sharing.
- Many of the new technologies being developed as part of the Smart Grid are tested and operated in trial conditions that do not reflect the way that a DNO currently operates and assumes a more DSO type of operating environment. Many of these technologies will only achieve their full potential through a dramatically modified operating environment that necessitates enhancements to the local management capability. This is not necessarily just limited to technical restrictions and is in many cases more appropriate to market restrictions. A prime example of this is energy storage which can currently only be used by a DNO for managing power flows and flattening demand profiles. Unfortunately the value of such services is not sufficient to merit storage in almost all circumstances, and energy prices are not high or volatile enough to stimulate private ownership in suitable locations. If a DSO was able to participate in markets as well as manage network conditions using storage assets the result would be symbiotic and potentially offer the economies of scale and service flexibility necessary to support their business cases.
- A DSO model where connections and markets operate together would open up further opportunities to address growing market issues. Currently incentives for renewable generation are provided on a flat structure regardless of local demand and needs. This is creating issues with inappropriate siting of large scale wind and solar farms that require large scale capital investments to resolve. A local market with appropriate long term forecasting could be used to address some of the locational demand and supply conflicts that are occurring and incentivise arrangements that support appropriate whereabouts of generators, storage and demand.

Currently the SO has direct contractual relationships with large embedded generators (defined within SP Distribution's electricity licence area as equal to or greater than 30MW) connected to the distribution network. These have a BEGA or BELLA contractual arrangement governed by the Connection Use of System Code (CUSC) that allows National Grid to reduce or cease the output at a generation site.

EVOLUTION will create efficiencies within that process whereby the customer will be able to provide the same services and be obliged to perform the same duties as required under the BEGA and BELLA agreements however their interface will be with the DSO as a

single contracting party. The DSO will hold a separate balancing and settlements obligation with the SO.

EVOLUTION will ensure that those contractual requirements can not only be executed, but also optimised to the benefit of all market participants. This will be a positive development in market structure that is advantageous to stakeholders including the SO, by being managed within a local balancing market. An additional benefit of proving the DSO concept through EVOLUTION, will be that the SO will contract with a limited number of DSOs, reducing the inevitable complexity and challenge of developing single centralised systems to communicate with vastly increased numbers of smaller sites. By taking over management of distributed sites at a local management level, the DSO arrangements should stimulate entry to new market participants to provide services and gain from a local energy balancing and settlements market.

In a recent report commissioned and published by Elexon entitled, Actively Managed Distribution Generation and BSC Quantitative Modelling, it was forecast that annual local balancing actions will reach 1TWh by 2023, all of which will be invisible to the SO. In addition, the report estimated that local balancing markets integrated with national system balancing could deliver an estimated reduction in constraint payments issued by National Grid seen today by between 5%-45% dependent upon the demographic of the local network.

The Elexon report referenced considered annual data covering 2012/2013. During the period, National Grid reported in the order of £169.6m in GB transmission constraint payments, of which £35.4m was identified as alleviating network constraints or issues (covering both constraint management and system rebalancing) across the Scottish Transmission boundary B6 (Anglo-Scottish Interconnector).

In 2013/2014, National Grid reported £339.9m in GB constraint payments (£52.4m for constraint management and £287.5m for system rebalancing). Further breakdown of these figures show that £90.1m was reported to alleviate network issues associated with the Scottish Transmission boundary B6, more than double the previous year.

Therefore based upon this independent analysis and evidence of the trend of increasing constraint/system balancing payments, the Elexon report referenced above, identified that the use of flexible resources under a targeted GSP, and the effect that this would have on transmission constraints and balancing alone, would equate to approximately 7% saving on constraint and system balancing payments. Based upon the 2013/2014 data, this would equate to a saving of **£6.3m** per annum based upon the £90.1m reported to alleviate network problems associated with the Scottish Transmission Boundary B6.

The work undertaken by Elexon also considered the affect that the introduction of ANM is having following deployment by a number of DNOs and it estimated that annual curtailment activity equates to between £0.5m-£2.0m per annum in lost revenues which are borne by the actively managed customers. The report went on to estimate that the impact of new managed connections under a singular GSP could equate to lost revenues (as well as curtailment and loss of renewable energy) of up to £10m per annum.

The DNO role has been developed primarily on the principle of managing assets and providing a passive conduit to the flow of energy for a centralised generation system. Traditional network topology has both transmission and distribution functions not only passive but with a single direction of flow carrying electricity from large and often remote generation to consumers. Consequently infrastructure is presumed to be predominately static in its operation due to the simple and predictable nature of its function. As a result the networks have largely been over engineered to accept periods of maximum demand and/or generation with in many cases at least 100% redundancy

achieved throughout large portions of the network. Several reasons now exist why this approach cannot be reasonably maintained as an enduring strategy in light of industry and market wide developments in energy:

- Requirement to actively manage power flows that can be highly variable and may result in reverse power flows
- Incorporation of many new processes and technologies that allow increased value to be extracted from existing network assets e.g. ANM (Active Network Management) and DSR (Demand Side Response)
- Regulator incentives for increased efficiency and use of the network and improved utilisation without significantly increasing risk to supply
- Increase of meshing and active operation
- Ability to accept increased levels of generation connections to the distribution system
- Increased visibility and downstream information flows from energy users and upstream to generators and transmission network
- Improved analysis and forecasting of network utilisation
- Voltage management within the context of increased activity
- Increased efficiency and reduced carbon impact

UK DNOs are highly proficient in engineering terms; in their ability to manage and maintain their assets and typically achieve the majority of their conventional performance metrics.

EVOLUTION will deliver an inclusive local energy market under our nominated Grid Supply Point where the trial will be executed. The purpose of this market is to make it inclusive and accessible to all participants including larger embedded generators, locally owned community energy initiatives, demand side response and storage providers. The principle objective of harnessing the greatest value from renewable generation and finding a route to market is to ensure that market participants are fairly compensated for the services which they provide.

4.3 Innovation Warrants the NIC Application

Response to (d) Is innovative (i.e. not business as usual) and has an unproven business

The role and extent of duties of the DSO and how it will operate and interact with various market actors and energy market stakeholders is undefined in the UK. The concept of creating a local balancing and network system operator is a new concept that has yet to be fully tested within the current GB electricity market or to any significant extent across Europe. The current regime promotes the existence of a single 'System Operator', National Grid who forecast demand and then dispatch generation to match it within existing constraints. However the reality is that the majority of customers are connected at distribution voltage levels and with many emerging problems on the distribution network the advent of the DSO needs to take the lead on many demand side initiatives.

As a result of the trials being centred more around the necessity for innovation in the design of a new local market that can interact with the National System, EVOLUTION requires the support of the regulator, TO and SO. Without the involvement of these key stakeholders it would be very difficult and unlikely to achieve the engagement necessary to achieve the level of independence required to ensure the findings are acknowledged across the industry. It is also the case that the benefits of restructuring the system architecture to establish a DSO role will serve the overall market. It is expected that this will bring a wide range of benefits that extend well beyond those that can be measured solely on a financial basis within the RIIO assessment metrics.

4.4 Relevance and Timing

Response to (f) Relevance and timing

EVOLUTION addresses the very immediate problem that network operators are facing of facilitating the transition to a Low Carbon Economy whilst extracting greater value for customers by making better use of the existing electrical network and infrastructure. The timeliness and cost of facilitating this generation onto the network is a key step in making this transition. There are also significant pressures being placed upon National Grid to agree outages and operate the network to enable the current significant network upgrades to take place as a direct consequence of the penetration of embedded generation. EVOLUTION is needed now to manage and operate the network at distribution voltage levels which will have increasing significance throughout GB particularly in Scotland and the South East England.

The advent of the Low Carbon Network Fund, now been replaced with the Network Innovation Fund, has enabled the development of the core technologies and potential benefits of their application to be realised however there is increasing recognition amongst market stakeholders including utilities, regulators and suppliers that market and structural barriers still remain.

As well as activity in this area in the UK, the Council of European Energy Regulators (CEER) has also commenced work in examining the role of Distribution System Operators (DSOs) in anticipation of current retail and wholesale market developments across Europe which will represent a large proportion of focus during 2016. The purpose of this activity is to create a regulatory toolbox which could be used to define the DSOs' role as facilitators of the market. EVOLUTION would represent a significant learning platform for this activity and allow the UK to take a leading role in the development of this work.

The work that CEER hope to undertake will be closely related to the work being taken forward as part of EVOLUTION as a key area of activity will include examining the interactions between transmission system operators as the DSO takes on greater responsibility for the active management of distribution networks.

Smart Grid development is now well underway in the UK and the trials that have taken place before now need the development of a distribution market for local balancing and settlement to enable them to grow and flourish. While many trials to date have been completed to determine capabilities of new technology and in some instances policy, they have typically neglected to determine the broader impact of these advancements within the context of the overall UK energy system. EVOLUTION will bridge that gap. In the UK we need to ensure that the transition from trial to Business As Usual application is not limited by the existing market structure and lack of opportunity to develop and create a market at the level where the real problems are starting to accumulate i.e. at distribution voltages and the affect they are having on the national transmission system. EVOLUTION will enable the processes, commercial interaction, interoperability and exchange of information between market participants to be established and trialled.

While many trials that are taking place currently or have been completed previously attempt to determine capabilities of new technology and even policies, they typically neglect to determine the broader impact of these within the overall UK system. In some cases the limited scope of the trials will even avoid identifying where Business As Usual applications can't currently be implemented due to market structure. This is particularly prevalent where trials include any third party elements as these will typically be subject to commercial arrangements, contracts and result in dependencies out-with sole DNO control. In many cases the proposed long term solution to these is operation of new

innovative technology and methods within a DSO arrangement, despite this not being fully defined or understood.

Furthermore, National Grid is set to radically overhaul the way it balances the UK's electricity system to rely mostly on demand side measures by the end of the next decade rather than using generating assets. Currently the GB System Operator spends around £850 million per year to keep the UK's supply and demand in balance, with the vast majority of this spent on paying generators to ramp up or curtail power output to meet fluctuating demand.

National Grid recognises the step change in shifting from a small number of large centralised generating plants and a predictable demand profile to the expected increased volatility and large quantities of small distributed sites. National Grid has therefore established a new internal group called Power Responsive to engage with educating the broader market as to its aspirations. They have already stated "In the next five years it will work with commercial and industrial energy users to normalise the use of demand side response before engaging with the domestic sector to broaden the scale of flexible demand capacity. They have also stated openly that this will be coupled with objectives to provide in excess of 50% of system balancing from demand side sources by 2030.

National Grid has for several years procured limited demand side services and encouraged demand side management but the increased deployment of intermittent renewable energy, advances in demand side technology and a greater need for the business to reduce energy costs means that an active demand side market has become critical.

National Grid's UK Market Operations Director, Cordi O'Hara recently stated "For the most part generation has followed demand, but now demand is going to follow generation and we need to ask how demand can be more intelligent". While this is an important overall objective for the GB market as a whole, it doesn't necessarily equate that this responsibility should be a centralised function.

National Grid's Power Responsive campaign has stated aims to engage the industry in order to "co-create" the framework needed to develop a demand-side market by removing "real and perceived barriers" and providing education on how to take advantage of measures already in place. Central to removing barriers will be helping to create a mind-set shift through greater market engagement and education of the products on offer. On this basis the timing of EVOLUTION is directly in keeping with and supportive to the general direction of market development.

4.5 Project Partners

Response to (e) Involvement of other partners and external funding

In taking forward EVOLUTION, we have considered the requirement for project partners and have partnered with several experts with considerable experience both within Great Britain and abroad on demand response behaviours, flexibility services and associated incentives. SP Energy Networks recognised from the very outset of developing the EVOLUTION concept that this is a paradigm shift in the way that both the system and distribution networks would be required to operate. We have therefore been working closely with experts within the fields of energy markets and commercial service development of Smart Grids at every stage of the bid process.

Smart Grid Consultancy (SGC), Director, Gary Swandells

SGC will be responsible for project EVOLUTION scope and architecture. They have successfully demonstrated their knowledge and capabilities through design and delivery of some of the key Ofgem funded innovation work relating to Demand Side Response (DSR) including sole responsibility for the design, build and operation of the Commercial Trials of Project FALCON for WPD. SGC are broadly recognised as the leader in the field of consultancy for Demand Side Management (DSM) initiatives. They have remained at the forefront of the industry through participation in the majority of UK innovation trials, consultations and industry working groups. SGC personnel were also involved in establishing the top two current UK Aggregators.

Smart Grid Consultancy have a wealth of experience and have been at the heart of the market development of DSR and Flexibility for its very inception back in 2006 when the first UK aggregator was founded. Gary Swandells was the first professional to engage UK industries in participation within DSR and has continued to play a key role in the ongoing development of services as well as a regular respondent to demand side related consultations;

- National Grid Balancing Services (STOR/ Frequency)
- STOR Runway
- Demand Side Balancing Reserve (DSBR)
- Capacity Markets
- WPD - Seasonal Generation Deployment (Tier 1 LCNF)
- UKPN - Low Carbon London (Tier 2 LCNF)
- NPG - Customer Led Network Revolution (Tier 2 LCNF)
- WPD - Project FALCON (Tier 2 LCNF)
- WPD - Project SYNC (Network Innovation Allowance)
- SP Energy Networks - Accelerating Renewable Connections (Tier 2 LCNF)
- Electricity Balancing Significant Code Review (P316/P305)
- National Grid/DNO DSR Shared Services Group
- Smart Grid Forum (Workstream 6)

SGC will be combining their expertise along with that of CGI to ensure that system designs provide the best endeavours to ensure that a DSO model will assist the proliferation of demand side services and not restrict them.

Global Energy Advisory, Advisory CEO, Aily Armour-Biggs

Aily Armour-Biggs will engage extensively with the wider industry and financial institutions. In order to gather concerns and design principles alongside uncovering and quantifying potential impacts of extending the DSO model to include facilitating wider trading and hedging opportunities. Aily is a respected international energy figure with trusted relationships at the highest levels of industry and the city. Aily started her energy and banking career in the earliest days of privatization of the electricity industry in the UK. She was quickly promoted 8 times making key contributions in the trading, retail and commercial businesses of Scottish Hydro-Electric, Scottish Nuclear, South Western Electricity and Energy Australia, where she was nominated for Business Woman of the Year. Other roles include Executive Director, International Corporate Finance for

UBS based in Zurich and Chairman of the Electricity Forwards Agreement Association in the UK. She was also Head of Power & Utilities, UK and Europe, for the Royal Bank of Scotland in London. For the past 11 years she has ran Global Energy Advisory, a respected advisor to the energy industry. She is also a Director in Utilidex. Utilidex offer an independent energy trading resource for financiers, investors, traders and risk committees. They also help structure transactions, arrange finance and act as expert witnesses.

Aily's specialist and comprehensive trading market knowledge covers electricity market reform, Clean Demand Side Response @ Scale, balancing market and future price projections, all forms of energy risk Management and credit management, UK, European and Australian energy market operations, REMIT regulation, Capabilities – 137 KPI framework showing the key attributes required from the trading firm of the future and European Market Infrastructure Regulation (EMIR).

Global Energy Advisory were recently engaged by the Edison Electrical Institute of the USA to present detailed potential embedded generation and demand side market models and challenges; the second part of this assignment is in negotiation. They have also performed expert witness work for embedded market and finance transactions for a USA based law firm in regards to UK and European embedded markets. The Global Energy Advisory also performed value analysis for Honeywell controls systems for the value of flexible load trading; this work resulted in a formal joint venture with Honey Control building management solutions.

CGI

CGI will have responsibility for the software development and coordinate with ELEXON to contribute to determining workable financial flows and settlement conditions for the trial, and subject to the final learning agree aspects that would contribute to an enduring arrangement that incorporates DSOs. CGI will lead the process of consolidating all the findings taken from the above delivery items and producing a high level design requirement for the systems that will be required to be delivered in order to demonstrate the DSO operation across the trial zone. CGI's UK Utilities business has been at the heart of every major change in the British Utilities sector since privatisation. It is recognized for its depth of understand of the markets in which it operates. It is known specifically for leading the industry in central systems development, smart grids, and asset optimisation. CGI's utilities business is regularly positioned in the leader group by industry analysts; especially in areas of innovation and smart grids. CGI have designed, built, financed and continue to operate the systems that enable settlements in the British electricity market on behalf of ELEXON. CGI are also in the process of building and will then operate the data systems at the heart of the British Smart Metering Implementation Programme on behalf for Smart DCC Ltd. They have also been appointed to develop, build and operate the systems that will enable the competitive water market in England and Trusted by 7 suppliers operating in the British market to deliver the systems for their Foundation Phase smart metering programmes through our award winning Instant Energy solution, developed for the British market. CGI also partnered on Low Carbon London and FALCON; providing programme management support and software development.

National Grid

Project EVOLUTION has the stated support of National Grid and SP Energy Networks will work closely with them to assess the impact on the current market but also support them in their stated objectives to increase demand side participation. National Grid have been very open about their own need to review the current arrangements around existing services but also ensure that a DNO / DSO dialogue will be an integral part of new services development. This was acknowledged recently by balancing operations manager at a public event on DSR hosted by Energyst Media and within the recent industry engagement by their 'Power Responsive' to gauge views on a 'turn-up' service. National Grid has been engaged extensively on the development of the project concept and how it will be executed. A key output of this discussion has been the agreement with National Grid to establish 3 GSPs as a recognised VBMU/ASA which is the key foundation for taking EVOLUTION forward. National Grid has also appointed an EVOLUTION Project Manager who will be the main point of contact for the EVOLUTION Project Team and coordinate the activities of National Grid as and when required as the project develops. The person appointed by National Grid will also sit of the EVOLUTION Project Governance Steering Board.

Elexon

Project EVOLUTION has received confirmation from Elexon that they acknowledge the important step that the industry requires to take in defining the purpose of a DSO and how it will function within a modified UK market. To this end they have confirmed their full support as a key stakeholder to participate from the early engagement stages of the project to define what impact the role of a new market entity may have. Included within this they have agreed to provide valuable input on how this would impact at both a UK and European market level. It was acknowledged by Elexon that the earlier phases of the project relating to Work Packages 1 and 2, will have very little material impact on trading and settlement as these early phases are primarily about the operational elements of DSO proposition development and interaction upstream to the SO and downstream to participants. It is therefore not expected that Elexon will be required to provide active participation in the development of DSO capabilities until the commencement of SDRC activity in late 2017. It was their expressed view that by this time it is more likely the impact of P305 and other possible developments to outline DSO responsibilities through other working groups will be better understood. From Work Package 3 through to final completion it will be vital that Elexon are engaged to assists with the modelling of market impact and evaluating the benefits that can be derived from accessing any remaining flexibility to create a local energy market.

Section 5: Knowledge Dissemination

5.1. Learning Generated

Building on the Learning

EVOLUTION understands that all markets are underpinned by confidence, therefore clear and transparent communications are critical. EVOLUTION will develop the basis for new industry processes and markets which can be replicated throughout GB. This will result in the advancement of regulatory mechanisms to facilitate the accelerating of the DSO model throughout GB.

EVOLUTION will build upon the dissemination activity which has been established as part of our 2012 and current flagship LCNF project, Accelerating Renewable Connections (ARC). Our ARC project has been extremely successful in creating a range of mediums to engage with a variety of stakeholders and we will build upon these successes by:

- Development of quarterly industry stakeholder events and forums
- Publication of six-monthly newsletters to industry stakeholders
- Attendance at various industry forums and events to inform and obtain views and opinions from industry participants and stakeholders
- Attendance at industry conferences including the annual Network Innovation Conference hosted by the Energy Networks Association
- At a local level will build on existing and completed LCNF projects such as FALCON, CNLR, CLASS and Low Carbon London.

Additional Dissemination

EVOLUTION will use a number of additional means for disseminating learning, including:

Business and Decision Process Maps

As EVOLUTION has a significant emphasis on changing the way in which the distribution network is used, operated and the services that are being offered to GB System Operator (SO) National Grid, as well as new and existing generation and demand customers connected to our network, the creation and publication of process maps detailing the steps which this project has developed will be one of the key learning outcomes and means of dissemination. New process maps will be designed to build on existing commercial mechanisms in place and new ones developed through EVOLUTION and how new processes can be developed and intertwined with the existing GB market.

The principle process maps which will be developed and published include:

- Decision making process for top-down versus incremental investment in network enablers and new technology
- Identification of trigger points for pre-emptive DSO investment within the DNO network to enable the development of DSO activities and operational procedures, contractual and governance arrangements as well as local balancing and settlements arrangements which can create economic value for all industry stakeholders
- Identification and publication of information exchanges and methodologies for enabling participation in local balancing and settlements arrangements to facilitate local energy markets and provision of services to wider network operators, facilitators, generation, demand customers, suppliers, DNO and TO
- Process and information exchanges required to interface between DNO, TO and SO National Grid to support the provision of balancing services

Influencing and Updating of Policies and Industry Standards

From the experience of undertaking project EVOLUTION, key learning will be fed into the relevant national policies and standards to ensure benefit to all parties so industry stakeholder groups and organisations can realise the benefits of the learning emanating from the project. One of the principal learning points which will help with the dissemination will be the recommendations for establishing local balancing and settlements markets within current DNO licence areas whilst delivering auxiliary services to GB System Operator.

Project EVOLUTION will draw upon and build on the learning derived from existing LCNF projects such as CLASS, FALCON, Low Carbon London and CNLR, however EVOLUTION will start from where other projects have finished; extrapolating and linking both commercial and technical learning as well as interfacing with national balancing obligations.

5.2 Learning Dissemination

Knowledge Transfer 'In' to the Project

As referred to above there are a number of existing projects that have been established via the Low Carbon Network Funding mechanism looking at demand side response innovation and initiatives including CLASS, FALCON, Low Carbon London and CNLR in addition to projects such as NINES taken forward by SSE. EVOLUTION will build upon both positive and negative learning generated from those projects to date, however their contribution is only part of what EVOLUTION is seeking to achieve and represent only part of the toolbox that can be used by EVOLUTION to demonstrate and develop a market based approach for the provision of balancing services that creates new opportunities for both new entrants and technology providers to realise greater benefits both economically and socially through exerting greater value from the existing electrical infrastructure in place throughout the distribution network of GB.

To ensure that EVOLUTION maximises this effort the project will include a task of knowledge transfer to ensure that the full benefits and learning from other UK projects are realised and to avoid any unnecessary duplication. In line with our existing Accelerating Renewable Connections (ARC) project, EVOLUTION will identify an individual who will form part of the EVOLUTION Project Team who will be responsible for all aspects of knowledge transfer and dissemination and who will be able to define the current landscape of projects which compliment EVOLUTION, as well as keeping an ongoing monitor on other projects both within the UK and Europe, as they develop to ensure that the learning is always being achieved and transferred.

Internal Dissemination

A vital activity from our portfolio of Low Carbon Network Funded projects is ensuring that the project delivery team maintains continual engagement of staff from across SP Energy Networks to ensure that outcomes and learning from the project can be adopted into future business application as soon as possible. Following on from the success to date in transferring the learning from our ARC project into a Business As Usual offering which will be completed 1 year ahead of the current project completion date, a similar range of techniques will be deployed as part of EVOLUTION to successfully build staff awareness, train staff in the new approaches and processes being developed. These methods include but not limited to;

- Inclusion of our graduate pool in project delivery as part of their accredited training programme

- Identification of project champions and key business points of contact within each internal stakeholder group or department who will be kept abreast of developments and to ensure that the customer experience is effectively managed.
- An annual internal technology conference which focuses solely on innovation developments such as Flexible Networks, Accelerating Renewable Connection (ARC) and EVOLUTION, which to date are well attended exceeding 100 staff members from across the business and structure.

As part of our staff development activities within SP Energy Networks, project EVOLUTION will utilise the vacancies within the Project Team as an opportunity to assist staff in their development through increasing awareness of innovation and involvement in delivering innovation projects. This is also a key enabler to building a solid foundation to transfer activity from a project into Business As Usual delivery. EVOLUTION will also complement the resourcing of the project team from members of our graduate programme as part of their accredited training programme to maximise their exposure to different activities and bring fresh perspective to the project.

EVOLUTION has a strong linkage to a number of business units including, Network Connections, Customer Service, Distribution & Transmission Control Room Staff, Regulation & Commercial, System Design and Network Planning. Principle points of contact will be established within these teams, which has already commenced in preparation of our bid documentation, to ensure adequate and efficient exchange of information to manage internal process as well as for learning dissemination. An EVOLUTION Project Governance Steering Board made up of directors and senior managers from across the business has been established, EVOLUTION will also identify project champions from each business unit who will act as ambassadors and lead engagement within their business unit. This will involve providing updates, monthly team briefs and making other presentations as appropriate to keep staff informed of developments.

In 2010, the Future Networks team established our annual internal technology conference to which in excess of 100 staff attends per annum to be informed on innovation activities and how as a business we are committed to implementing a greater amount of alternative and innovative approaches to deliver our goals and deliverables for RIIO-ED1. We also use this forum to inform staff of the learning emanating from across GB and what innovation is being taken forward by other Distribution Network Operators.

We consider that this broad range of activities will provide a comprehensive dissemination of the learning from EVOLUTION, and can prove from our existing ARC project, that by undertaking such activities we ensure that learning will be embedded into day to day practices across SP Energy Networks.

5.3 IPR

This project will conform to the NIC default IPR principles. It is not anticipated that the project will develop foreground IPR that will fall outside of the default IPR requirements.

Section 6: Project Readiness

Requested level of protection required 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 our proposal for EVOLUTION, the team has undertaken engagement with a number of internal and external parties to obtain feedback and views on the objectives and deliverables of EVOLUTION to ensure that the project is timely and relevant. Internally this has involved close collaboration between the bid team, Colin Taylor, Director Engineering Services, Scott Mathieson, Director Network Planning & Regulation and their respective department representatives who are responsible for the overall Network Design, Asset Management, Commercial & Regulation, Network Control Centre and Billing & Settlements activities across the company.

In addition, Frank Mitchell, Chief Executive Officer, SP Energy Networks, has been consulted during preparation and in advance of both our Initial Screening and Final Screening documentation and is fully supportive of our EVOLUTION proposal. Indeed in April 2015, Mr Mitchell was appointed Chairman of EURELECTRIC's Distribution System Operator (DSO) Committee.

Our RIIO-ED1 strategy clearly states that our NIC project proposals would be developed within the guidelines of the Network Innovation Competition and also align with our stakeholders views and that a particular area of interest would include; *'Demonstrating the Distribution System Operator (DSO) concept and the future role of the DNO – our long term strategy is a move to be a DSO and this will require demonstration of some of the components that this will entail as we enter this journey'*

Ref: SP Energy Networks 2015-2013 Business Plan Updated March 2014, Annex Innovation Strategy SP Energy Networks, Page 17

Project EVOLUTION is in line with SP Energy Networks RIIO-ED1 ambition, strategy and expected deliverables.

Events and engagement have also taken place with a number of industry stakeholders including Elexon and GB System Operator National Grid, as well as a number of interested stakeholders who are keen to engage and offer services in support of EVOLUTION. We have also taken forward project EVOLUTION to compliment and drive forward work being taken forward as part of Smart Grid Forum Work Stream 6.

EVOLUTION is the natural next step from our existing Accelerating Renewable Connections (ARC) project which has deployed Active Network Management (ANM). A key part of the learning from ARC to date has been the recognition of the limitations of trying to facilitate the advent of a greater penetration of generation onto the network on the basis of solely a physical capacity constraint, and discussions with GB System Operator National Grid on the advancement of ANM have signalled the requirement for DNOs to consider the wider implications for national system balancing through the development of alternative commercial and technical mechanisms under a Grid Supply Point (GSP). EVOLUTION will explore those wider issues around market coordination, and the affect, upon national system balancing and settlements using ANM as the foundation for this activity. As part of our stakeholder engagement activity for ARC we have introduced the concept of project EVOLUTION and sought opinion from stakeholders on the advancement of EVOLUTION and whether it is the correct course of action for SP Energy Networks and other DNOs to take. To date feedback from stakeholders and industry participants has been overwhelmingly supportive of our

EVOLUTION project. This is evidenced by the response to the question asked at our recent ARC stakeholder event shown in Figure 5.

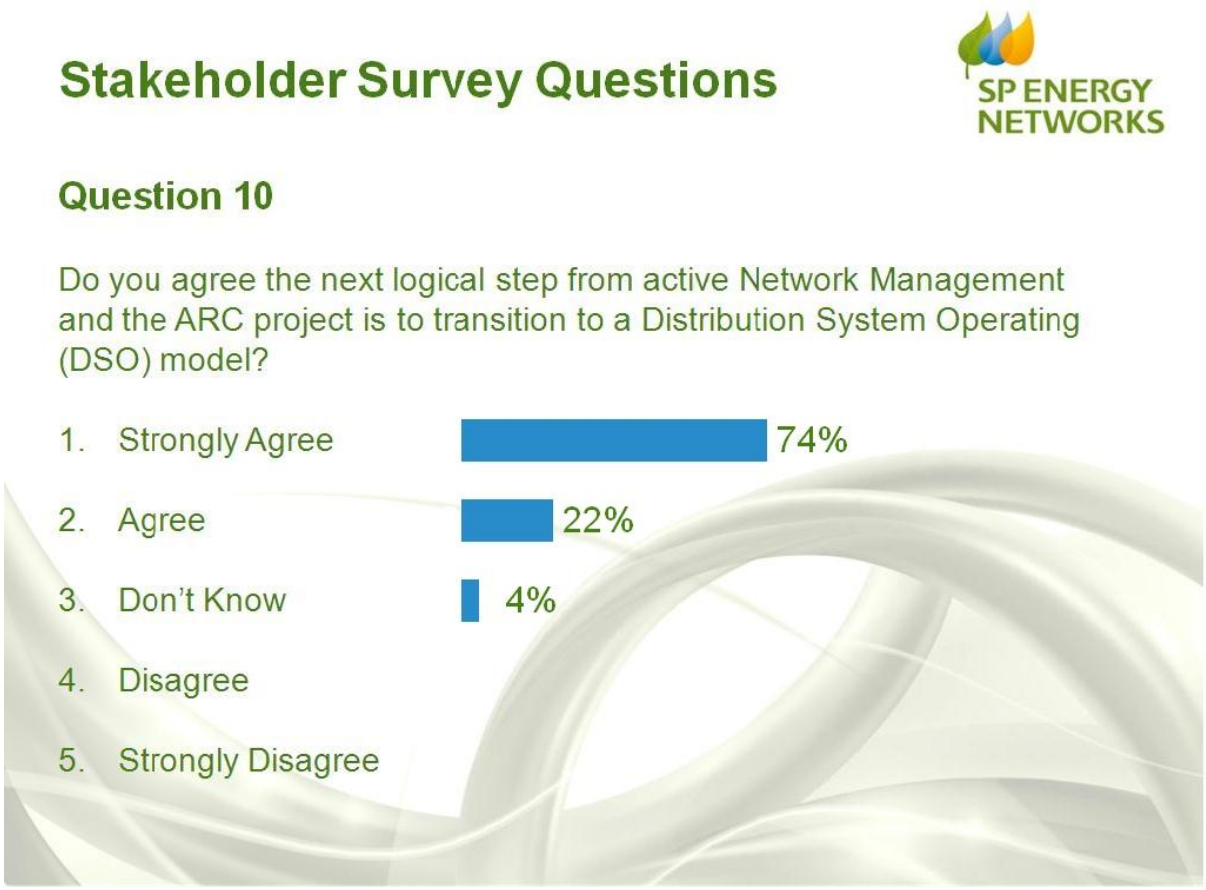

Figure 5. Stakeholder Response to EVOLUTION

Resourcing

The resource structure for EVOLUTION is shown below in Figure 6. The resource structure involves the appointment of 6 dedicated staff, of which the Project Manager has already been identified should the EVOLUTION bid be awarded funding through NIC. The recruitment of these staff has been pre-approved internally on the basis of EVOLUTION being successfully awarded. The formation of this team will be supported by existing resources from within the Future Networks team. It is anticipated that all resources will be appointed within the first quarter of 2016. These dedicated resources will also be complemented by the support of our graduate trainee programme who will be involved in the project on a rotating 3-6 month secondment.

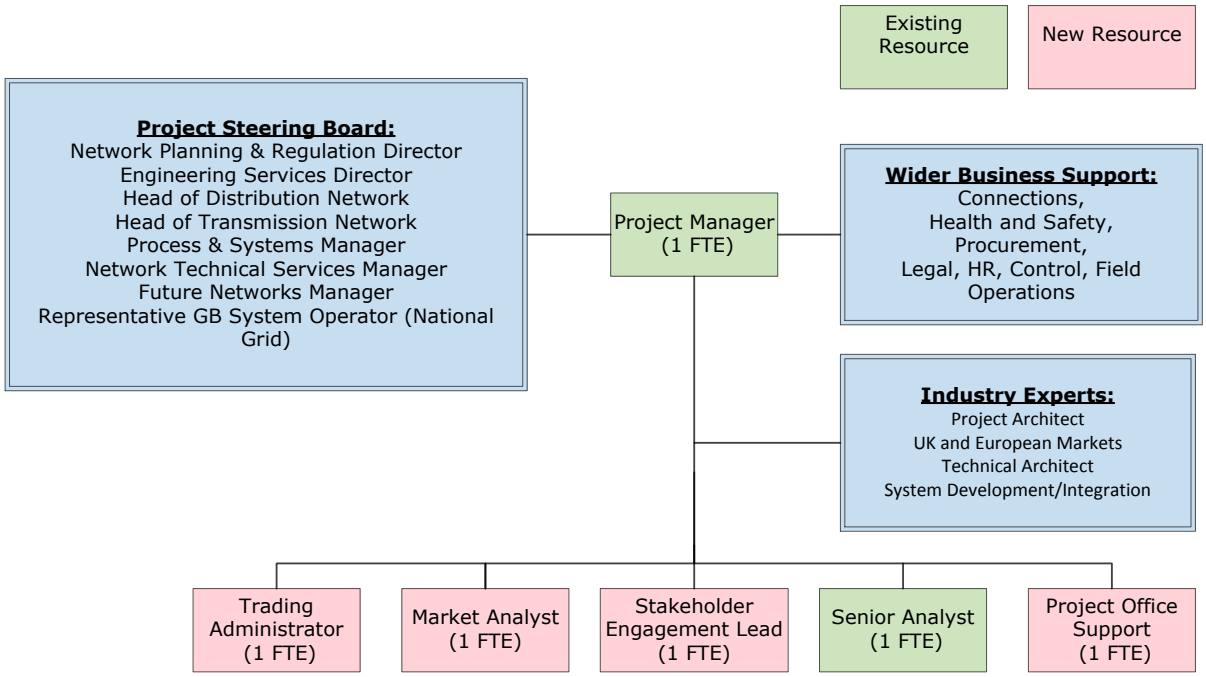

Figure 6. EVOLUTION Resource Structure

Project Partners

From the conception of EVOLUTION we recognise that the purpose of the project is to develop a market and stimulus for local balancing and local energy management under a VBMUthat will serve national interests and continue to realise economic and social benefits for consumers as the UK transitions towards a low carbon economy. Socialising the concept of EVOLUTION has made it clear that there are already a variety of market participants in existence ready to take full advantage of the concept that the project will prove and demonstrate. The key learning that will be established from EVOLUTION will be the commercial and industry processes required to take forward this concept.

As the project develops we recognise that there will be technology equipment required to send instructions and receive various information from market participants, for interaction between control rooms of both SP Energy Networks and GB System Operator National Grid and to establish trading platforms. However, we consider that the completion of EVOLUTION will realise greater value and better serve GB consumers by running competitive tender processes for those services and equipment that can be readily supplied by a number of different vendors, service providers and equipment manufactures.

As part of our bid preparation and during the ISP stage we have engaged in extensive dialogue with a variety of interested parties and stakeholder organisations and this process has highlighted the number of market participants already in place to take advantage of the market which EVOLUTION is seeking to create and who can bring forward and demonstrate novel solutions and application for immediate deployment.

We will continue to work closely with those project partners who have already worked with SP Energy Networks on Flexible Networks, Accelerating Renewable Connections

(ARC) and VISOR where appropriate, where their synergies are relevant and following a tender process should delivery of activity be required.

Project Governance

A Project Governance 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:

- **Network Planning & Regulation Director** (Responsible for Network Planning, Regulation, Commercial & Asset Management activities across SP Energy Networks)
- **Engineering Services Director** (Responsible for Engineering Design Standards, Technical Services, Future Proofing the Network & Sustainability)
- **Head of Distribution Network**
- **Head of Transmission Network**
- **Process & Systems Manager (SP Energy Networks)**
- **Network Technical Services Manager (SP Energy Networks)**
- **Future Networks Manager (SP Energy Networks)**
- **Representative of GB System Operator National Grid**

The Governance Board will have full authority to oversee the project and ensure appropriate action is taken to rectify any issues that arise and need addressed. The Governance Board will meet bi-monthly to support the establishment and to ensure that activity is undertaken effectively and in line with the Project Direction issued by Ofgem.

The project also has an Executive Sponsor from our Senior Management Team who will review on a fortnightly basis:

- Project milestone progress (baseline versus 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 activities.

The EVOLUTION Governance Board will have the authority to suspend or cease the project or take the most appropriate course of action and identify critical points at which the project should be referred to Ofgem for review as necessary.

Risk Management, Mitigation & Contingency

A project Risk Register is included in Appendix E.

Risks include not knowing the number of potential market participants, and importantly their expected level of payment for their services. Furthermore the commercial terms between the SO and the Network Licensee are expected to be similar to any other BMU, however, special dispensation may be required to account for the inevitably unique characteristics of a VBMU, not present in existing BMUs.

These risks along with the unknown true costs of implementing such a market and the level of compensation the Network Licensee can expect to receive for implementing it, make for an extremely strong case to explore this in a demonstration project where methods for mitigating these risks can be developed before committing to a full scale rollout. Furthermore, by focusing on only one trial zone for this demonstration, it avoids the multiplication of risks associated with having to set-up multiple, what are essentially independent, DSO markets. The choice of the 3 GSPs should provide access to the broadest range of potential demand and generation customers, with a combination of

rural and urban networks, in order to explore as many system services and commercial arrangements as possible.
Unfortunately this does not allow for demonstration of the DSO method for operating multiple DSO markets and their interaction, if any, at the SO level. However, the technical and commercial issues associated scale up of the Method across UK GSPs will be part of the project.

Accuracy of Costing and Verification of Proposals

All elements of EVOLUTION have been designed in conjunction with the wider SP Energy Networks business and industry stakeholders such as GB System Operator National Grid, to ensure it is both accurate, feasible and meets the needs of both internal and external stakeholder requirements whist maintaining its objective of being innovative. The EVOLUTION Governance Board has reviewed the full submission and associated documentation for accuracy and all cost information is based on existing contracts or known costs where available. Where no cost information has been available as a comparison, in particular some of the key innovation elements of establishing the local balancing and settlements markets, these have been discussed with relevant industry stakeholders in order to form a reasonable forecast of expected costs.

As discussed above, due to the nature of EVOLUTION and the key innovation being the establishment of a local system balancing market under a VBMU, we consider that EVOLUTION can achieve greatest value for money through operating a more formal competitive tendering process for individual solutions that will realise value for money but enable a variety of industry organisations and groups to participate and benefit from the project.

A summary of the cost breakdown and assumptions are included below;

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

Equipment Costs – These have been estimated through discussion with prospective technology providers and vendors and based upon experience of deploying similar technology but on the scale of the trial.

Contractor Costs – This includes provision of commercial, legal, process design and analysis services, as well as assistance from industry stakeholders such as GB System Operator National Grid. Legal costs will be incurred for developing commercial and contractual arrangements and these are included within this forecast cost.

Information Technology – IT costs relate to the development of existing and creation of new systems to enable interaction between various industry stakeholders, and providers of both generation and demand services. Costs for enabling the network under the chosen Grid Supply Points (GSPs) and the management of such an IT system and communications infrastructure are also included. EVOLUTION will require the addition of a new IT platform within SP Distribution and will require the appropriate testing and precautionary measures for it to be integrated. Furthermore, working in partnership we will develop a new low cost and high reliability customer control interface that will enable the monitoring and M2M communications necessary to facilitate smart grid functionality.

Intellectual Property Rights – We do not anticipate any IPR costs. The project is not funding the development of any technology which should create foreground IPR.

Travel & Expenses – Travel expenses have been allocated for additional travel to and from the various stakeholder and industry locations with whom the project will require to engage. Expenses have also been allocated for undertaking various engagement activities at customer locations within the network area from which the trial will be conducted. The project will only incur travel and expense costs for those activities that would not have been required for 'Business As Usual' activity. 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 travel and expenses costs for international travel or travel to remote locations.

Payment to Users – As part of the project, the DSO will require operating capital in order to have liquidity to operate and make payment to DER providers and settle trades. A provision of £300k has been made for this liquidity and it is envisaged that at the end of the project this would be retained and redistributed to UK DNOs in line with an Ofgem NIC funding direction, as the model should ensure, if operated properly, that the DSO does not lose this capital investment. This is included in Work Package 5 and links to Market Go Live.

Contingency – A risk register with risk ratings, mitigation and contingency plans has been developed for EVOLUTION and is provided in Appendix E. This will be maintained and updated throughout the duration of the project. This has been utilised to provide an indication of the level of costs contingency that will be required for each work package, broken down by cost items such as labour, equipment, contractor etc. Equipment and IT costs have been allocated a higher level of contingency due to possible price variations when the competitive tender exercise is undertaken, an increased level of contingency has also been allocated to contractor costs which may be subject to change due to the specialist skills required to take the project forward.

Section 7: Regulatory Issues

Consideration has been given to the potential regulatory impacts or derogations that might be required in order to take EVOLUTION forward. In considering the possible regulatory impacts or derogations required we have also engaged National Grid who has also contributed to this section.

National Grid has considered the concept that will be taken forward as part of EVOLUTION and concluded that they are comfortable that there are no significant blockers at this stage to the implementation of the project. They do however consider that as the project develops should an assessment be made that does require further consideration then a derogation or letter of comfort from Ofgem may be required in order to allow National Grid to act contrary to their statutory and/or regulatory obligation.

EVOLUTION may require the development or re-definition of the current roles that market actors play and how the Distribution System Operator role will be incorporated. This may lead to amendments or development of relevant regulatory frameworks to account for the more active role and advent of greater local energy balancing and settlement at the distribution voltage level.

A detailed breakdown of the relevant licence condition and industry codes is provided below:

National Grid Electricity Transmission (NGET) Licence

SO Standard Condition B3 (Disposal of relevant assets and restrictions on charges over receivable)
To the extent that NGET relinquishes control of any part of the network to a DNO then consent may be required under Condition B3. To the extent that a DNO in effect acts on NGET's behalf in controlling part of the system then NGET believe that their 'general consent' in respect of contractors could be invoked for the period of the project. NGET would remain liable for any breach of their licence conditions that resulted from the actions of SP Distribution as part of the EVOLUTION trial and therefore would seek a letter of comfort from Ofgem on this subject.

SO Standard Condition B7 (Availability of Resources)
In developing project EVOLUTION care will require to be taken to ensure that the trial does not lead to inefficient dispatch of balancing solutions through separate operation of the transmission and distribution networks. However, EVOLUTION will potentially allow NGET as System Operator to improve the management of 'exporting' Grid Supply Points (GSPs). Therefore NGET would seek a letter of comfort in this area from Ofgem.

SO Standard Condition C16 (Procurement and use of balancing services)
A key deliverable of EVOLUTION is to establish a 'Virtual Balancing Mechanism Unit (VBMU) or dispatchable capacity as Ancillary Services Aggregator (ASA) at East Kilbride, East Kilbride South and Strathaven Grid Supply Points (The Trial Zone), and where bids and offers will be taken in line with the current arrangements for BMUs under the Balancing Principles Statementm or participate on non-BM ancillary balancing services. Therefore this will not cause any breach of Condition C16.

Industry Frameworks

Grid Code
In delivering project EVOLUTION, SP Distribution will comply with all technical requirements through the Distribution Code, which is the distribution equivalent of the

Grid Code and therefore it is not envisaged that there will be any non-compliance with the Grid Code.

Connection Use of System Code (CUSC)
NGET consider that as part of the delivery of Project EVOLUTION, the manner in which BEGA and BELLA customers are treated and dispatched will require to be determined. At this stage of the project development, any existing customers will not be disadvantaged and will still be able to execute their BMU obligations during the trial. However the trial area does not currently include any sites that have such arrangements. Should any new sites require these operating conditions it is envisaged that those customers would be managed by the Distribution System OperatorUnder sush arrangements NGET would advise them that the Distribution System Operator would be managing them for the duration of the trial on behalf of NGET in a contractor capacity.

Balancing and Settlements Code (BSC)
Currently Distribution Network Operators are not currently party to the BSC and therefore part of project EVOLUTION will require the legal entity formed that will undertake the Distribution System Operator function, to become a BSC party and meet the associated requirements. The aforementioned VBMU would would require a new category to be created. At this stage of the project and for the purposes of the trial, we would seek to register the VBMU under new temporary category and with the support of Elexon as a participant define how this should be treated and categorised going forward.

Any requirements for metering would need to be considered but given that existing Grid Supply Points (GSPs) are extensively metered, this would not present an expected barrier to the establishment of a VBMU within the trial zone.

System Operator Transmission Owner Code (STC)
It is the responsibility of NGET to operate the transmission system in a manner that ensures no overloading of TO assets. For the purposes of the trial, NGET and SP Distribution would agree specific limits within which the EVOLUTION trial can be undertaken as a contractor of the GB System Operator. As a DSO, in the event of any overload on the TO assets in the Trial Zone, caused by the actions of SP Distribution, executed as part of the trial, SP Distribution would be liable for any physical damaged caused under the STC (CUSC) up to a value of £5m.

System Security and Quality of Supply Standards (SQSS)
It is not expected that the delivery of project EVOLUTION would have any impact upon the SQSS.

In addition to the specific Network Licence Conditions and industry codes referred to above we have also considered derogations/exemptions that may be required from the Electricity Licence of SP Distribution. Similarly to the view taken by NGET we do not consider that there are any specific blockers that would prevent SP Distribution to undertake project EVOLUTION.

Engineering Recommendation P2/6 – Standard Licence Condition 24
We consider that demand side management contractual arrangements with business customers and provision of actively managed embedded generation connections will enable the deferment of some load and connection reinforcement. However, the security of contracted demand side services might be less than that provided by conventional network reinforcement. We do not consider that we will require any derogation from ER P2/6 however a probabilistic approach will be applied to determine the level of security and/or the probability of any unplanned network outage coinciding with both a peak demand period and the non-availability of responsive demand – hence leading to a shortfall of capacity to managed or deliver an instruction received from the GB System Operator.

Standard Licence Condition 13A.18
We do not consider that project EVOLUTION will require any alteration of the current DUoS charging methodology for any customer within the trial area. This includes those customers that will actively participate within the trial (distributed generation and demand side management).

The payments that these customers will receive in connection with their participation will be made independently of their DUoS charges, and those contracts put in place will form part of the innovative learning developed through the project, thus, we do not believe that derogation will be required.

Section 8: Customer Impact

Following the dramatic growth across GB in the number of embedded generators seeking to connect to the distribution network at all voltage levels coupled with the current and expected growth in low carbon technologies, it is clear that the current market and the current approach of national system balancing and settlement needs addressed to reflect that in future the real issues affecting our network across GB is going to be concentrated at a local and community level in respect of energy transfer, consumption and system balancing.

To combat the impact of generation a number of Distribution Network Operators have taken forward schemes deploying Active Network Management (ANM). However one of the key learning points from our own ANM rollout under our highly successful Accelerating Renewable Connections (ARC) LCNF project, is that the greater penetration of ANM schemes means the level of constraints or curtailment will increase as the UK connects greater distributed or embedded generation and therefore not realising the full benefit of renewable generation. This dilemma presents a new challenge for both operators and customers: how to connect more DG and allow it to fully operate without the need for significant investment in new infrastructure, therefore the natural next step is to create a local market and demand to enable that power to be best utilised and in turn provide balancing and settlement services to the GB System Operator (SO) National Grid. In addition the advent of an increased penetration of generation is putting pressure on our national infrastructure now to the point that the GB System Operator is struggling to agree system outages with the three Transmission Owners (TOs) as we have seen a disappearing demand in recent years and thus is affecting the reinforcement of networks and connection of further renewable generation projects. EVOLUTION is required now and will start the process of addressing some of those issues by taking greater control and creating a more sustainable market at a local and community level.

EVOLUTION has been developed in recognition of the limitation of the rollout of Active Network Management (ANM) in its current form as well as dialogue with GB System Operator (SO) National Grid on the adverse effect that ANM could have on national system balancing if the DNO does not take greater control of assets connected locally and develop the ability to act as a virtual generator unit with balancing obligations. Another failing of the current rollout of ANM in its current form is that actions taken by distributed ANM schemes are not currently visible to the SO and which if left in their current form will lead to the SO taking unnecessary curtailment actions against transmission connected generators and paying for that service. In parallel, actions taken by the GB System Operator with distributed generators managed through bi-lateral agreements (BEGA and BELLAs) are equally unsighted by distribution ANM schemes, this is why EVOLUTION is going to establish the DSO role who will have visibility and can contract for services with the SO to ensure that no customers connected to the network are adversely affected by constraint management actions taken independently by different network operators. The rollout of Active Network Management technology still has its merits to facilitate greater availability of capacity and become the foundation of taking real-time control actions to manage physical network constraints, EVOLUTION will seek to marry that real-time physical control with technology that also takes controlling actions based upon market signals where return and reward can be derived for both the customer and network providers.

EVOLUTION like ARC, is fully committed to and recognises that effective stakeholder engagement is essential to the successful delivery of EVOLUTION which is designed to develop a new market that can be accessed by both generation and demand network users as well as create a viable financial model and stimulus for those companies and stakeholders who believe that they can offer economic facilities, such as storage, to harness renewable generation and responsive demand response services. EVOLUTION will establish a comprehensive communication strategy that will be relevant, meaningful

and transparent to all stakeholders as we recognise that the success of any market based approach is openness and confidence.

As part of our bid process, we have developed an appropriate stakeholder engagement map which identifies key stakeholders that will be directly impacted or have an interest in the learning derived from EVOLUTION. Analysis of the main work package objectives have been undertaken to ensure that learning from the project will be relevant and applicable to the wider GB energy network market. We have also actively engaged with a number of key stakeholders including GB System Operator National Grid, SP Transmission, Elexon and various private companies who would be keen to operate within the local market and provide services to the DSO when established through EVOLUTION. These organisations will be critical in supporting the project as it develops to utilise and apply the learning generated.

Existing & New Generation Developer

Within the distribution network in the trial zone, EVOLUTION will directly affect both existing and new generation applicants in the sense that they will form part of the wider balancing and local energy market and have greater opportunity to realise the wider benefits of local balancing and demand side response services. This should realise greater utilisation of their proposed or existing generation developments. Any such arrangements will form part of their connection agreement and contract for connecting to the distribution network. Building on our work under ARC to date, we have already established a contractual arrangement that satisfies developers, National Grid, distribution and transmission licensees and does not conflict with the various industry codes for connecting renewable generation. We consider that the extension of such an agreement to include the opportunity to receive and provide balancing serves is possible. The advent of EVOLUTION would not preclude or prevent any existing operator from providing services already contracted with National Grid and indeed we would seek to build upon the work already undertaken by the Energy Network Association's Demand Response Sharing workgroup that has been taken forward by DNOs and National Grid and presented at Work Stream 6 of the Smart Grid Forum.

As Active Network Management is still a relevant technology under the EVOLUTION project, it should be noted that this will form part of Business As Usual connection solution as SP Energy Networks are in the process of rolling out ANM as a Business As Usual product offering therefore no funding has been requested to implement ANM but only additional control equipment that would require to interface with an ANM as part of the DSO deliverables and to ensure visibility of actions to all relevant industry stakeholders.

Delivery of Customer Information Pack

A primary delivery of EVOLUTION immediately following funding award will be the production of a Customer Information Pack for Generation, Demand Response and Storage services customer and stakeholders. This pack will outline the process by which SP Distribution will engage, contract, provide and request services. The pack will also inform customers of how they will benefit from being part of this new localised balancing market.

Dedicated Facilities to Receive Information & Respond to Enquires

Following the implementation of EVOLUTION, a dedicated resource will be identified as part of the project team and linked to our wider business contact centres to receive enquires and be the main point of contact with customers who are connected to the network governed by the trial and for those stakeholders and service providers who require information to enable the trial to be conducted effectively.

Customers and stakeholder organisations will be able to contact the EVOLUTION team directly through a dedicated email address and telephone number for all enquires. In

addition, using our SP Energy Networks website, we will host a dedicated EVOLUTION project page that will provide details of the EVOLUTION project, information on the affected trial area and key contact details for relevant staff as well as a list of FAQs that will be updated periodically as the project develops.

As part of our stakeholder engagement work package we will incorporate the roll of a Stakeholder Engagement Lead who will manage the interface between the customers engaged and active within the trial and the EVOLUTION team as well as our wider stakeholders such as GB System Operator National Grid. This role will represent a key interface over the course of the project.

The purpose of ensuring that we have a dedicated Stakeholder Engagement Lead will be to facilitate learning on the key interfaces, processes and information gathering and sharing required to ensure that all stakeholders are benefiting and can participate effectively in the local market for balancing services and realise best operating value for their respective generation, demand response or storage service.

Again building upon our experience from ARC we will follow a similar process for EVOLUTION where we will develop a number of local community group workshops. We have found these of great benefit under ARC in understanding issues on the ground and gaining feedback on what customers want which has fed into the decision making process and shaped our project and services we seek to provide.

Our communication methods within the trial area will take the form of

- Establishment of a dedicated Stakeholder Engagement Lead
- Use of web based information supported by local customer information
- Regular surveys and feedback to engage effectiveness of communications between all project stakeholders in operating the trial and receipt of information to chart its progress
- Quarterly Stakeholder Workshops to provide project updates on progress, activity, achievement of deliverables.

Wider Stakeholder Engagement

A number of indirect stakeholders will have an interest in the development and execution of project EVOLUTION. These stakeholders include regulatory bodies, suppliers, aggregators, financiers, academic institutions, technology and equipment manufacturers, customer and trade associations as well as GB network operators.

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

Local Government & Regional Development Agencies – Local government authorities and policy departments will be interested in the learning and activity that we hope to deliver through EVOLUTION as there is a direct link between the implementation and development of a local balancing and settlements energy market and growth of communities and how energy provision and services are a vital consideration for communities. By disseminating the learning and achievements of EVOLUTION we hope to provide information on how the project will affect the future development of both renewable generation and demand side response services going forward.

National Trade Associations – National trade associations from the retail, aggregation, storage, renewables and many other industry participants will have a significant interest in EVOLUTION. Through continued liaison with those groups we will ensure that representatives from each association are kept abreast of the project to enable them to inform and obtain opinions from their members on how the project is developing and what impact it may have for their own ambitions to operate within a similar market space.

Banks & Financial Institutions – From our stakeholder engagement to date the issue of what Finance Institutions require from their customers seeking to develop demand side response services or develop a renewable generation project to enable them to secure adequate funding is a key consideration of the project. Through EVOLUTION we will also seek to engage with the banking and finance sector to deliver key messages on the development of the project and what implications and opportunities this could have for their customers seeking to participate in similar markets.

Academic & NGOs – The project may require support from academic institutions and SP Energy Networks have developed a good working relationship with a number of academic institutions. As the project develops it is likely that one or more academic institutions will be requested to provide impartial analysis of EVOLUTION so that the outcomes of the project can be verified and recommendations made to the future adoption of the various tools and network techniques that can accommodate and facilitate a local balancing and services market as well as services to the SO. In addition however throughout the project we will seek to further and continually engage with organisations who we consider competent and complement the aims of the project EVOLUTION.

Section 9: Successful Delivery Reward Criteria (SDRCs)

SDRC 1

Delivery of Initial Market and Technical Design Report

Delivery of a report that details an initial market and technical design specification. The report will detail a new proposed control heirarchy and financial flows / systems that will enhance the current arrangements for National Balancing Services and the key interfaces required between transmission & distribution network operators, energy traders and end DRS providers. The report will also detail a suitable optimisation strategy for use of 'Smart' technologies and a control methodology. The report will also define an open architecture development program that will allow the DSO to be tailored to ensure broad deployment through GB in different locations and customers mixes.

Evidence

Report submitted to OFGEM and disseminated to industry stakeholders in accordance with the deliverables of Work Package 1. The report will ensure clarity and detail around the market design and technical requirement for a) delivering trial b) integration with industry and c) the technical specification for system requirements and interfaces

Completion Date – 30th November 2016

SDRC 2

Delivery of Stakeholder Interface Report

Delivery of Stakeholder Interface Report that will detail the views and opinions of industry stakeholders on the development and introduction the Distribution System Operator (DSO) model in the UK. This will include details on the affect the introduction of the DSO will have on industry participants, their appetite for its introduction or otherwise and feedback on the planned industry workshops and dissemination events that will take place over the course of the first year of the project.

Evidence

Report submitted to OFGEM and disseminated to industry stakeholders in accordance with the deliverables of Work Package 2. The report will ensure clarity and detail around the need for DSO the way stakeholders wish to see it implemented and provide clarity around the impact the DSO will have on specific industry participants.

Completion Date – 30th November 2016

SDRC 3

DSO Market Needs Case Report and OFGEM 'gate' Decision

Upon completion of SDRCs 1 & 2, a report shall be produced consolidating the key outputs from each report, needs case for the delivery of the DSO model and trial, key stakeholder feedback and detailed evidence of why and how DSO trial will be taken forward. This report will represent a decision point in the project to take the project forward into full delivery and will be made by OFGEM

Evidence

Report submitted to OFGEM and disseminated to industry stakeholders in accordance with the deliverables of SDRC. The report will ensure clarity and detail around the need for DSO the way stakeholders wish to see it implemented and provide clarity around the

impact the DSO will have on specific industry participants. Upon completion of the Report OFGEM will decide upon the project being taken forward into full delivery.

Completion Date – 31st January 2017

SDRC 4

Based on the outputs of the prior SDRCs we will establish a new set of arrangements for working with National Grid and Elexon for system balancing and settlements processes.

This is likely to require an approach that will trial the registration of East Kilbride Zone as a Virtual UK Balancing Unit, or a restructure of the ancillary services operating model for non-BM providers. Through the completion of SDRC 1-3 in close cooperation with National Grid, Elexon and key industry stakeholders, a preferred approach will be established along with a delivery plan that details the changes additional components necessary for operating distributed assets to serve national balancing requirements while optimising an active distribution network.

Evidence

Categorisation of East Kilbride traiZone as a trial UK Virtual Balancing Unit in line with Balancing and Settlement Code or creation of a new ancillary services arrangement with National Grid enabling a DSO to act as a regional system operator with the responsibility to control distributed assets within the trial zone.

Completion Date – 31st July 2017

SDRC 5

Demonstration of Delivery of Services to System Operator through DSO model

Implementation of Distribution System Operator model and establishment of local balancing and services market arrangement to facilitate the provision and delivery of those services required by the GB System Operator either through the balancing mechanism or new Non-BM ancillary services

Evidence

Report detailing balancing services provided to GB System Operator during live trial of Project EVOLUTION, detailing action, services provided, financial impacts and how this was achieved.

Completion Date – 31st March 2020

SDRC 6

Delivery of Commercial Contracts to Support DSO Rollout

Evidence of delivery of required commercial contracts between industry stakeholders and arrangements required for operation of the DSO model through the creation of a Balancing Unit at the Grid Supply Point. Based on existing aggregation models we will create contracts and service propositions that will enable the DSO to interact with distributed assets in order to meet the upstream National Services requirements defined in SDRC 4.

Evidence

Report detailing commercial contracts established and in place with distributed energy resources connected under the nominated Grid Supply Point and documentation of process maps detailing engagement, interactions and communication protocols between SO/DSO and DR service providers.

Completion Date – 31st March 2020

SDRC 7

Delivery of Technical Solutions Required to Deliver DSO model

Based on existing aggregator models and capability we will develop and deploy top-down enabling technology to undertake and execute project EVOLUTION within the trial zone. This will include associated communication, optimisation, financial settlement and control system platforms in order to operate the DSO model.

Evidence

Report detailing technical and customer interface technology required to deliver, manage and operate a DSO. This will include standards which should be established for metering,settlement, priority hierarchy for control of distributed assets and how to coordinate outage management between entities.

Completion Date – 31st March 2020

SDRC 8

Detailed Publication and Dissemination of Learning from Project

Effective dissemination of project learning and business process maps to ensure that UK and international stakeholders can benefit from the delivery of project EVOLUTION.

Evidence

Publication and dissemination of project learning including:

- Detailed business process maps for alternative approaches to establishment of DSO model and services
- Proposals for structure of future market for establishment of DSO model
- Learning and technical documentation to support the technology deployed and how this interacts with commercial mechanisms established with DER providers/DSO/SO

Completion Date – 31st March 2020

List of Appendices

A	**Benefits Table**
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Appendix A – Benefits Table (Financial Benefits)

Financial benefit (£m)								
Scale	**Method**	**Method Cost**	**Base Case Cost**	**Benefit 2020**	**Benefit 2030**	**Benefit 2050**	**Notes**	**Cross-references**
Post-trial solution *(individual deployment)*	Method 1	0.84	6.84	15.7	59.4	196.3	The benefits are quantified from: [1]. Saving in constraint balancing costs [2]. Curtailment mitigation through active outage management and distribution balancing services 2020 benefits consists of: [1]. £0.819m per annum [2]. £2.231m per annum 2030 benefits consists of: [1]. £4.676m per annum (Low Carbon Life growth scenario) [2]. £2.231m per annum 2050 benefits consists of: [1]. £4.613m per annum (Low Carbon Life growth scenario) [2]. £2.231m per annum In each case what is presented is in terms of **cumulative financial benefit.** Benefits for [1] are based upon the 7% reduction in balancing costs due to one GSP being utilised as a Balancing Unit. It is expected that this is towards the higher range of benefit and these benefits can be expected to reduce by 50% (i.e. 3.5% reduction in balancing costs) in more conservative cases. This benefit does not include difference between Method Cost and Base Case Cost that is stated in Submission Spreadsheet.	The underlying assumptions were calculated in the following sections of Appendix B: 2020: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 7 2030: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 7 2050: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 7
Licensee scale	Method 1	5.5	6.84	176.4	882.3	2,740	The benefits are quantified from: [1]. Saving in constraint balancing costs [2]. Curtailment mitigation through active outage management and distribution balancing services (15 GSPs) 2020 benefits consists of: [1]. £1.638m per annum [2]. £33.465m per annum (15 GSPs)	The underlying assumptions were calculated in the following sections of Appendix B: 2020: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 7

							2030 benefits consists of: [1]. £9.35m per annum (Low Carbon Life growth scenario) [2]. £66.3m per annum (30 GSPs) 2050 benefits consists of: [1]. £9.23m per annum (Low Carbon Life growth scenario) [2]. £83.66m per annum (38 GSPs) In each case what is presented is in terms of **cumulative financial benefit.** Benefits for [1] are based upon an estimate of 15% reduction in balancing costs due to 15 GSPs being utilised as a Balancing Unit. This is an approximation and it is possible that these benefits can be expected to reduce or increase by 50% (i.e. 7% increase/decrease in balancing costs).	2030: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 8 2050: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 8
GB rollout scale	Method 1	71.5	6.84	21,265.2	106,336.8	319145.1	The benefits are quantified from: [1]. Saving in constraint balancing costs [2]. Curtailment mitigation through active outage management and distribution balancing services 2020 benefits consists of: [1]. £3.8m per annum [2]. £4,250m per annum (127 GSPs) 2030 benefits consists of: [1]. £15.62m per annum (Low Carbon Life growth scenario) [2]. £8,500m per annum (263 GSPs) 2050 benefits consists of: [1]. £15,41m per annum (Low Carbon Life growth scenario) [2]. £10,625m per annum (328 GSPs) In each case what is presented is in terms of **cumulative financial benefit.** Benefits for [1] are based upon the 7% reduction in balancing costs due GSPs being utilised as a Balancing Unit across the UK. It is expected that this is a conservative estimate and these benefits may increase by up to 100% (i.e. reflecting up to a 14% reduction in balancing costs) in more optimistic cases.	The underlying assumptions were calculated in the following sections of Appendix B: 2020: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 7 2030: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 8 2050: [1]. Section 1.1.1; Page 5 [2]. Section 1.3.1; Page 8

The method cost has been derived as a scaled value assuming licensee-scale costs rolled-out across all 13 GB distribution license areas.	

Benefits Table – (Carbon and/or Environmental Benefits)

Capacity released and/ or environmental benefit (MWh)								
Scale	**Method**	**Method Cost**	**Base Case Cost**	**2020**	**2030**	**2050**	**Notes**	**Cross-references**
Post-trial solution *(individual deployment)*	Method 1	£0.84m	£6.84m	139,435	418,305	976,045	No associated MWh method or base-case cost. The benefits are quantified as approximations of the additional MWh renewable energy production enabled through curtailment mitigation via active outage management and distribution balancing services at a single GSP. 2020: 27,887 MWh per annum 2030: 27,887 MWh per annum 2050: 27,887 MWh per annum In each case what is presented is in terms of **cumulative additional MWh low-carbon energy produced.**	The underlying assumptions were calculated in the following sections of Appendix B: 2020: Section 1.3.1; Page 7 2030: Section 1.3.1; Page 7 2050: Section 1.3.1; Page 7
Licensee scale *If applicable, indicate the number of relevant sites on the Licensees' network.*	Method 1	£5.5m	£6.84m	2,091,525	10,457,625	31,377,625	No associated MWh method or base-case cost. The benefits are quantified as approximations of the additional MWh renewable energy production enabled through curtailment mitigation via active outage management and distribution balancing services. 2020: 418,305 MWh per annum (15 GSPs) 2030: 836,610 MWh per annum (30 GSPs) 2050: 1,046,000 MWh per annum (38 GSPs)	The underlying assumptions were calculated in the following sections of Appendix B: 2020: Section 1.3.1; Page 7 2030: Section 1.3.1; Page 8 2050: Section 1.3.1; Page 8

							In each case what is presented is in terms of **cumulative additional MWh low-carbon energy produced.**	
GB rollout scale *If applicable, indicate the number of relevant sites on the GB network.*	Method 1	£71.5m	£6.84m	2,656,250	13,281,250	39,843,250	No associated MWh method or base-case cost. The benefits are quantified as approximations of the additional MWh renewable energy production enabled through curtailment mitigation via active outage management and distribution balancing services. 2020: 531,250 MWh per annum (127 GSPs) 2030: 1,062,500 MWh per annum (263 GSPs) 2050: 1,328,100 MWh per annum (328 GSPs) In each case what is presented is in terms of **cumulative additional MWh low-carbon energy produced.**	The underlying assumptions were calculated in the following sections of Appendix B: 2020: Section 1.3.1; Page 7 2030: Section 1.3.1; Page 8 2050: Section 1.3.1; Page 8
If applicable, indicate any carbon and/or environmental benefits which cannot be expressed as kVA or kWh.	**Post-trial solution:** [Explain any carbon and/ or environmental benefits which cannot be expressed as kVA or kWh]							
	Licensee scale: [Explain any carbon and/ or environmental benefits which cannot be expressed as capacity or kVA or kWh]							
	GB rollout scale: [Explain any carbon and/ or environmental benefits which cannot be expressed as kVA or kWh]							

Appendix B – Business Case Supplement

The cost of balancing the electricity system will continue to rise if the SO has to contend with limited visibility and rising uncertainty over GSP load profiles coupled with insufficient resources under its influence to deliver the required balancing and ancillary services. National Grid estimates that system operation costs could increase by approximately £1700m within the next 10 years assuming a Low Carbon Life as future energy scenario. This scenario is chosen here because it represents the potential cost to consumers if our electricity system is not fully engaged with SMART technologies, which reflects the importance of introducing innovative solutions to reduce the cost of balancing the demand and generation by providing SO with greater visibility and influence over GSP import and export[1].

One solution to this problem could be to extend the role of the SO. However, an expansion of direct SO influence into the distribution system, beyond present arrangements, is not desirable as it could at times impede the Network Licensee from fulfilling its obligations, leading to financial penalties.

What is desirable is a new market mechanism, administered by the Network Licensee, which continues to allow the Network Licensee to meet its obligations, but also gives the SO greater visibility and influence over GSP import and export. In the proposed project, the trial zone will be enrolled as a VBMU/ASA and will provide balancing and ancillary services to the SO. Service provision will be achieved through procurement of similar services from resources connected downstream of the GSP by the Network Licensee. A fair and transparent local distribution services market will be designed during the project so as to allow the Network Licensee to act as a neutral Distribution System Operator across the trial zone and eventually across multiple GSPs in its Licence Area.

This project is a first of its kind in the UK and is therefore highly innovative. While there have been a few European FP7 projects looking at the implementation of a DSO model (e.g. EvolvDSO[2]) the concept has never been applied to the UK regulatory environment. A trial project to explore the potential issues, in the context of the UK market and regulatory environment, is essential to progressing the DSO concept being considered by the Smart Grid Forum and other industry groups such as the IET Power Network Joint Vision experts.

The success of this project could potentially accelerate the most significant progression of the energy industry since privatisation. With this progress comes significant risks that warrant caution in what is attempted at this fledgling stage of developing the innovation.

1.1. Balancing Services Market

Figure is a table extracted from the Monthly Balancing Services Summary published by National Grid in April 2015. What it shows clearly is that the balancing services market value, close to £1 billion annually, represents a significant opportunity to new participants. The size of the market that could be captured by a VBMU depends greatly on its locational and temporal characteristics.

Ability to earn revenue from constraints payments, for example, is largely down to a VBMU's location on the network and therefore its ability to solve a location specific problem. There have been a number of high profile examples[3] where this has resulted in BMUs in heavily congested areas of the network receiving very large constraint payments because of limited competition in that particular area. Other temporal

[1] National Grid, The Electricity Ten Year Statement 2014, Page 151.
[2] EvolvDSO, http://www.evolvdso.eu/, July 2015.
[3] National Grid Website, Grounds for Constraint, http://www.nationalgridconnecting.com/grounds-for-constraint/.

characteristics such as speed of response and coincidence of availability with problem times of the day also significantly impact on potential revenue.

There is the very real possibility within a competitive market of being continually outbid by less expensive alternatives. Therefore any new revenue stream for both the Network Licensee and the DSO market participants should be treated as supplementary to primary sources of revenue, as should be the case for existing BMUs. However, having a DSO open up a market at appropriately located GSPs to a much greater number of participants will result in more competitive supply of services.

Simply having this increased competition at the very least should drive down system balancing costs, which is of major benefit to all customers. However, due to its richness of resources the VBMU could eventually become the most competitive source of balancing services. Ultimately, due to its nature, it is very unlikely to result in payments being concentrated amongst one or two fortunately placed resources.

2015/16 £m	A. Year to Date Total Cost	B. Year To Date Target	C. Year to Date Latest Cost Forecast	D. Year to Date Initial Target Forecast	E. Projected Total Cost for Year (Cost Outturn + Latest Cost Forecast)	F. Projected Scheme Target Total (Year 1)	G. Initital Forecast for Year
Energy Imbalance	-£14.0	£0.0	-£4.4	-£14.3	-£47.8	£0.0	-£94.0
Operating Reserve	£5.9	£0.0	£4.9	£16.9	£86.8	£0.0	£174.8
BM Startup	£0.0	£0.0	£0.0	£0.5	£2.7	£1.9	£4.8
STOR	£2.9	£0.0	£4.4	£6.5	£62.1	£0.0	£82.8
Constraints - E&W	£5.9	£0.0	£14.2	£58.5	£296.1	£0.0	£610.9
Constraints - Cheviot	£3.0						
Constraints - Scotland	£4.8						
Footroom	£0.3	£0.0	£0.7	£0.2	£10.2	£0.0	£15.6
Fast Reserve	£8.6	£0.0	£11.0	£11.8	£124.6	£0.0	£148.9
Response	£15.6	£0.0	£14.5	£18.6	£177.7	£0.0	£213.4
Reactive	£6.7	£0.0	£6.7	£7.1	£72.2	£0.0	£87.8
Minor Components	£4.2	£1.7	£3.0	£3.8	£40.6	£21.4	£51.8
TOTAL	£43.9	£1.7	£55.0	£109.5	£825.2	£23.2	£1,296.8

Figure 1: National Grid "Monthly Balancing Services Summary 2015/16", April 2015

In addition, transmission constraints occasionally impose limitations or cuts to renewable generators connected to both transmission and distribution which could impact the decarbonisation of UK economy. The year to date breakdown of constraint costs for financial year 2015-2016 shown in Figure illustrate that £1.01m has been spent on wind farms alone to balance the system.

FY2015-2016	All Values £m		
Fuel Type	Payments to Manage Constraint	Payments to Rebalance System	Net
COAL	-3.06	-0.61	-3.67
GAS	1.26	16.36	17.62
INTERCONNECTOR	-0.65	-0.76	-1.41
WIND	1.01	0.00	1.01
OTHER	-0.09	0.20	0.10
Total	-1.53	15.19	13.66

Figure 2: National Grid "Monthly Balancing Services Summary 2015/16", April 2015

Figure illustrates the total cost incurred between 2010 and 2015 for payments to wind power generators due to transmission network constraints. The overwhelming majority of the payments have been in Scotland, where the bulk of wind farms are located[4].

£m	2010/11	2011/12	2012/13	2013/14	2014/15
Payments to Wind powered generation	0.2	34.1	7.6	49.7	65.4

Figure 3: National Grid Website, Balancing Services, July 2015

The inclusion of GSPs as an additional source of BMU could significantly reduce the dependence on a small number of large wind farms to secure the network and balance the system. The Elexon report entitled, Actively Managed Distribution Generation and BCS Quantitative Modelling[5], identified that the use of flexible resources under a targeted Grid Supply Point (GSP), and the effect that this would have on the B6 transmission constraints and balancing alone, would equate to approximately 7% saving on constraint balancing payments.

1.2. Quantification of Benefits: Balancing Services Market

It has already been referenced that the democratisation and expansion of the balancing services market to include a single GSP in central Scotland can introduce an approximately 7% saving on constraint and system balancing payments in Scotland[6]. An approximate benefit can be quantified financially across the proposed trial, at a licensee scale, and at a GB-wide scale using the methodology that follows. At this stage the benefit forecasts only considers the benefits of new distribution smaller-scale balancing units providing constraint alleviation balancing services. It is recognised that these generators may provide additional balancing services, which will be investigated further in the project.

[4] The Telegraph, By Emily Gosden, November 2014.
[5] Elexon, Actively Managed Distribution Generation and BCS Quantitative Modelling, Page 6, June 2014.
[6] Elexon, Actively Managed Distribution Generation and BCS Quantitative Modelling, Page 6, June 2014.

Across Scotland, a typical example of annual constraint balancing payments is £11.7m[7]. Enabling a **single** GSP to provide services as a BMU can reduce this balancing cost by up to 7%, or **£819k** per annum.

Across the SP Distribution licence area, it has been estimated that 15 GSP sites have significant volumes of DG connected and as such are frequently exporting to the transmission network. At present there is no available studies or data to show the overall commercial benefit of providing BMU services from multiple GSPs, however it can be safely assumed that a greater number of participants in the balancing market will serve to drive costs down. We can assume that the reduction in balancing costs of 7% will be further improved. If a doubling of the single-GSP benefit was achieved through participation of 15 GSPs, a constraint balancing cost saving of **£1,638k** would be achieved per annum.

Expanding this across the entire GB system, where Figure 3 shows that the average annual balancing costs since 2011 has been £39.1m, using the expectation of at least a 7% reduction in constraint balancing costs, we can assume that the provision of BMU services from GSPs will provide a saving of at least **£2,737k**.

The above estimates have used available information from previous studies, however it is expected that as a better understanding of the market potential for VBMUs is gained through the proposed project, a stronger business case for rollout can be defined.

Looking to the future, National Grid Low Carbon Life energy scenarios estimates an increase in balancing costs to £6bn (£6,000m) in 2030, with this stabilising into the future[8]. Assuming existing total annual balancing costs of £1,296m as found in Figure , we can approximate the future percentage increase in balancing services and apply this to the estimated values of constraint balancing saving benefits that has already been calculated.

2030 and 2050 (assuming no change in balancing costs between 2030 and 2050)

Percentage increase in balancing services: (£1,296m + £6,000m)/£1,296m = 563%

Trial benefit growth: **£461.097m**

Licensee scale benefit growth: **£922.194m**

GB-wide benefit growth: **£1,540.931m**

At this stage it is difficult to quantify the environmental or carbon-benefits directly associated with the democratisation of the balancing market. As described previously, it may be the case that increasing the number of participants in the balancing market provides greater network availability for renewable generators to export, however this will be highly dependent on specific balancing conditions and cannot be quantified at this stage.

1.3. New Revenue Streams

Revenue generated by the VBMU will in the first instance go towards settling payments to DSO market participants for services provided. This will open up an entirely new revenue stream for the vast majority of DER. Some DER do participate in the ancillary balancing services market today, chiefly Short Term Operating Reserve (STOR), however

[7] Elexon, Actively Managed Distribution Generation and BCS Quantitative Modelling, Page 31, June 2014.
[8] National Grid, The Electricity Ten Year Statement 2014, Page 151.

this is severely limited in terms of overall balancing services market share, as quantified in Figure .

Most DER are prohibited from directly participating in the balancing services market due to their small size. Then there are the large generators connected to the distribution network, known as BELLAs, which elect not to participate due to the high cost of participation which is approximately £30k-£40k per site with ongoing cost of £7k[9]. Having the Network Licensee administer this DSO market at GSPs allows for aggregation of smaller units and the cost burden of enrolling as a VBMU to be borne initially by the Network Licensee and then socialised across market participants over time. Thus removing significant barriers to entry making a stronger business case for DER to participate.

Customers installing DER will have the opportunity to capture the full value of their DER and the benefits it can provide to system operation. This additional source of revenue for DER could ultimately lead to a reduction in the reliance on subsidies for low carbon technologies.

For performing this role, the Network Licensee would expect to receive compensation commensurate with the value of the service it is providing as the market facilitator. How the Network Licensee conducts its market trades, the mark-up it applies to services it is procuring, cost recovery over time and the profit it can make from this new opportunity will be the subject of scrutiny during the project.

1.4. Quantification of New Benefits: New Revenue Streams

The scope of the project ensures that the economic and environmental benefits of new generator revenue streams are thoroughly investigated and quantified. At this stage, however, the benefits of new generator revenue streams have not been quantified. The economic and environmental benefits as suggested above are all subject to a large number of external factors that are expected to have a significant impact on renewable generation penetration in the future.

1.5. Continuation of ANM Rollout and Enhancement Through New Distribution Balancing Services

Network Licensees have already invested a lot of customer money in the development of ANM, the benefits of which include lowering carbon emissions through facilitating cheaper faster connection of renewable generation are very well understood. Not having a DSO entity today is not a threat to wider scale ANM adoption. However, it can provide an enhancement to this already greatly beneficial technology.

As it is predominantly low carbon technologies that connect to the distribution network through an ANM connection, curtailment has a quantifiable cost to society in terms of lost CO_2 reduction as well as lost revenue to the owner. In addition to ANM connected generators, there are non-ANM connected generators, either not BMUs or BELLAs, which are curtailed for long periods of time so as to allow Network Licensees to take outages on their network. These outages are critical to the ongoing maintenance and operation of the national infrastructure, however the resultant lost CO_2 reduction and lost customer revenue is becoming so significant as to warrant greater investment in finding a resolution.

Anticipating that in the future the situation may become unacceptable to customers or that Network Licensee may be required to compensate curtailed generation, now is the

[9] National Grid, Managing intermittent and inflexible generation in the Balancing Mechanism, Page 4, 2011.

time to investigate ways to reduce this. By investing in the creation of a DSO market to facilitate the VBMU, the Network Licensee creates significant opportunity to expand this to new distribution network focused balancing services. Or, use the infrastructure to administer bi-lateral contracts between disparate DER, in a virtual private wire arrangement for example, a wind farm could procure energy storage to avoid or limit curtailment during a network outage or times of low demand.

The expected result is further additional revenue for DER, reduction in lost revenue to generators, and increased CO_2 reduction. The Network Licensee would similarly expect compensation for facilitating this service and the SO could have full visibility.

1.6. Quantification of Benefits: Continuation of ANM Rollout and Enhancement Through New Distribution Balancing Services

The economic benefits of providing new distribution balancing services and continuation of ANM rollout is primarily experienced by the distributed energy resources that can participate in a DSO market and minimise the impact of events such as system outages. Using the trial zone example of 3 GSPs, one of which isdescribed in greater detail below. Under existing conditions East Kilbride South has contracted generators which are expected to operate at reduced export during outage conditions as follows:

3 generators operating at reduced export: 32.2MW + 29.9MW + 26MW = 88.1MW Capacity.

Aggregated export limited to 20MW

Assuming 35% capacity factor and 65 days under restrictions due to outages:

Unrestricted total export during period: 48,103MWh

Restricted export during period: 10,920MWh

Total lost energy due to restriction: 37,183MWh (lost revenue @£80/MWh): £2.975m

Assuming the provision of an actively managed connection and participation in DSO balancing arrangements results in 75% network availability/capacity during the outage period, the following economic and environmental benefits will be observed.

Additional energy produced during period: 75% of 37,183MWh: **27,887MWh (£2.231m @£80/MWh) per annum**

The above approximation relates to the single GSP benefits of the project. This can be scaled across the SPD licence area and GB wide as follows.

Under the assumption that 15 GSPs in the SP Distribution (SPD) area (19% of total SPD GSPs) have high DG penetration and similar outage periods as East Kilbride South, the total benefits will be scaled linearly across 15 GSPs.

Licence area annual additional energy produced: **418,305MWh**, **£33.465m @£80/MWh**.

There is a total of 671 GSPs in the GB system[10]. Using the SP Distribution proportion of 19% as exporting with high DG penetration, it is possible to approximate the total benefits scaled linearly across 127 GSPs GB-wide.

GB-wide annual additional energy produced: **531.25GWh, £4,250m @£80/MWh**.

[10] National Grid, The Electricity Ten Year Statement 2014, Appendix B – System Data.

Looking towards 2030 and 2050, it is expected that continued DG growth will affect the licence area and GB-wide cases where a greater number of GSPs will be subject to export limitations during scenarios such as outages and the benefits of active management and DSO market flexibility can be exploited. It is expected that the trial-area GSP case will not see significant increase in benefit as the GSP is already significantly congested with limited scope for further release of capacity.

Based upon an assumption that the number of affected GSPs at a licence area and GB-wide scale will double by 2030:

Licence area annual additional energy produced: **836,610MWh**, **£66.30m @£80/MWh**.

GB-wide annual additional energy produced: **1,062.5GWh, £8,500m @£80/MWh**.

Based upon an assumption that the number of affected GSPs will start to level off towards 2050, with an increase of 250% on 2020 forecasts:

Licence area annual additional energy produced: **1,046GWh**, **£83.66m @£80/MWh**.

GB-wide annual additional energy produced: **1,328.1GWh, £10,625m @£80/MWh**.

1.7. Case Study: East Kilbride South GSP

East Kilbride South GSP was chosen for Evolution because it is at saturation point under normal design conditions as a consequence of the large volume of renewable generation connected and contracted. There is already over 80MW of connected generation with another 26MW contracted to connect. The penetration of embedded generation on the distribution network means relatively small generation projects are unable to connect ahead of major reinforcement works being completed. No reinforcement works are planned and therefore no more capacity will be released. The export of East Kilbride GSP in 2014 is shown in Figure 4. The maximum generation exported from East Kilbride GSP was 58.77MW on 11th August at 3am. The maximum generation import at the GSP was 13.99MW on 2nd July at noon.

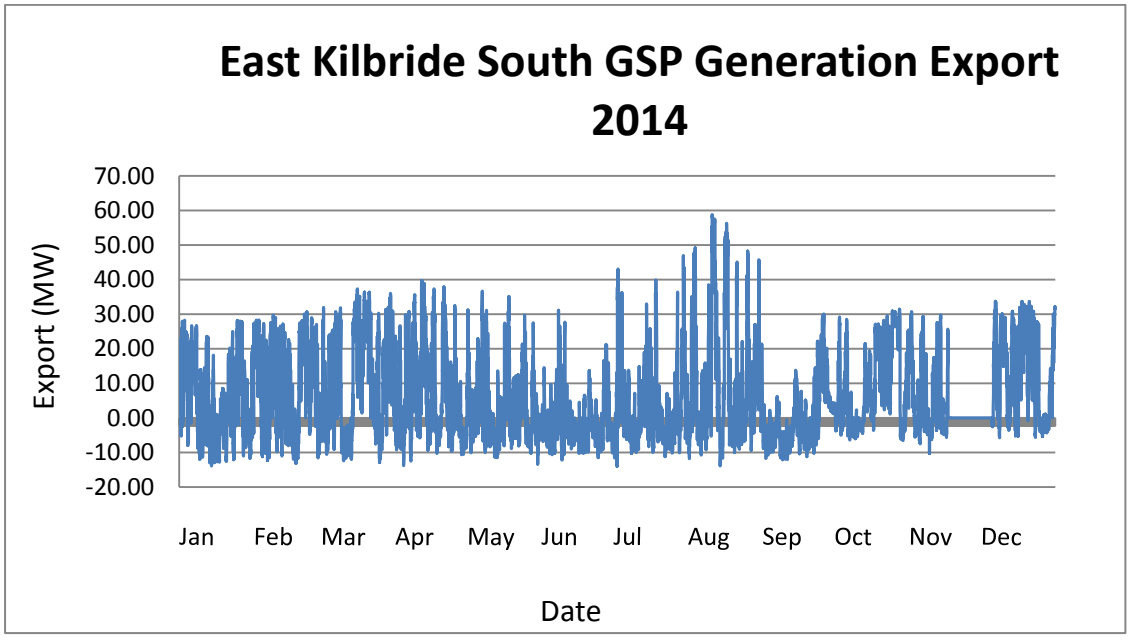

Figure 4: East Kilbride South GSP Generation Export 2014

The network fed from East Kilbride South GSP offers a good mix of urban and rural areas as well as a suitable variety of industrial, commercial and domestic customers. We see opportunities to facilitate growth in demand side response by engaging with local industrial customers like Freescale as well as commercial customers like the EK Shopping Centre and Kingsgate Retail Park.

An overview of the energy export from East Kilbride South is shown in Figure . The GSP has two 275kV/33kV 120MVA transformers. East Kilbride South GSP supplies 2 primary substations, 75 secondary substations and around 9,300 customers. Common Farm Primary Substation has two 33/11kV 11.5MVA transformers and had a maximum load of 8.9MW last year; this maximum is expected to rise to 9.2MW by 2019. Kelvin Primary Substation has two 33/11kV 12MVA transformers and reached a maximum demand of 10.1MW last year; this maximum is expected to increase to 10.5MW by 2019. There is currently one customer connected at 33kV; semiconductor manufacturer Freescale who had a maximum demand of 0.5MW last year. There are three large wind farms connected at 33kV; Ardoch Over Enoch (11.5MW), Calder Water (32.2MW) and West Browncastle (29.9MW). A fourth wind farm, Dungavel (26MW) is due to be connected to the 33kV network in the near future. At 11kV, there is one turbine (0.6MW) connected at the Sainsbury's Distribution Centre and two landfill sites; Cathkin and Rigmuir (2MW). Cathkin landfill is permanently capped at 4.5MW despite having a maximum capacity of 5.32MW.

To allow essential maintenance to the network, there are a number of outages scheduled within the trials zone in 2015 which will require generation at both West Browncastle and Calder Water wind farms to be constrained to 10MW each. Once connected, the Dungavel wind farm will also be fully curtailed under such circumstances.

The wind farms will be constrained for at least 65 days in 2015 and this will continue to rise in each of the following years. Having reviewed the last three years of wind data, West Browncastle wind farm expect lost revenue due to these constraints to range between £300k and £400k in 2015. After Dungavel is connected, constraints at East Kilbride South will result in projected lost earnings to customers of at least £1million every year.

1.8. Risks

A risk is that the commercial terms between the SO and the Network Licensee are expected to be similar to any other BMU, however, special dispensation may be required to account for the inevitably unique characteristics ofGSPs operating as a VBMU, not present in existing BMUs.

These risks along with the unknown true costs of implementing such a market and the level of compensation the Network Licensee can expect to receive for implementing it, make for an extremely strong case to explore this in a demonstration project where methods for mitigating these risks can be developed before committing to a full scale rollout. Furthermore, by focusing on 3 GSPs as a combined trials zone for this demonstration, it avoids the multiplication of risks associated with having to set-up multiple, what are essentially independent, DSO markets. The choice of the East Kilbride, East Kilbride South and Strathaven substations should provide access to the broadest range of potential demand and generation customers, with a combination of rural and urban networks, in order to explore as many system services and commercial arrangements as possible.

Unfortunately this does not allow for demonstration of the DSO method for operating multiple DSO markets and their interaction, if any, at the SO level. However, the technical and commercial issues associated scale up of the Method across UK GSPs will be part of the project.

1.9. Summary of Benefits

The approaches discussed in this document are innovative solutions that will have a direct impact on SO and Network Licensee. Benefits include:

- Opening up the balancing market to allow a larger number of smaller customers to participate. This will democratise the balancing market and allow generators to not just sell energy, but services as well.
- Increasing the number of participants in the balancing market will introduce greater competition, bringing down the cost of services. This will reduce system operation costs and ultimately provide benefit to customers.
- Participation in the balancing market will allow distributed generators to capture the full value of their offering and further promote low carbon technologies. This will reduce reliance on subsidies to be profitable and strengthen the business case for low carbon technologies.
- Increasing the number of participants in the balancing market will provide more levers for the GB System Operator to manage system operation. This will ultimately reduce risks to system operation by ensuring a higher degree of controllability.
- The creation of a market offering balancing services at distribution level can provide more options to generators when the DSO is managing outages. This can have benefit for generation customers and increase production from low carbon technologies.
- Ensure that managed connections can be adopted on a wide scale. This will provide the opportunity for more low cost and accelerated connections for distributed generation that is subject to technical network constraints.

Appendix C – Technical Description Supplement

Problem Statement

Historically, National Grid was able to predict demand and manage large scale generation when the network was configured as shown in Figure .

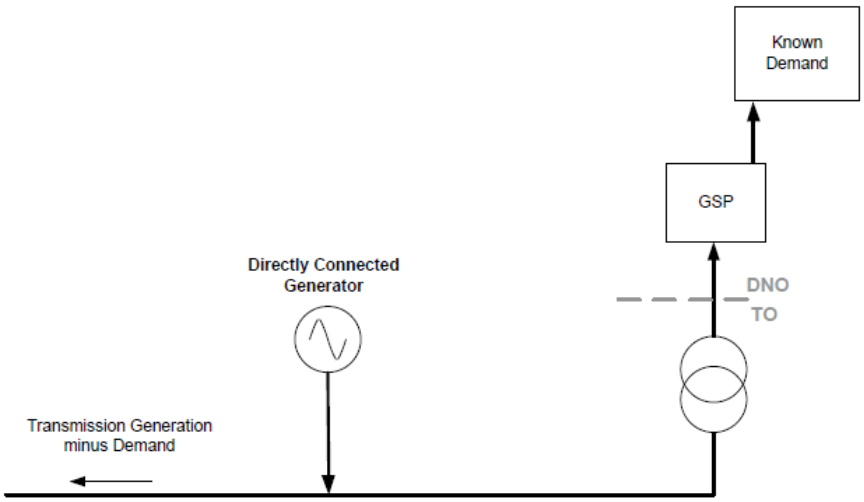

Figure 1 Basic Network Configuration

BELLA arrangements grant Transmission Entry Capacity (TEC) to large embedded generation i.e. generation connected at distribution level but granted export to transmission level. BEGA arrangements are similar to BELLA arrangements, with the added capability of participation in the Balancing Mechanism. Most importantly, both BELLA and BEGA embedded generators are visible to the GB System Operator (SO).

Technology continued to develop, and soon smaller embedded generation was connected at distribution level. This generation has the advantage of being located close to the demand, therefore facilitating the supply of local load. However the SO does not have visibility of this generation, and it is masked as a reduction in the demand. Now, the known demand which the SO could previously rely upon, is now variable due to the embedded generation connected behind a GSP.

The embedded generation makes system operation much more difficult and less of the overall generation supply is controllable at any point in time i.e. less large transmission connected generators or BEGA connected embedded generation to manage. The challenges are well articulated in the National Grid System Operator Framework (National Grid, 2014), with particular reference made to the requirement for DSOs to support system operation in the future:

- "The increase in distribution connected resources such as embedded generator, energy storage, and Demand Side Response (DSR) requires better coordination of resources to ensure the impact on operability of the whole system is assessed"
- "DSOs role is expected to be active distribution network operation with the aim to aid technically and economically optimal overall electricity system operation."
- The evolution of these active DSOs is not expected at least until the end of the current DNO price control RIIO-ED1 that ends in March 2023.

With these issues already prevalent in the UK, EVOLUTION will begin to address the DSO role before the end of the RIIO-ED1 price control period, with an aim to provide valuable learning to enable DNOs to rollout the DSO model in suitable areas of the network from 2023 onwards.

Future growth predicted by National Grid's Future Energy Scenarios (National Grid, 2015) indicates that:

- There is 4.8 GW of PV now connected in GB and this is estimated to increase to 19 GW by 2025 under a 'Gone Green' scenario.
- Under the Gone Green scenario, total distributed generation is forecasted to rise from 12.6 GW to 23.5 GW by 2025 in the context of a maximum demand of 61 GW.
- The increase in generation connections has resulted in negative prices and system constraint costs rising rapidly.
- The traditional means of operating the system is becoming more difficult and more costly.

In parallel, at distribution level, proliferation of ANM to provide cost effective and timely connection for DG customers is increasing the amount of embedded generation. The majority of projects e.g. Orkney, FPP are operated on Non-Balancing Mechanism Units (Scottish and Southern Energy Power Distribution, 2014; UK Power Networks, 2015).

The Catalyst for EVOLUTION

The SPEN ARC project (SP Distribution, 2015) started looking at the interaction between distribution and transmission networks. This was limited to managing TO local constraints at a grid transformer by using ANM to control power flow through the constraints allowing additional generation to connect to a GSP that was saturated under normal design conditions.

The ARC project has looked at the case of Aikengall generator. This large generator has a BEGA connection with SP Transmission i.e. it has a TEC and is a BMU. We have trialled the unit's interaction with emergency signalling from National Grid. This has flagged the issue of increasing interaction of ANM with the Balancing Mechanism and National Grid as SO.

For example, the SO may ask Aikengall as a BMU to reduce output in order to manage transmission constraints. As Aikengall reduces output, the ANM system of Non-Balancing Mechanism Units would see available spare capacity resulting in these units filling the gaps left – the constraint would not be recognised and constraint costs would increase. In future, this could lead to multiple GSPs behaving in this manner with further complexity added to system balancing, shown in Figure .

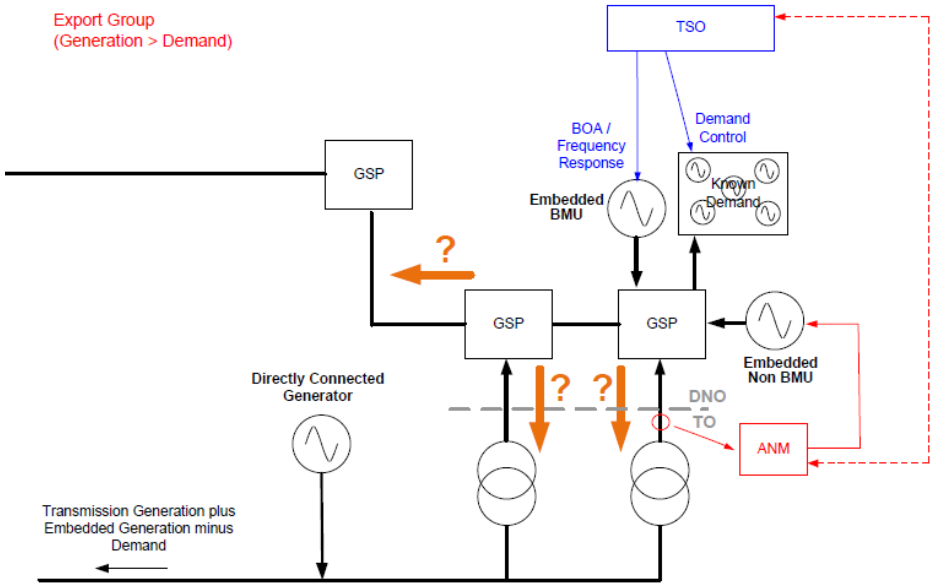

Figure 2: Demonstrating the Future Scenarios which could cause Balancing Issues for the SO

Democratising the Services Market

The ARC project, in tandem with a recent report from Elexon (Sinclair et al., 2014), highlighted the increasing interaction of ANM connected generation with the Balancing Mechanism. The report estimates that balancing actions taken on DG will be around 1 TWh annually by 2023 (only 10% of 15-17 TWh of total annual balancing volumes at transmission level) however this will increase should DG continue to grow post 2023.

Analysis carried out in the Elexon report suggested that there are potential savings to transmission constraint costs of up to 7% if a DSO allowed the SO to access curtailment of DG. The report concludes with strong recommendations for trials of DSO models to be carried out to allow further learning to be gained in this area.

More recently, in June 2015 the CIRED working group (CIRED, 2015) was established to explore the SO/DSO interface, the evolving roles and technical solutions which could be required in future energy systems. This working group is composed of experts from across Europe and the result of the working group will be published at the next CIRED Conference in 2017.

ANM is a key smart grid technology for delivering RIIO-ED1 plans and recent publication of a Good Practice Guide (Energy Networks Association, 2015) in tandem with DG Action Plans indicates that there is a desire across the industry to offer more non-firm connections across the UK. In the most recent ARC project update, the project team had initiated the process of extending the ARC trial to other areas of the network and making ANM connections Business As Usual (SP Energy Networks, 2014). Other DNOs have also outlined similar rollout plans for ANM to Business As Usual.

Without addressing the interaction between ANM and the SO there is a risk that the pace of offering connections to new customers will slow down. For managed DG connections this should be resolved as part of 'Business As Usual' operation, outside of an innovation project.

The timing of connections is critical in order to provide connections to customers before the renewable subsidies (including FITs, ROs and CfDs) degrade further.

The question for the longer term is how can distributed generation, including non-firm connected DG, in its wider sense become part of the solution to the SO problem rather than the cause?

For renewable development, the reduction in subsidies is increasing pressure to identify cheaper grid connections and also identify new revenue streams for distributed energy resources to ensure that development is viable in the long term without subsidy. To deliver this it is necessary to open the market for system operation services to the ever increasing DG base. Other markets around the world are also moving in this direction – seeing the value in having distributed energy resources (demand, storage and generation) providing a much greater role across the energy system for the benefit of customers (New York State, 2015).

The concept behind this project is therefore to:

- **Democratise the services market by opening it up to a wider range of generators who currently do not have access to the market**
- **Improve visibility and controllability for system operation**
- **Reduce wider system operation costs**

While many of the benefits of this approach are felt by the SO and by customers (with access to the services market) it is the DNO who is in the best position to deliver the project. Only they have access to the information to perform the role and manage the power flows, voltages and fault levels across their network. Letting others perform this role could easily result in licence obligation breaches which the DNO would no longer own the levers to prevent.

While non-firm connections and distributed generation have been the genesis for this project, the requirement to turn GSPs into a dispatchable VBMU/ASA requires the following services:

- Reactive power
- Turn up
- Turn down
- Frequency response

Providing this response from a local level to the SO results in the DNO performing SO services.

This showcase project will therefore explore the role of a future DSO and explore issues such as the scope of a DSO, future market structures and the regulatory implications of operating a GSP as a VBMU/ASA.

Aims and Objectives

The aims and objectives of EVOLUTION are as follows:

- Demonstrate the commercial and technical implementation of a DSO
- Address the current regulatory and grid code barriers to create greater interaction between transmission and distribution systems in order to deliver whole system benefits
- Successfully demonstrate how a DSO can act as a neutral market facilitator for DER.
- Improve visibility and control of DER for system operators
- Prove thatGSPs with significant levels of unpredictable export can be converted into a predictable and controllable generator that can participate in balancing services
- Achieve this through the creation of a distribution network services market that is open to many more participants, currently locked out of providing these services.
- Achieve a reduction in system operation costs

Precedents

There have been a number of LCNF Tier 1 and Tier 2 projects which have trialled elements of distribution markets, typically focused around demand response and storage. EVOLUTION is proposing to take a market trial to the next level. As with the ARC project, EVOLUTION will not only explore issues at distribution level, but also how they interact with and impact upon transmission level.

Most of the projects below explore new types of commercial arrangements and new revenue streams for storage devices. EVOLUTION will create new contracts and arrangements for all assets types connected within the trial location.

Orkney Storage Park

Orkney Storage Park is an LCNF Tier 1 funding project (Urquhart & MacLeman, 2013). It built upon the work carried out under the RPZ funding to create an ANM system on the island of Orkney in order to delay the high reinforcement cost of upgrading 33kV subsea cable. The Tier 1 project explored the installation and operation of a 1MW sodium sulphur NAS battery. The project also created the commercial incentives required to encourage a third party Energy Storage Provider (ESP) to own and operate the battery, or energy storage system (ESS) on Orkney and provide benefits to the DNO. The incentives were tested by running a commercial tender process to identify if suitable ESPs were attracted to the contracts available.

The key learning from the project included the creation of a novel commercial contract, an ESP identified and now operating on the system, a better understanding of the interface between ANM and storage system and a definition of the business processes required to support the project.

Smarter Storage

The Smarter Network Storage project is funded by Tier 2 of LCNF. The project aim is to carry out a range of technical and commercial innovation strategies to tackle the challenges of utilising storage and facilitate a more efficient and economic adoption of storage devices. The project explores the use of storage within the distribution network, and outside the boundaries of the network. The project began in January 2013 and will run until December 2016.

Objectives of the project include:

- Deployment of large scale distribution connected energy storage
- Implementation of a smart optimisation and control system in order to manage and optimise the storage flexibility
- Innovative commercial arrangements to support the shared use of energy storage in providing wider system benefits, including standby reserve and managing frequency
- Assessment and validation of the full value that storage can provide to DNOs and the wider system to support future business models for storage.

The commercial arrangements portion of this project, focuses on increasing revenue streams for storage providers above providing basic network support for the distribution network. A report published in 2014 (UK Power Networks, 2014) outlines the first of a kind contracts for operating storage as a commercial entity and shares them in the form of 'skeleton' contract heads of terms in order to be tailored for use by other DNOs and/or third party storage developers.

Low Carbon London

Low Carbon London is a Tier 2 LCNF project which explores the impact of a wide range of low carbon technologies on London's electricity distribution network. The key themes explored during the project include demand side response, distributed generation, electrification of heat and transport, network planning and future DSO arrangements.

As part of the future DSO theme, new innovative smart solutions were trialled in order to aid the process from proof of concept to a wider scale rollout. One of the learning reports addresses novel commercial arrangements for smart distribution networks (I. Konstantelos , D. Papadaskalopoulos, D. Pudjianto, M. Woolf, 2014). This report includes:

- Results of modelling dynamic time of use pricing for management of congestion in distribution networks and future development scenarios are characterised with large penetrations of flexible demand.
- Demonstration of the importance of a whole system approach to planning of distribution networks which includes the management of interaction between distribution network, energy supply, transmission networks and EU interconnectors.
- Commercial arrangements for DER and specifically the operation of demand side response.
- Exploration of the value of balancing services for DER and demand side response and the potential revenue which could be gained via a VPP concept.

The fourth item listed above is of most relevance to the EVOLUTION project. The VPP concept was tested using a computational simulation method. EVOLUTION builds upon this LCNF learning and the learning from ARC, by proposing a new DSO market design and following design iterations and improvements, an open loop trial of a DSO market of real GSPs.

Capacity 2 Customers

Capacity to Customers, (C_2C) is a Tier 2 LCNF project which trials the use of new technology and innovative contracts to increase the amount of energy that can be transmitted through the existing electricity network, and avoid costly reinforcements (Turner, Turner, Bircham, Cox, & Haigh, 2015). The project looked to test two different elements

- Enhanced technology used to enable better utilisation of existing assets
- Customer engagement to facilitate the commercialisation of releasing capacity on the network.

The outcomes of the project included a series of model commercial contracts that could potentially be used by other DNOs. This also includes a new connections process.

Similar to other projects mentioned in this section, the commercial arrangements focus on the interaction with demand, and demand response services within the distribution network.

Evolution Trial Description

The purpose of the trial is to demonstrate the commercial and technical implementation of a DSO in a real network location.

At a technical level, the project will establish a model of existing market arrangements, process flows, commercial responsibilities and technical systems that are required. This will then lead on to the creation of an alternative market design that will address both the existing operational requirements and deliver the enhanced capabilities required for a DSO.

A full operational trial is possible with the existing regulatory framework and therefore an open loop trial will be the final goal of the project trial, following closed loop iterations to trial and improve upon initial implantation of design.

During the trial, EVOLUTION will demonstrate (as far as possible and can be recruited through the project) the following services to the SO:

- Turn down services
- Turn up services
- Frequency response
- Reactive power management
- Outage management (which might be physically delivered as turn down or turn up services)
- Virtual private wire
- Local balancing to a dynamic TEC

During the trial, EVOLUTION will demonstrate delivery of the services outlined above, from the broadest range of assets possible:

- Generation
- Storage
- Demand
- Community schemes
- Virtual Private Wires between assets to create groups of mixed generation e.g. wind and solar.

Trial Location
In the trials zone, there are several outages planned in 2015, and more in future years which will have a significant impact on the existing wind farm generation.

There are three large wind farms connected to the 33kV network of East Kilbride South GSP; Ardoch Over Enoch (11.5MW), Calder Water (32.2MW) and West Browncastle (29.9MW). A fourth wind farm, Dungavel (26MW) is due to be connected to the 33kV network in the near future. To allow essential maintenance to the network, there are a number of outages scheduled for East Kilbride South and Strathaven GSPs in 2015 which will require generation at both West Browncastle and Calder Water wind farms to be constrained to 10MW each. The wind farms will be constrained for at least 65 days in 2015 and this will continue to rise in each of the following years. Having reviewed the last three years of wind data, West Browncastle wind farm expect lost revenue due to these constraints to range between £300k and £400k in 2015. After Dungavel is connected, constraints at East Kilbride South will result in projected lost earnings to customers of at least £1million every year.

Generators are already showing a keen interest in participating to the DSO trial, as with BELLA contracts they are currently unable to enter in to the transmission balancing services due to the high costs of installing the required BMU control and communications infrastructure. By introducing a services market, there will be opportunities for generators to receive revenue for balancing services offered to SO via the DSO.

This area is also likely to allow recruitment of a broad range of assets including Balancing Mechanism, Non-Balancing Mechanism generation, demand and storage assets due to the mix of urban and rural areas, as well as a suitable variety of industrial, commercial and domestic customers. Having a reasonable mix of assets will facilitate better market operation as opposed to a GSP which contained a single generator type. For example, a GSP which contained a large majority of wind may find itself in a position where it is unable to respond to service request due to low wind availability. By having a range of assets available, they can be aggregated together and other generation, demand and storage technologies available at times when renewable resource is low.

Project Method
The key objective of the trial is to convert normally uncontrolled GSPs in to a virtual, dispatchable BMU. This will allow the DSO to act as an aggregator for the currently Non-Balancing Mechanism Unit DER connected within the GSPs.

The recruitment of DER within GSPs will help to inform the DSO of the types (and capacity) of services available to offer the SO. The DSO will formally register with National Grid as a VBMU/ASA, have any additional communication devices installed and will have a TEC allocated. The DSO is then able to offer services dependent on those available within the GSPs.

The DSO will have the control to dispatch services when required by the SO but will always ensure that the technical network constraints within the local distribution network are kept within operational limits. This is a requirement of the licence conditions for the DNO. It is for this reason, that it would not be feasible to the SO to directly control generation within the distribution network as it would not have the visibility of network operational limits and could cause issues such as voltage rise on the local network.

Active Network Management will act as a control mechanism for the DSO. The ANM system will enable the DSO to monitor and control the DER in real time.

As well as supporting transmission level balancing, the DSO will facilitate local balancing markets within the trial area. The DSO will meter and settle the services as contracted.

The diagram below in Figure demonstrates how GSPs may operate as a VBMU. The ANM system is used as the control and data infrastructure for the DSO, and will interact with National Grid's EBS.

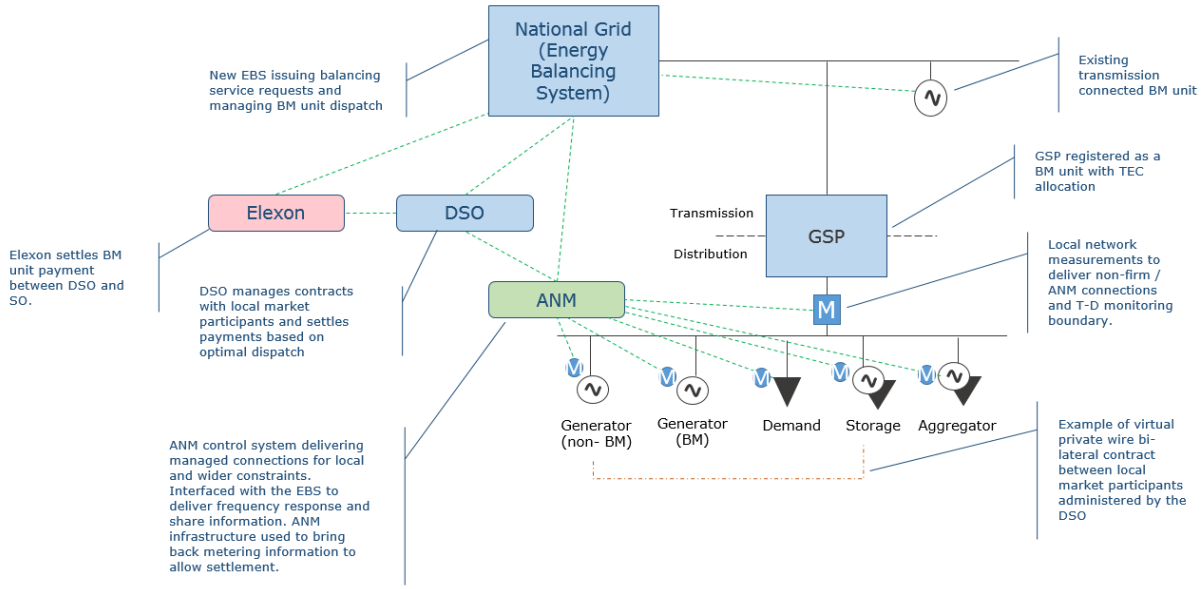

Figure 3 Diagram of How a GSP Might Operate as a BMU

The step by step process which could be followed is outlined below.

1. The GSPs are registered as a VBMU/ASA and during the initial stages of the trial, market participants are identified. These participants will pay a market participation fee to the DSO.
2. The DSO offers services to the National Grid EBS.
3. When they are required, National Grid will issue instructions to the DSO for balancing services, the DSO will assess local network conditions and confirm the supply of services to National Grid.
4. Following typical settlement procedure, Elexon will calculate the services provided by the DSO to National Grid and issue payment for availability and utilisation of those services. This revenue is then passed through to market participants.
5. Within the GSPs

a. Individual DER units will offer local balancing services to the DSO. Partnerships could be created between DER via virtual private wire links.
b. The DSO will contract with, and settle with local DER as required.

Technical and Commercial Aspects

The key focus of the trial is on the commercial rather than technical aspects and many of the methods will involve stakeholder engagement and consultation to establish what is feasible and acceptable to current market actors. In particular, engagement with SO and TO is essential to ensure new methods and procedures are compatible with existing practices.

There will be some operational aspects and systems that will require development. These will potentially be adapted from existing systems within DNO Control Room, Supplier Control Room or in conjunction with the SO. They may in turn have to be developed from an original concept. Due to the uniqueness of this proposed trial, lack of prior precedent and predominant association with commercial factors any innovative technology testing will relate to systems development and integration.

To deliver the proposed DSO model, new contracts are required between the SO, the DNO and market participants. The format of these contracts will be similar to those which already exist on the UK market in order to allow simple transition to the new DSO market for participants who already have an understanding of the UK market.

Innovative Aspects

EVOLUTION will be the first project of its kind in the UK to explore the utilisation of GSPs as a VBMU/ASA via the use of a DSO as aggregator. This will allow the SO to have visibility of the actions carried out at distribution level and therefore remove the uncertainty the SO is facing in the next decades regarding the growth of distribution connected generation.

The concept of creating a local balancing and network system operator is a new concept that has yet to be fully tested within the current electricity market.

By allowing the DNO to operate as DSO, the SO can now be fed important information with regards to system balancing. In addition to this, EVOLUTION will open up the services market to distribution level services, with the aim of increasing revenue for DG and driving down the cost of system balancing by increasing competition.

This inclusive local energy market will be open to all generation connected within the GSPs including generators, demand response, storage and community energy schemes. There are a number of possibilities which this market facilitates. For example, Virtual Private Wires (VPW) can be installed between generator and storage devices to aggregate within a GSP, and operate as a single entity in the balancing market.

Key Learning and Innovation

The learning for this project will cover a number of key areas. These key Learning Outcomes (LO) are outlined in the table below.

Table 1: Learning Outcomes for EVOLUTION

	Key Learning	Description
LO1	Commercial contracts and arrangements required to operate as a DSO	This learning outcome includes the commercial arrangements between SO/DNO and DNO and the service providers. This is not limited to any one service, and will include contractual arrangements for all services currently available to standard BMUs at transmission level. This learning outcome will also investigate commercial issues which may arise during the DSO trial and in the future. For example, what happens with existing BMUs connected within a GSP.
LO2	Technical solutions required to deliver a DSO	This learning outcome will provide the technical solutions required to deliver, manage and operate a DSO. This will include determination of the mechanism which should be for metering/settlement, what should the hierarchy of control be for a system of systems (Power Network Joint Vision, 2014) and how to coordinate outage management between entities.
LO3	Investigate grid code changes and make proposals	This learning outcome will investigate the ability to create contracts and operate a DSO within the current regulatory environment, and also investigate the potential for future code and regulation changes as DSOs become Business As Usual in the UK market.
LO4	Investigate implications on existing licence conditions of the DNO	This learning outcome will focus on the existing licence conditions of the DNO and if the role of DSO contradicts any licence conditions or creates any new licence conditions for future versions of the DSO market.
LO5	Explore issues of where the boundaries of regulated and unregulated entities should lie	This learning outcome will consider how existing SO licence, obligations and incentives could be applied to a DSO. The current System Operator Incentives have proved effective in regulating National Grid as the GB System Operator, therefore it would be appropriate to use this as a starting point for developing DSO operator incentives.
LO6	What distribution level services could supplement the marketplace	This learning outcome will explore which services could feasibly be offered by the DSO on behalf of distribution connected generators. A number of services will be implemented during the trial in order to determine how they may operate in the open loop market scenario. This may be limited to the generation which is available in the trial area.

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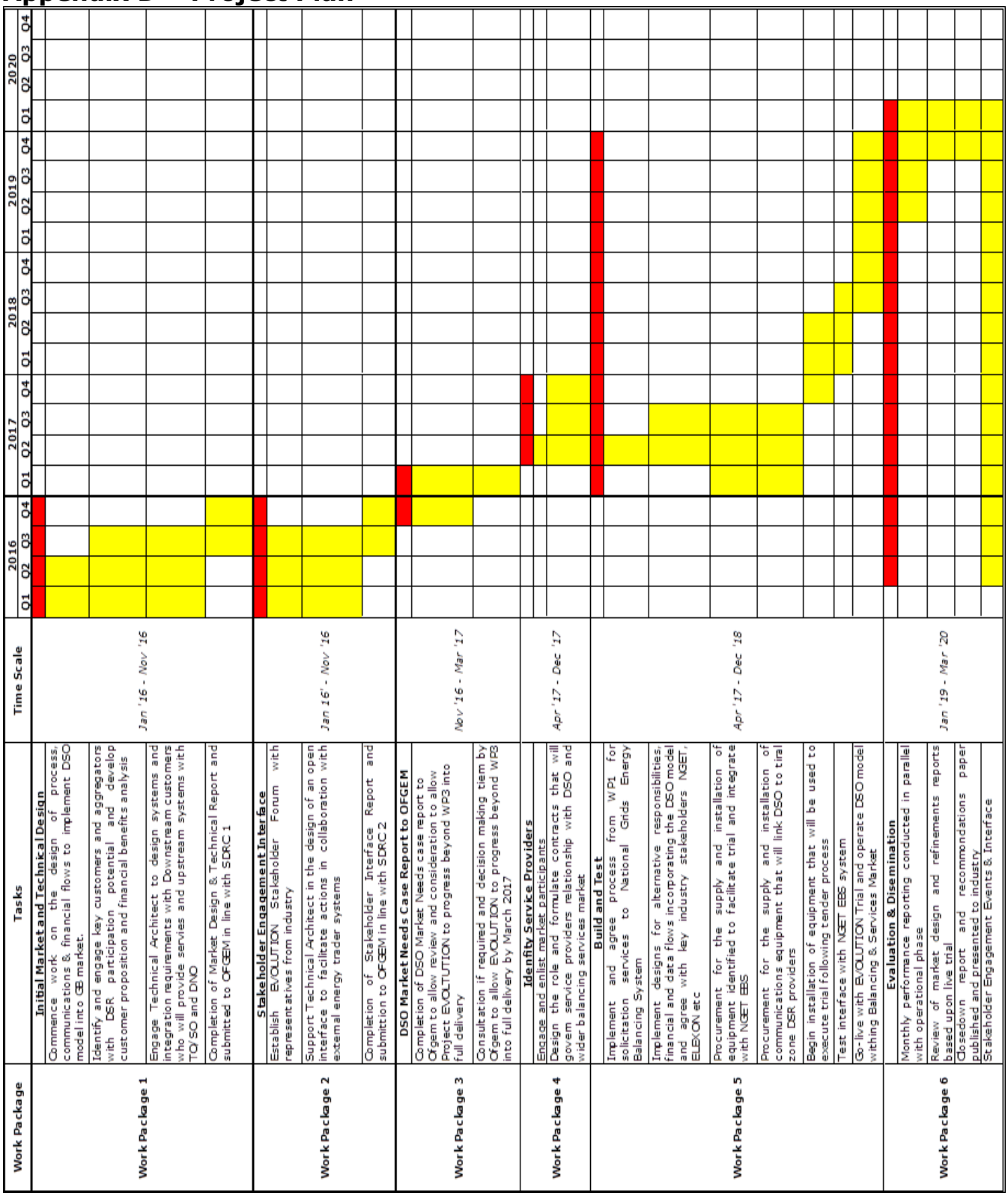
Appendix D – Project Plan



Work Package	Tasks	Time Scale
Work Package 1	**Initial Market and Technical Design**	Jan '16 - Nov '16
	Commence work on the design of process, communications & financial flows to implement DSO model into GB market.	
	Identify and engage key customers and aggregators with DSR participation potential and develop customer proposition and financial benefits analysis	
	Engage Technical Architect to design systems and integration requirements with Downstream customers who will provide servies and upstream systems with TO/SO and DNO	
	Completion of Market Design & Technical Report and submitted to OFGEM in line with SDRC 1	
Work Package 2	**Stakeholder Engagement Interface**	Jan 16' - Nov '16
	Establish EVOLUTION Stakeholder Forum with representatives from industry	
	Support Technical Architect in the design of an open interface to facilitate actions in collaboration with external energy trader systems	
	Completion of Stakeholder Interface Report and submittion to OFGEM in line with SDRC 2	
Work Package 3	**DSO Market Needs Case Report to OFGEM**	Nov '16 - Mar '17
	Completion of DSO Market Needs case report to Ofgem to allow review and consideration to allow Project EVOLUTION to progress beyond WP3 into full delivery	
	Consultation if required and decision making tiem by Ofgem to allow EVOLUTION to progress beyond WP3 into full delivery by March 2017	
Work Package 4	**Identify Service Providers**	Apr '17 - Dec '17
	Engage and enlist market participants	
	Design the role and formulate contracts that will govern service providers relationship with DSO and wider balancing services market	
Work Package 5	**Build and Test**	Apr '17 - Dec '18
	Implement and agree process from WP1 for solicitation services to National Grids Energy Balancing System	
	Implement designs for alternative responsibilities, financial and data flows incorporating the DSO model and agree with key industry stakeholders NGET, ELEXON etc	
	Procurement for the supply and installation of equipment identified to facilitate trial and integrate with NGET EBS	
	Procurement for the supply and installation of communications equipment that will link DSO to tiral zone DSR providers	
	Begin installation of equipment that will be used to execute trial following tender process	
	Test interface with NGET EBS system	
	Go-live with EVOLUTION Trial and operate DSO model withing Balancing & Services Market	
Work Package 6	**Evaluation & Dissemination**	Jan '19 - Mar '20
	Monthly performance reporting conducted in parallel with operational phase	
	Review of market design and refinements reports based upon live trial	
	Obsedown report and recommendations paper published and presented to industry	
	Stakeholder Engagement Events & Interface	

Appendix E – Risk Register

A 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 Project Governance Steering Board. The risk register provides guidance for the level of cost contingency used for each work package. The work packages associated with risk item is indicated in the register.

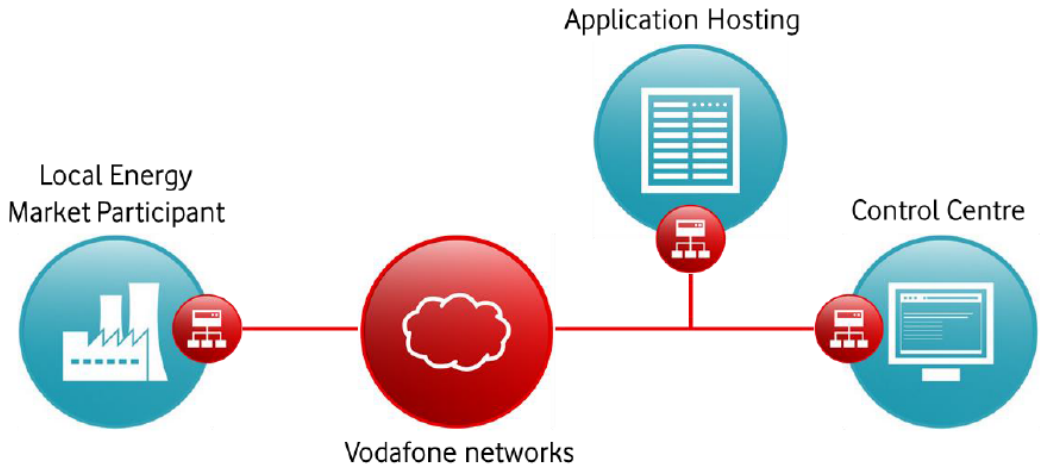
A risk rating (RR) has been calculated for each risk item by allocating a probability (P) and a consequence (C) rating, where 1 is low, 2 is medium and 3 is high, and multiplying to get the overall risk rating. This enables identification of significant risk items and development of suitable mitigation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

Risk No	Work Package	Risk Description	P	C	RR	Mitigation	Contingency Plans
1	WP 1 & 4	Distributed Energy Resources are not willing to participate in trial	2	3	**6**	Establishment of Stakeholder Forum and Stakeholder Engagement Plan	Work closely with local authorities, existing DER providers, NGET and Industry representative bodies
2	WP 2	The development of new processes and commercial mechanisms prove too complex and timely	1	3	**3**	SPD has engaged NGET and industry representatives to develop the concept of the DSO model	Work within existing market regulation and governance arrangements to establish DSO model & benefits
3	WP 2	Compensation scheme identified for trial is not financially attractive to DER providers	1	3	**3**	Establishment of DSO on same basis as existing market participants to ensure transparency and competition	Expand on previous LCNF trials and ensure learning is captured when engaging when designing the market
4	WP 2 & 4	Market size under GSP is not sufficient to establish sufficient trial process and delivery	1	3	**3**	Detailed analysis of GSPs within SPD has been undertaken to identify GSP with required characteristics to execute the trial	Extend trial area to include second GSP if require to provide adequate scale and market
5	WP 2	Existing DER providers consider DSO trial has adverse market implications which could affect competition for energy balancing services	2	1	**2**	Ensure communications are open, transparent and local energy market design considers all market participants needs	Work closely with local authorities, existing DER providers, NGET and Industry representative bodies
6	WP 3	Integration of existing data sources and systems is not successful due to incompatibility	1	1	**1**	SPD will engage technical experts and conduct robust competitive tender process to integrate systems and data into a single streamlined solution	Utilise learning from existing system integration programs and network trials
7	WP 3	There are communication issues with telecoms infrastructure that prevents DER from participation in trial	1	2	2	SPD have engaged strategic communications provider Vodafone to develop solution for communications infrastructure	Seek market review and engage alternative vendors to provide satisfactory solution
8	**WP 5**	**Establishment of Virtual BM unit is not possible as part of existing industry codes and regulation**	**1**	**3**	3	**Engagement with NGET and Elexon has already been undertaken and which category the GSP BM will register under**	**Regulatory intervention if required or prevented from establishing project deliverable**
9	WP 5	Balancing instructions cannot be received from NGET or executed by DSO due to systems failure or lack of interoperability issues	1	3	**3**	Establishment of control room protocols and procedure between NGET and SPEN	Manual process identified to enable trail to take place during interim rollout

Appendix F – Vodafone Estimate of Cost for Communications Platform

Introduction

Vodafone proposes to provide the end to end connectivity services required by Project Evolution. This can be summarised as linking local energy market participants to the market application and SP Distribution control point. This will include customer premises equipment (CPE) used to present communications interfaces and all of the networking components that join the CPE together. Additionally Vodafone will support the design, test and development phases before moving to implementation and operation for the duration of the project.



Vodafone has an established enterprise presence in Scotland, developed partly to support our relationship with SP Energy Networks, along with a skilled field based workforce and wide ranging communications services portfolio, all of which can be engaged to support Project Evolution.

Since the acquisition of Cable&Wireless Worldwide, Vodafone has become a total communications provider in the UK, in that it now has access to in-house capability in all main stream communications technologies plus many more niche options. From fibre optics to copper based digital services, to fixed radio, cellular and satellite, they're all supported and fully integrated.

In addition there is ongoing focus to expand the capability set through partners and innovation, for example Cellular Internet of Things which is a low power wireless access technology with greatly improved penetration and range (compared to standard cellular technology) which is being developed by Vodafone. Not all of Vodafone's capability will be required in support of Project Evolution but having this flexibility at the start will ensure that there are no stranded locations and the eventual solution is appropriately engineered and best value for money.

A core focus of Project Evolution is innovation and this should be reflected in all the elements of the overall proposition. Innovation will be provided in the communications component by combining heterogeneous technologies to provide the optimal overall solution, plus utilising Vodafone's Machine to Machine (M2M) and utility services capability to provide enhanced service management.

Additionally, Strathclyde University's Power Networks Demonstration Centre will be made available as a test and development resource prior to field deployment.

Solution Proposal

Overview of solution

The solution proposed is based upon using Vodafone's enterprise grade private MPLS network, coupled with its cellular infrastructure and M2M platform. Access through and to the internet can be provided but is not included at this stage. MPLS, or Multi-Protocol Label Switching, is an established international standard and is the foundation technology for modern secure and highly available networks. It supports the transport of IP and Ethernet as well as legacy TDM technologies.

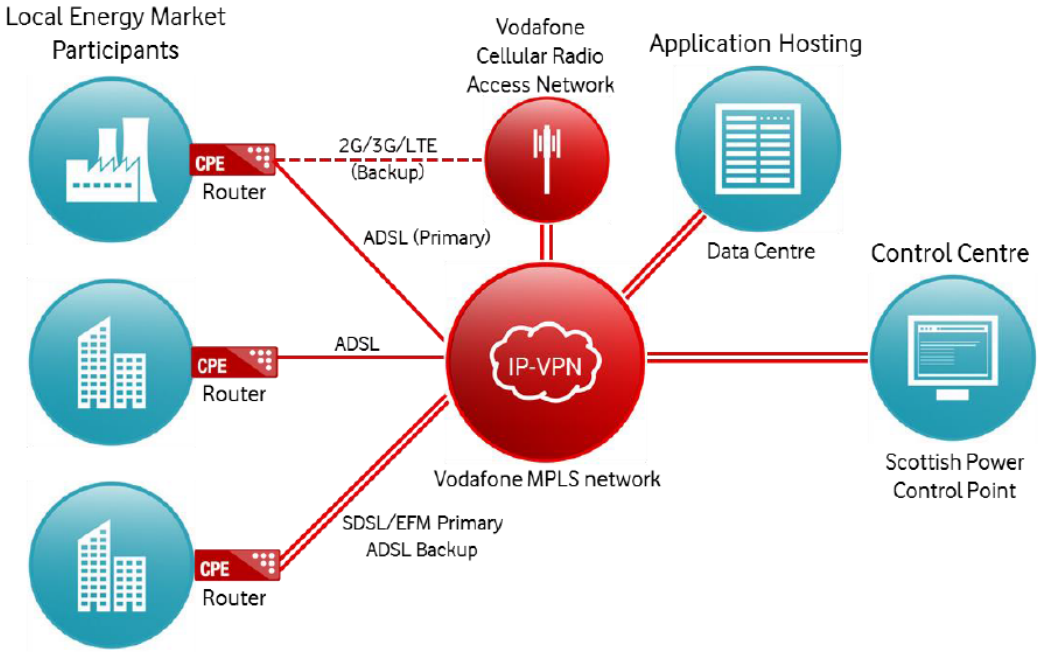
MPLS creates a virtual private network (VPN) on a customer/site by site basis, in essence a series of logical tunnels that separate traffic between users. It also provides enhanced performance and availability through Quality of Service/Class of Service options, intelligent routing and re-convergence, a fully meshed core and multiple access technology options.

The latest capability upgrade is to integrate Vodafone's cellular estate with its existing MPLS infrastructure to provide an even wider range of complementary access options. The cellular access solution will be supported by Vodafone's M2M platform. This is an application that provides enterprise grade visibility and control over cellular assets which typically would have limited support if any at all. An additional feature of the M2M platform is the ability to deploy roaming SIMs if required, which means a cellular connected device has access to any of the UK mobile networks, not just the one operated by Vodafone, thus providing greater coverage and availability.

The access solution proposed for local energy market participants uses xDSL as the primary technology backed up with either cellular or a secondary xDSL link to mitigate outages. The actual deployment model used will depend on bandwidth and availability requirements.

The solution proposed at this stage utilises a small selection of the options available in order to reduce complexity and cost, yet provides high availability and suitable performance through the pairing of disparate access technologies.

The diagram below describes the connection options proposed:



Components

CPE options

For the CPE installed at local energy market participant sites Cisco routers are proposed. The models selected support the range of potential WAN access solutions offered at this stage. Each of the router types has been integration tested by Vodafone and is fully supported. To provide the greatest flexibility in terms of interface with the market participant's energy device, and to reduce complexity and costs, it is proposed that dedicated Serial (RS232,RS485…) to Ethernet converters from Lantronix are used.

The table below shows the WAN interfaces supported by each of the router types proposed, plus mounting option and security support.

Router	ADSL2+	VDSL2	SDSL	Cellular	Mount Type	IPsec
887VAG	✓	✓		✓	Desk/Wall	✓
1921	✓	✓	✓	✓	Rack	✓
2901	✓	✓	✓	✓	Rack	✓

Access solution options

The table below describes the access options available and their bandwidth characteristics. It is proposed that ADSL16 and EFM/SDSL with Cellular Radio backup are considered for Project Evolution.

Access Circuit Connection	Upstream Access Circuit Line Rate	Downstream Access Circuit Line Rate	Minimum Assured Rate
ADSL16 (ADSL2+)	≤832kbps	≤16Mbps	144kbps
VDSL2 Assured	≤20Mbps	≤80Mbps	15Mbps ⬆ / 30Mbps ⬇
EFM/SDSL	≤2-20Mbps	≤2-20Mbps	2-20Mbps
Fibre Ethernet	100Mbps-10Gbps	100Mbps-10Gbps	100Mbps-10Gbps

VSAT	10Mbps	10Mbps	10Mbps
Microwave Radio	10Mbps-100Mbps	10Mbps-100Mbps	10Mbps-100Mbps
Cellular Radio	Variable	Variable	Variable

The table below describes the availability targets linked to symmetric access types. Symmetric bandwidths are Fibre Ethernet and EFM/SDSL

Site Configuration	Symmetric Bandwidths	Cellular Radio
Single Access	99.90%	Reasonable endeavours
Single Access with DSL, VDSL2 or Cellular Radio Access Backup	99.95%	
Dual Access, Dual Parenting	99.95%	n/a
Dual Access, Dual Parenting, with Standard Separation	99.99%	n/a
Dual Access, Dual Parenting, with Enhanced Separation	100%	n/a

The table below describes the availability targets linked to asymmetric access types. Asymmetric bandwidths are ADSL16 and VDSL2 Assured

Site Configuration	Care Level	Availability
Single Access	Standard	93%
Single Access with backup	Standard	96%
Single Access	Enhanced	96.5%
Single Access with backup	Enhanced	98%
Single Access	Premium	99%
Single Access with backup	Premium	99.5%

Backup options are DSL or Cellular. Care levels are based on MTTR targets.

The table below describes the target fix times linked to symmetric and asymmetric access types and care options.

Access Circuit and Bandwidth				
Symmetric bandwidth (on-net)	Symmetric bandwidth (off-net)	Asymmetric bandwidth (Premium care)	Asymmetric bandwidth (Enhanced care)	Asymmetric bandwidth (Standard care)
4hrs	5hrs	7hrs	24hrs	48hrs

On-net is when using Vodafone's own infrastructure, Off-net is when using third party infrastructure e.g. BT. Where a service is carried via PSTN lines, the PSTN line will also require an equivalent support level.

Latency

The following diagram displays the target and typical latency for the service components described above. The end to end latency is composed of the inbound access latency, added to the MPLS core component and the outbound aggregated bearer delivery.

MPLS Core Network

The (MPLS) IP-VPN technology used is broadly described in the architecture framework covered in IETF RFC 4364 (2547bis). It uses Differentiated Services Code Point (DSCP) based marking and per-packet scheduling, to manage quality of service (QoS) and protect sensitive data end-to-end. The network is accredited to carry secure government traffic (CTAS 224) as well as being ISO27001 compliant.

It is possible to order the IP-VPN services as a 'Managed Service' or as a "Wires Only Service". With the "Managed Service" option a router is provided along with the connection service and this is managed centrally by Vodafone using standard support processes, With "Wires Only" just the connection service is provided, with the option for a break/fix contract on the routers, leaving the customer to install and manage the CPE. In this instance it may prove optimally flexible to order a "Wires Only" service and then to provide router procurement and ongoing management through the Vodafone SPEN services and support team.

Data from the local energy market participants will be collated (in logically unique streams) within the MPLS network before being delivered to the application hosting location or control centre as required.

Resource and Service Procurement

Target number of participant sites: 100 - 250

Project Duration: 4 Years

Start Date: Jan 2016

Day rates for defined roles

Function	Role Title	Timescales	FTE	Rate	Sub Total
Design	Solution Architect			£594*	
Project Mgt	PM			£492*	
Trials	Engineer			£515*	
PNDC	TBC			tbc	
Procurement	Account Admin			£317*	
Implementation	Engineer			£515*	
Field Support	Engineer			£515*	
NOC Support	Engineer			£515*	

Assumptions: Based on a total resource commitment of 80 days. *Annual rates have been applied as opposed to quarterly or daily rates.

Equipment charges

Equipment Type	Unit Price	Units	Sub Total
Cisco 887VAG	£510.00	100	£51,000.00
Cisco 1921	£375.00	100	£37,500.00
Cisco 2901	£625.00	50	£31,250.00
Protocol converter	£130.00	175	£22,750.00

Assumption: Equipment list supports a mix of the router types proposed to offer a range of deployment options. Protocol converters are assumed to be required in 175 instances, i.e. it is assumed that 175 locations will not present an Ethernet interface on the participant device.

Service charges

Service Type	Bandwidth	Backup Option	Unit Price	Units	Sub Total
IP-VPN	1Gb for DC	1Gb	£16,649	4	£66,596.00
IP-VPN	As required	As required	£1095.00	250	£273,750.00

Assumptions: Four Data Centre and Control Centre connections. 250 participant connections using xDSL as primary access.

Value contribution

Vodafone will provide value contribution to the programme through a number of channels, namely, allocation of investment resource, procurement advantage and contract terms flexibility.

Vodafone will be investing £150,000 annually in to the Power Networks Demonstration Centre run by the University of Strathclyde. A minimum of 10% of the access and resources this investment enables will be assigned to project Evolution. 10% of annual cost = £15k pa, x 4 years = £60k.

An initial estimate of 80 working days resource has been assumed that can be called off using the rate card provided above. The rates are already the lowest offered by Vodafone in this sector, additionally these are applied to FTEs on an annual basis, even though the resource estimate is ¼ of a year, for which higher rates would normally be charged. 80 man days pa x £200 saving per day x 4 years = £64k.

Vodafone are able to realise significant preferential procurement savings on Cisco Systems hardware (60%+) due to the size of our global spend. These savings will be passed on, along with a reduced mark-up below that is agreed for our existing SPEN contracts.

The solution proposed is constructed using a wires only service with CPE managed and supported by the SPEN dedicated support teams. This provides flexibility and cost savings when compared to a standard Enterprise managed router service as it reduces the number of field resources required to implement and support the service.

Additionally, choosing a small pool of CPE (routers) that support all the WAN options proposed but a standard LAN interface and supplementing them with simple third party protocol converters reduces the cost of sourcing more flexible but expensive routers. This is also enabled by using the SPEN dedicated support teams.

Item	Description	Value
PNDC Access	Access to PNDC environment through existing investment	£60,000.00
Preferential resource rates	Use of SPEN long term rate card for resource cost efficiency	£64,000.00
CPE procurement discount	Vodafone procurement advantage	60%+ off list price and reduced mark up of just 6.7%
Specialised service focus	Adaptable field force that carry out all elements of implementation or support	£50,000.00
Service flexibility	Managed service that supports a common router model/s with flexibility through site specific protocol converters	£25,000.00

Appendix G – EVOLUTION DSO Trial Area

East Kilbride and the surrounding area has been chosen as suitable location to demonstrate the trial operation of a Distribution System Operator, under project EVOLUTION. Within the 44,000 km sq. catchment area, the current electrical infrastructure includes approximately 3 Grid Supply Points, 45 primary substations, 898 secondary substations, 1 EHV customer, 45 HV customers and 70,139 low voltage customers. The Three Grid Supply Points of East Kilbride, East Kilbride South and Strathaven consist of a diverse range of customers, including;

- Mix of Urban and Rural Domestic Customers
- Supermarkets
- High Voltage Engineering Manufacturing, Process and Food Production
- Embedded Generation & Water Treatment/Pumping Stations

The decision to target these locations is based on the recent appearance of distribution and transmission network constraints, primarily due to reduction in demand and an increase in embedded generation. Driving these changes are factors which include;

- Connection of several large scale embedded generation projects over the course of DPCR5 and into RIIO-ED1.
- Impact of domestic energy efficiency measures such as G83 FiT photovoltaic installations, LED lighting and home insulation measures etc...
- Rise of small scale G59 FiT renewable generation projects, especially wind.
- Changes in customer behaviour due to Economic circumstances.

At present, approximately 126MW of embedded generation is connected or contracted to connect within the trial area. Future projects wishing to connect into East Kilbride South GSP would be unable to connect without need for significant upgrade works under current network design rules, unless some form of constraint scheme is implemented (such as ARC's Active Network Management scheme) whereby generators would receive restricted access to the network . Currently no reinforcement works are planned and therefore no more capacity is anticipated to be released.

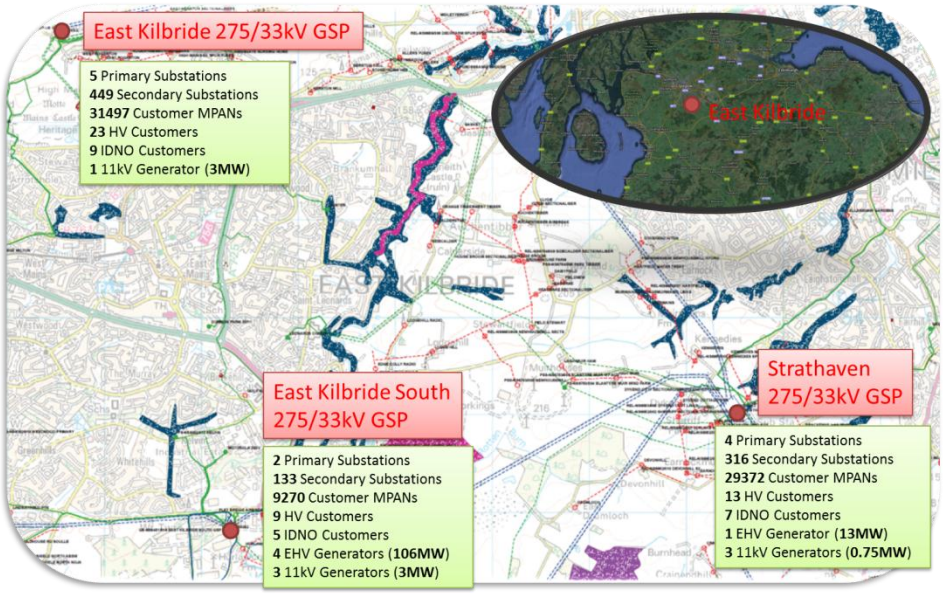


Figure 1. East Kilbride – EVOLUTION DSO Trial Area

Electrical configuration of the existing distribution and transmission network within the identified trial area are depicted within figure 2.

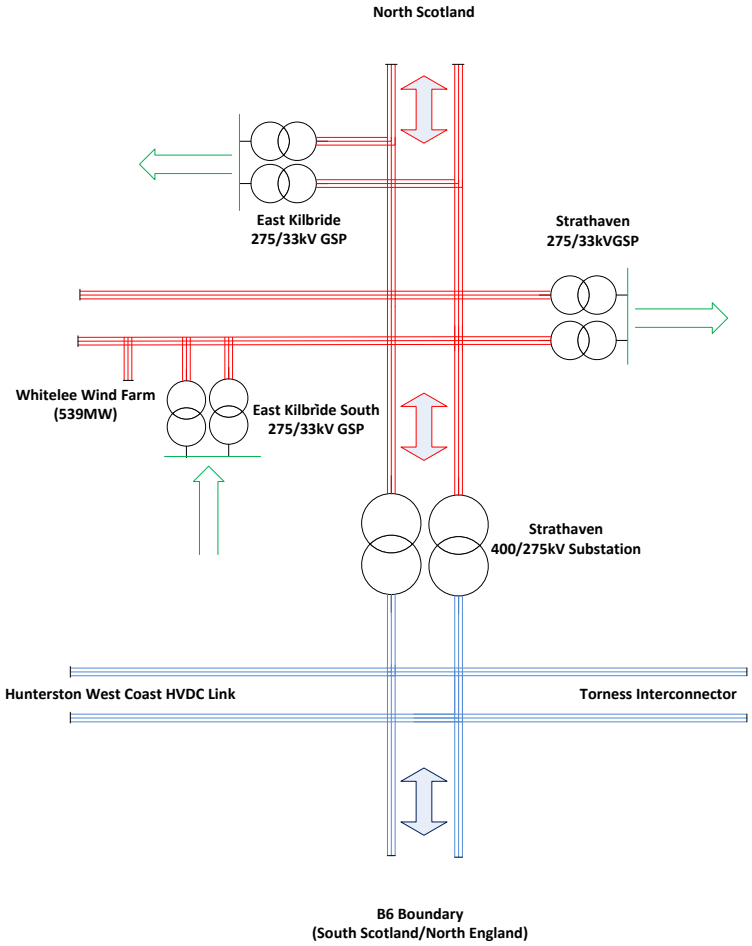


Figure 2. Distribution and Transmission Electrical Network - East Kilbride and surrounding area

Looking forward, the impacts of the UK's transition towards a low carbon economy will result in further challenges to the system includes, but not limited to;

- Thermal overload of East Kilbride South Grid transformers under N-1 conditions i.e. loss of SGT1 or SGT2 during high generation, low demand conditions.
- Thermal overload of the 33kV East Kilbride South / Strathaven GSP interconnector cable during alternative network running arrangements. (Figure 3.)
- Cumulative impact seen on the B6 transfer boundary between SPT and National Grid during high generation, low demand conditions.

East Kilbride South GSP consists of two 275/33kV 120MVA grid transformers, with a winter maximum demand of 14MW, summer minimum demand of 3.75MW and maximum recorded reverse power flow of 59MW during high wind conditions. With 2 primary substations, 133 secondary substations, supplying 9 High Voltage customers, 5 IDNO sites and 9,270 low voltage customers. Electrical Layout depicted in Figure 3.

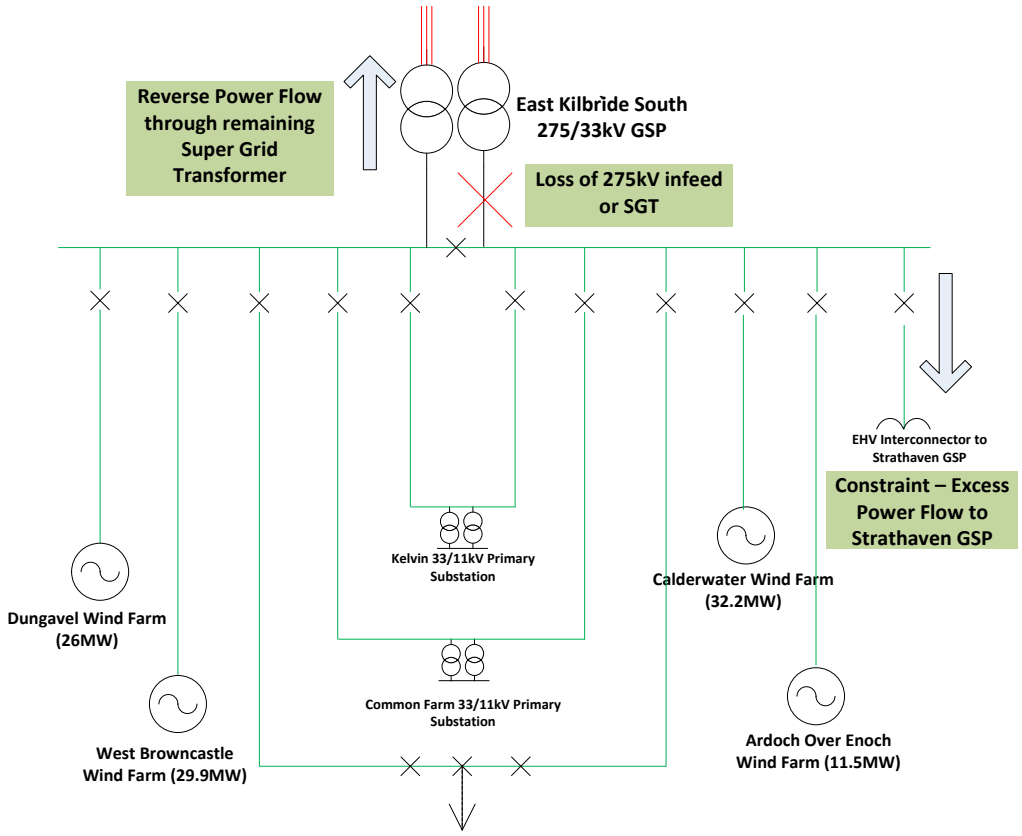


Figure 3. East Kilbride South GSP – Distribution System

There are currently four large wind farms connected to the 33kV network at East Kilbride South GSP; Ardoch Over Enoch (11.5MW), Calder Water (32.2MW), West Browncastle (29.9MW) and Dungavel (26MW). To allow essential maintenance to the network there are a number of outages scheduled for East Kilbride South and Strathaven GSP throughout RIIO-T1/ED1 which will require generation at both West Browncastle and Calder Water to be restricted to 10MW, whilst Dungavel would be fully off. Planned maintenance of SGT1 & SGT2 means several wind farms will be constrained for at least 65 days in 2015 and this will continue to rise in each of the following years as SPD & SPT continue to modernise the network. In this instance the nature of the constraint is a risk of thermal overload of the 33kV interconnection circuit between East Kilbride South GSP and Strathaven GSP, as shown in figure 3. Having studied the last three years of wind yield in the area, as an example, West Browncastle wind farm would typically experience lost revenue of between £300K and £400K due to be constrained during high production periods. Projected loss of earnings across the wind farm group is expected to reach £1 million per annum.

East Kilbride GSP consists of two 275/33kV 120MVA grid transformers, with a winter maximum demand of 59.6.7MW and summer minimum demand of 17.1MW and consists of 5 primary substations, 449 secondary substations, supplying 23 High Voltage customers, 9 IDNO sites and 31,497 low voltage customers. Electrical layout depicted in Figure 4.

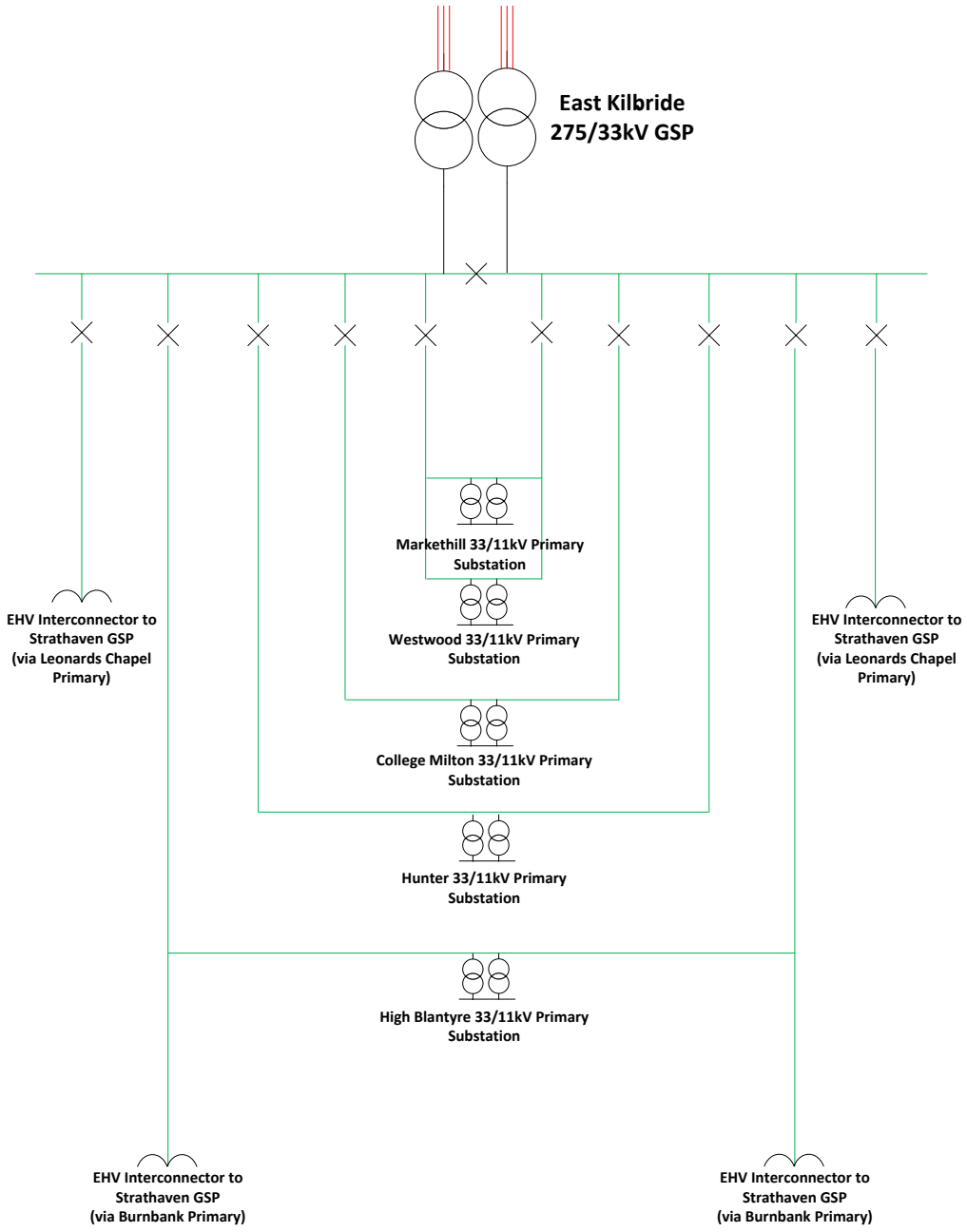


Figure 4. East Kilbride GSP – Distribution System

Strathaven GSP consists of two 275/33kV 120MVA grid transformers, with a winter maximum demand of 46.7MW and summer minimum demand of 4.2MW and consists of 4 primary substations, 316 secondary substations, supplying 13 High Voltage customers, 7 IDNO sites and 29,372 low voltage customers. Electrical layout depicted in Figure 5.

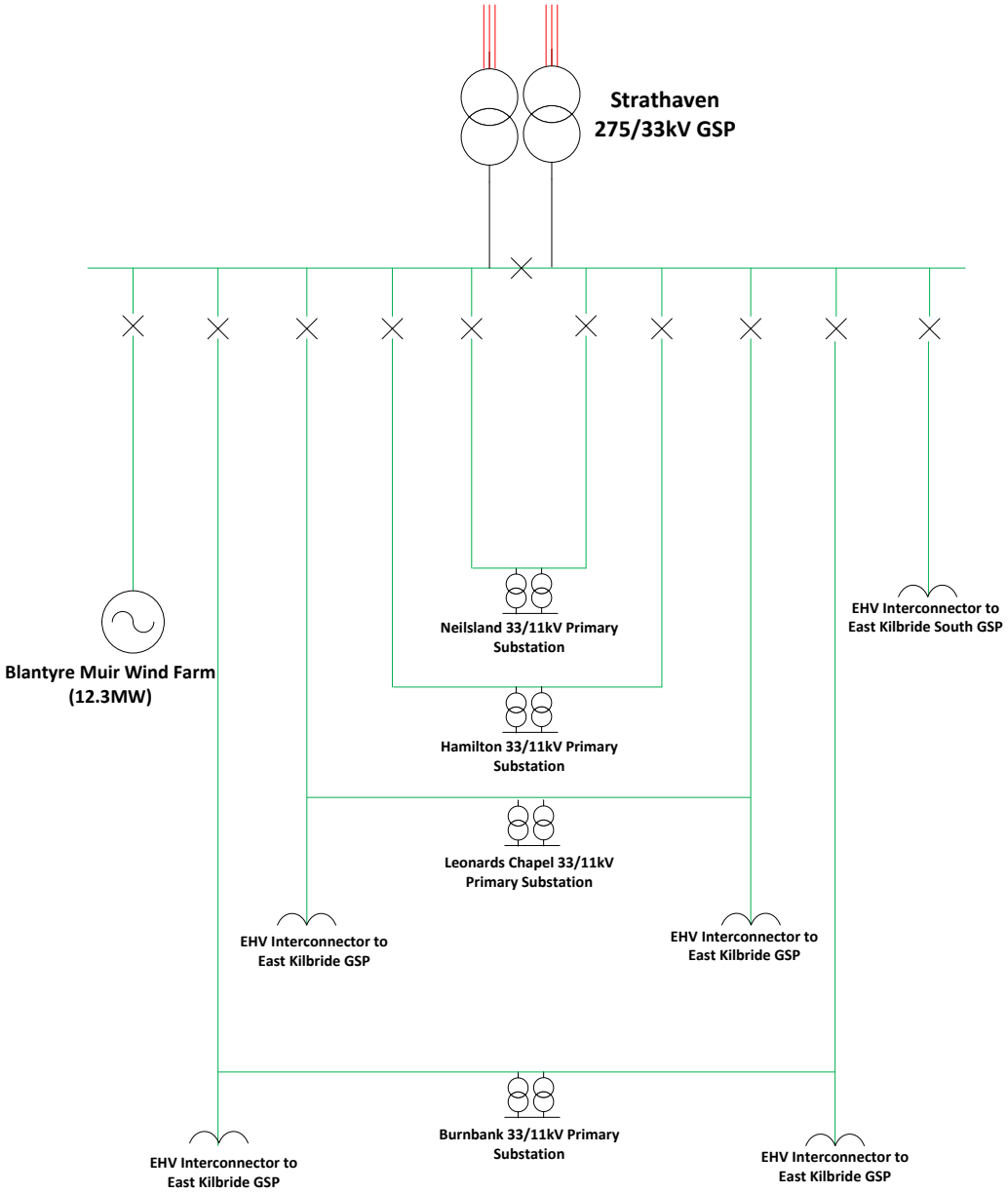


Figure 5. Strathaven GSP – Distribution System

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Date 10th July 2015

Dear Euan

National Grid Support to Project EVOLUTION

Further to our note from Scott Bannister earlier this week related to the potential regulatory impact of project EVOLUTION, I confirm that we welcome the opportunity to support the proposal and thereby share in the learning that this will undoubtedly provide.

At this stage we are unable to advise on the resource commitment that National Grid would expect to commit in support until there is more specific project detail from SPEN. However, due to the nature of the skills likely to be required, early notice of this expectation will be essential if we are to contribute fully and thereby maximise the value of the project.

1. From National Grid's perspective it is anticipated that the trial would address issues including the following:-

1.1. Establish a legal framework that may be required to enable National Grid to sub-contract out its obligations as SO locally.

1.2. Evaluate the newly drafted System Operator Transmission Owner Code Procedure for ANM's

1.3. Development of suitable fall-back modes of operation in the event of communication failure and timescale of their action

1.4. Develop an equitable rationale for the ranking of generation within the GSP across a range of contract types.

1.5. Acceptable target for reliability and mean time between failures of the ANM, including associated systems (eg Communications and SCADA).

1.6. Establish an acceptable level of duplication of systems to deliver the required level of reliability of the ANM.

1.7. Provide a benchmark for the level of manual override facilities that may be required after unforeseen events

1.8. Potential for extension and adaptation of ANM Scheme as the local network evolves

1.9. Evaluate the practicality of devolving local operational control to a third party, who would in turn be responsible for the equitable treatment of customers

1.10. Evaluate the feasibility of extending the scheme to multiple GSPs such that transmission constraints may be better controlled in a region

2. The services that NG would anticipate procuring at the GSP interface would be those that would normally be expected from a Balancing Market participant, namely:-

2.1. Reactive Support at the Grid Supply Point

2.2. Positive Reserve services – headroom capability understanding and ability to increase generation

2.3. Negative Reserve services; foot-room capability understanding and ability to decrease generation

2.4. Frequency Response service –

2.4.1. dynamic where mandated and/or static where available

2.4.2. fast frequency response

2.4.3. enhanced frequency control (sub 1-2 seconds or in proportion to the rate of change of frequency)

2.5. General despatch to manage transmission network constraints

I see this as an opportunity to move embedded generation control to the next level and thus improve its integration whilst optimising the use of renewable sources.

Yours sincerely

Keith Dan
Network Strategy

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Dear Euan

Aston University Support to Project EVOLUTION

Aston University has a history of undertaking applied research in conjunction with DNO's into Power Systems to help realise long term benefits for the customer through innovation. In particular, Aston has worked on several related projects to EVOLUTION around the field of energy storage and its application to grid support at network and system level. These include; EPSRC ref: EP/1008764/1 and ref: EP/137649, TSB ref: 130708 and ref:49436-345365 and the LCNF funded FALCON project.

A key issue with the research in this area is the challenge of making energy storage cost effective under the current market mechanisms to assist with de-carbonisation of the grid system. The cost benefit work undertaken on ex-transportation vehicles (second life) batteries, which should be available cheaper than new batteries, has indicated that in order to justify the investment needed, the batteries need to operate in more than one market (eg FFR and Network deferment). At present it is not possible for a DNO to operate in the FFR market and it is difficult for a private investor to realise the benefit of Network deferment.

If such schemes are distributed as opposed to centralized then there are further cost implications around metering. Aston University welcome the opportunity to support this proposal as it provides learning on the mechanisms of overcoming some of the key issues. An example of this would be the single point metering at the GSP to cover a distributed system made up of multiple parts to meet SO requirements.

From Aston's perspective key learning which would be investigated and addressed include;

1. How DSO obligations could and should be met locally to ensure that
    a. Reactive support capability is present at the GSP
    b. Frequency support services are devolved down to different generation/energy storage within the DSO to meet suitable time frames of operation
    c. How dispatch is calculated and operated
2. How systems downstream of the GSP should be operated under different operational modes including fault conditions
3. How metering for frequency response is undertaken downstream of the GSP and in fact understanding if this is required under a new DSO operational strategy
4. Understanding the life cycle and cost analysis of systems made up of distributed generation and energy storage to meet SO and Network operational conditions
5. Determining and quantifying reliability and failure modes effect and analysis (FMEA) and understanding the mitigation required to overcome any issues.
6. Understanding the practicality of operating and scaling a small Network to undertake SO activities

We see this work as an important facet in addressing the energy trilemma by investigating devolving TSO control on the cost of local energy, the security of supply and increasing the decarbonisation of the grid. To this end Aston would be willing to offer support. Although it is not possible to advise on resource commitment at this stage without more detail, Aston would be prepared to help match overhead costs.

Yours sincerely

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