RIIO T1 Business Plan

Section 8 Innovation Strategy

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Section 8 Innovation Strategy

Summary

The use of Innovation to develop a sustainable, SMART and economic transmission system plays a key role in the delivery of the SPT Licence obligations in the most economic and sustainable way.

Scotland has the richest source of renewable wind energy in Europe with huge untapped resources from wave and tidal sources. Within the price control period SPT will continue to play a major role facilitating Government renewable energy targets and delivering a low carbon economy. We recognise the importance of innovation as we strive to provide economic new windfarm connections and enhance the main infrastructure required to transmit energy south.

Existing assets continue to form a major focus for innovation as we seek to maximise the performance and utilisation of these assets, and extend their useful life wherever possible.

This section will demonstrate the extensive use of innovation in Network Development, Asset Management and Operational areas of the business with proposals to deliver significantly more in the next review period. Within our business plan we have embedded the application of a variety of unique and innovative concepts and technology, this document summarises some of the most notable projects within the business plan as well as our intentions for the Innovation Allowance and Network Innovation Competition.

Contents

1. Introduction

This section describes the approach to innovation taken by SPT. It covers the following key areas.

- The use of innovation within the ongoing capital investment programme
- The Innovation Allowance
- The Network Innovation competition

We consider that innovation is an essential part of all our future plans for the transmission network. As the generation mix changes from coal and nuclear to renewables, this will create many pressures on the transmission network. These pressures will be addressed using new technology, techniques and commercial arrangements. Furthermore, the ageing asset base and the pressures of extensive asset replacement will require an inherent level of innovation to ensure that installed assets are future proof and the doors are not closed on future opportunities.

Changing load patterns through the uptake of new technology such as Electric Vehicles, heat pumps, micro-generation & energy efficiency will create a challenging landscape for transmission networks which will require innovation throughout.

2. Overall Approach to Innovation

There are a number of factors that drive innovation within SPT. These include-

- Improving our asset performance and utilisation
- Meeting customer service expectations
- Becoming more cost efficient
- Reducing our environmental impact
- Facilitating Government energy targets
- Preparing for future changes in the use of electricity

In some instances our developments are specifically focused on a particular driver. In other cases, a particular development may satisfy a number of these drivers. For example, the innovative deployment of dynamic line ratings improves asset utilisation while helping to get new customers connected more quickly. It also reduces our environmental impact by limiting the number of new overhead lines and speeds up the industry's progress against Government energy targets.

We welcome the inclusion of the Network Innovation Competition (NIC) and Innovation Allowance (IA) for funding of research, development and demonstration of new technologies and techniques which will help us to respond effectively to these drivers

Our transmission innovation agenda is driven by stakeholder involvement, both internal and external. Externally, the key stakeholders are as follows –

Stakeholder Involvement –

- National Grid and SHETL for collaboration and sharing learning;
- Academia; to ensure that the transmission network is taking advantage of R&D activity and steering this where necessary for the benefit of the network;
- Other research and policy making bodies including EPRI, CIGRE, ENTSOE and Eurelectric in order to inform and keep abreast of developments in transmission technology and policies;
- Technology providers to assist with the development of new products; and
- Transmission customers, to ensure the network meets their changing needs.

ScottishPower has a long standing, strong relationship with University of Strathclyde and other institutes through our IFI programme and distribution activity.

Stakeholder Case Study –

Scottish Power Active Research Centre (SPARC). This initiative between SP Energy Networks and the University of Strathclyde has been running since 2006. In this programme we sponsor research that is relevant to the power sector with particular emphasis on how ScottishPower can improve the network in the short to medium term. The programme has delivered new techniques for cable health monitoring and software tools for the analysis of alarms among many other developments. The collaboration also presents ScottishPower with new R&D opportunities and oversight of new technologies, whilst allowing University of Strathclyde to disseminate learning through the appropriate channels.

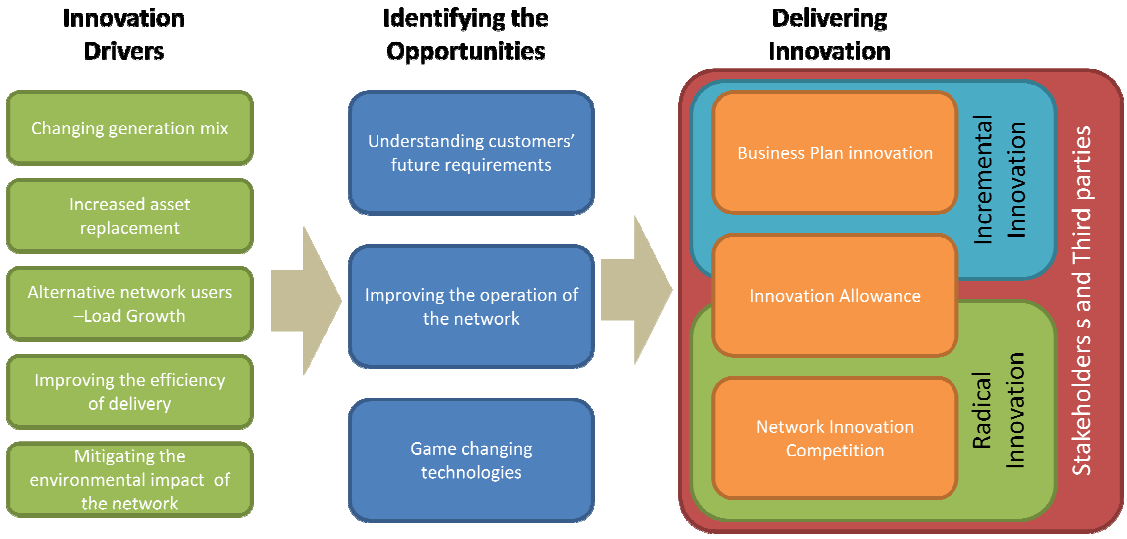
Our innovation process is formally controlled and subject to a governance procedure. This ensures that regulatory rules and reporting requirements are met. We also use the process to ensure that all parts of the business can influence the innovation agenda according to the pressures they are facing. In this way we achieve a balanced portfolio of innovation projects with strong engagement from the operational parts of the business. We use the widely recognised Technology Readiness Level (TRL) approach to classifying innovation projects. Our focus tends to be on higher TRL projects which are closer to deployment and our progress is documented in our annual IFI report. We do also have involvement with a number of lower TRL projects to help in the development of these products which is vital to many of our technology providers.

It is also vital that R&D/Innovation projects are adopted by the business to become business as usual processes. SPT have a proven record of being successful at this as demonstrated by our pioneering approach to the use of IEC61850 communications for inter trips and increasingly using this regularly with new schemes.

We place significant focus on disseminating this learning across the business to ensure that the relevant staff are aware of new technology as it is developed. Our current organisational structure has a dedicated member of the executive team leading network development, and we undertake dissemination through events such as our annual technology conference which makes staff from across the company aware of developments and gives them the opportunity to become more involved.

Innovation can take two distinct forms; incremental innovation which is building upon existing technology, and radical innovation which creates a completely new concept to change the way the network can be operated. SPT believe that both incremental and

radical innovation have a place within our business. Our innovation strategy can be summarised as:



Our initial plans for innovation in RIIO-T1 are summarised in the table below.

Business Plan Innovation	**Indicative cost**
Series Compensation	Within business plan
Embedded HVDC – West Coast Interconnector	Within business plan
Integrated Offshore Transmission – East Coast Interconnection	Within business plan
New protection and control techniques	Within business plan
Innovation Allowance	
Wide Area Monitoring	£0.5m
Smart Transmission Zones	£2.5m
Dynamic Rating of Overhead Lines	£1.0m
New conductor corrosion testing techniques	£0.3m
Non intrusive health monitoring of transformers	£0.5m
Protection assets management tools	£0.15m
Circuit breakers diagnosis tools	£0.25m
Risk assessment of substation earthing systems	£0.1m
Alternative low cost tower foundations	TBC
Various other projects, continuing from TPCR4 IFI	TBC
Network Innovation Competition	
Energy Storage	TBC
DC Technology	TBC
Understanding the impact of demand side management and embedded generation	TBC
Other alternative technology demonstrations and initiatives	TBC

3. Innovation within the Business Plan

Throughout our business plan, we have embedded a variety of innovative technologies and techniques in order to deliver a very efficient and extensive investment plan. The innovation associated with the investment we are making to increase the Scotland England transfer capacity is of particular importance at this time. In addition, the integration of 30GW of wind generation to the GB transmission system requires extensive innovation within our capital programme to accommodate the new generator connections. Some examples of the innovation which is built into our business plan include:

Series Compensation

The planned introduction of Series Compensation on the Interconnector circuits (circa £85m) will substantially remove previous limitations and will achieve a 4.4GW boundary transfer capacity. Series compensation has not previously been widely used in the UK on the transmission network and this project will genuinely break new ground in the deployment of this technique. The end result will be a cost effective solution to reduce constraint costs faced by the system operator.

Embedded HVDC

The joint venture with NGET for an embedded HVDC interconnector is already out to tender to develop and construct an HVDC subsea link between Hunterston in Scotland and Deeside in North Wales. SPT will take responsibility for the 90km of subsea cable from Hunterston to the Scottish Territorial waters boundary and 4km onshore at Hunterston as well as a convertor station at Hunterston.

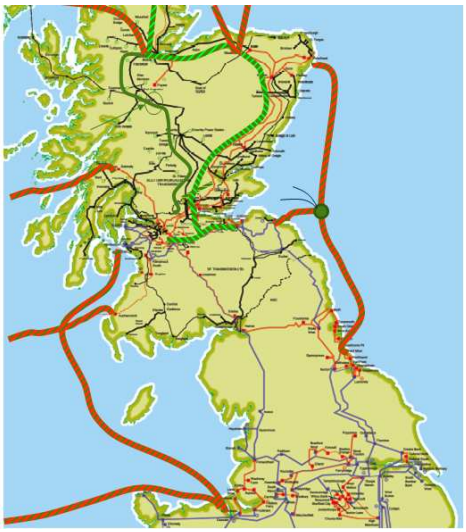
Out of the £383m SPTL project costs £307m investment will be required in RIIO-T1. This is a highly complex and unique project in that it is embedding HVDC into a heavily meshed network along with series compensation to a level that has never before been achieved.

New Protection and Control Techniques

Within many of our projects for Wider Works & Boundary Reinforcement, SPT will be utilising unique control and protection techniques to enhance the performance of the system. This includes SPTs use of IEC 61850 technology which has been developed as part of an IFI project and replaces conventional wiring with an optical Ethernet system. We have made substantial progress in implementing this technology and will continue to lead the way in demonstrating this technology within our investment plans.

Integrated Offshore Transmission

SPT are actively engaged with NGET in the development of the integrated approach to offshore transmission, which seeks to accelerate the delivery of



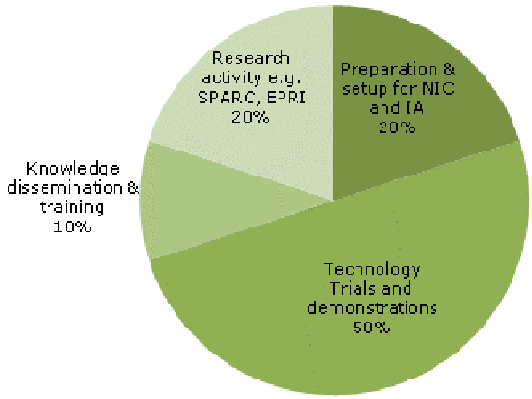
offshore transmission connections with significant overall lifetime and capex savings. This will be achieved by the use of larger capacity offshore assets, the co-ordination of onshore infrastructure and connection assets and the coordination of offshore and onshore environmental planning activities.

SPT have provided construction offers for the connection of circa 3GW of renewable generation in the Forth estuary. These offers cite the need for an east coast HVDC link from Torness to the north east of England as enabling works. In line with the development of the Integrated approach, SPT are liaising with NGET and SHETL for the design of a multi-terminal HVDC link Peterhead – Torness – Lackenby with a possible offshore hub collector substation. More detail on this proposal is presented in Section 4 of the Business Plan.

Throughout the delivery of our business plan, we will continue to look for new and innovative technology which will allow us to deliver these plans at the lowest cost and most by the most efficient means. This will include not only new assets, but also new methodologies and techniques for constructing our assets and minimising the impact on their surroundings as we deliver our plan.

4. Innovation Allowance

SPT believes that the Innovation Allowance (IA) will create an environment whereby incremental innovation which may have a slightly higher risk than business plan activities can be progressed. Further, it has been identified that the Innovation Allowance will allow SPT the opportunity to pursue developments as and when they arise throughout the RIIO T1 period, as many of these cannot yet be anticipated. We believe it is vital that the Innovation Allowance can be used for a range of purposes including the preparation for the Network Innovation Competition (NIC) as has been permitted in Tier 1 of the Low Carbon Network Fund, as well as training and dissemination of staff for the adoption of new technology and techniques into business as usual processes. We see this approximate split as set out below.



Some areas being developed for funding under the Innovation allowance are listed below.

Wide Area Monitoring

The development of Wide Area Monitoring (WAM) provides a new dimension to system monitoring providing enhanced visibility of system oscillatory modes and real time visibility system stability limits. This enhanced visibility will enable us to push the transmission system harder without compromising system security. We believe this technology is necessary for a future power system with rapidly varying power flows from large volumes of intermittent wind generation. Other benefits of WAM include enhanced visibility of synchronous zones and black start capability, accurate measurement of system impedance and network model validation.

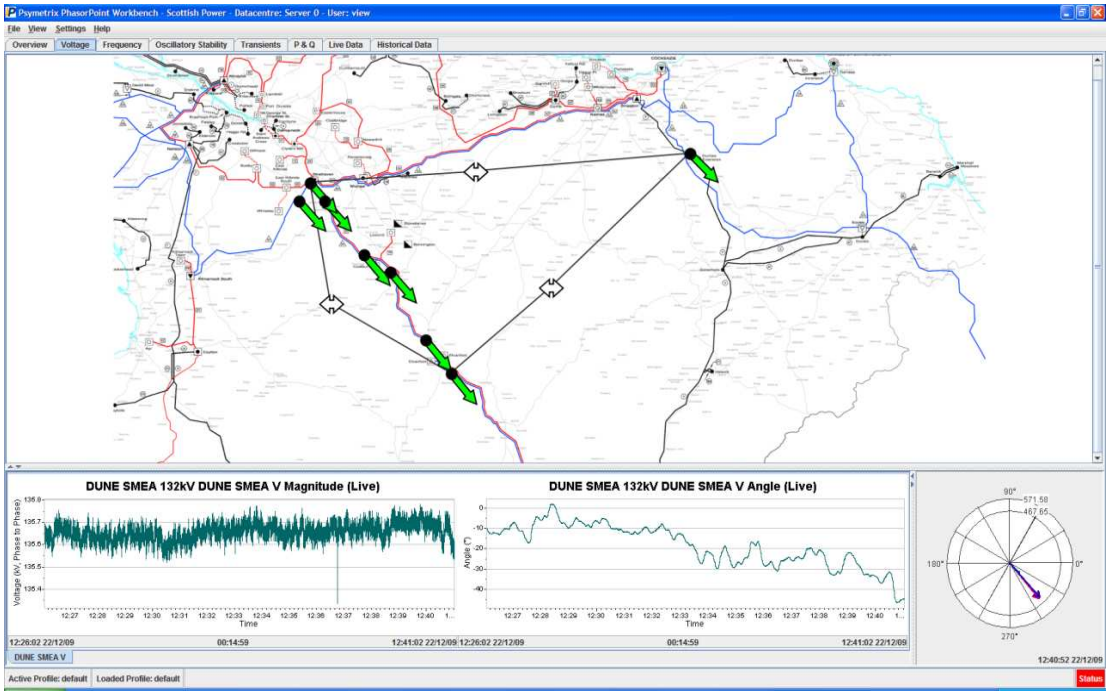
SPT are acknowledged industry leaders in this field and have the skills and aptitude, working with the supplier (Psymetrix) and NGET, to tailor the technology to deliver the

system monitoring needs of the future. The developments proposed include but are not limited to the following:-

- The networking of Phasor Measurement Units (PMUs) from the SPT Licenced area to be used by the GBSO in real time network security visualisation tools
- The development of the WAM data acquisition systems to capture Sub-Synchronous Resonance (SSR) frequencies that may be produced by the commissioning of Series Compensation and embedded HVDC links across the Anglo-Scottish boundary.
- The integration of WAM with the SMART transmission zone proposal below.
- Joint development of network security visualisation tools with NGET.

The anticipated cost required for engineering, hardware, communication equipment and software development is estimated at £500k.

The figure below shows a display from the Wide Area Monitoring Phasor Point showing instantaneous system vectors based on the technology which we have trialled to date as part of existing innovation projects.



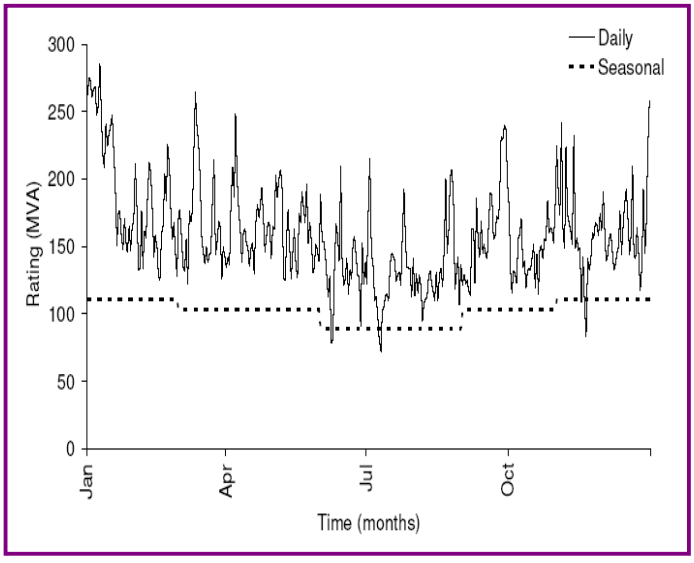
Smart Transmission Zone

The current manual generation despatch system operated by the GBSO will need to be replaced by a much more sophisticated, automated system more closely integrated with the transmission system network monitoring and control systems. As a first step towards this radical change, the development of distributed control systems is appropriate and SPT in their role as TO, are to propose and develop with NGET a SMART Transmission Zone across the Anglo-Scottish transmission boundary, to manage the secure transmission of up to 10GW of wind through the SPT transmission system. This system will utilise Wide Area Monitoring technology to provide inputs to a control system that will monitor the integrity of the interconnector circuits and provide automatic post fault control actions to re-secure the system following critical interconnector faults.

These post fault control actions will rapidly reduce the AC power transfer from Scotland to England by automatically tripping conventional/wind generation and also instruct the HVDC link(s) to use their available short term overload capability to unload the AC network. The system may also control the use of Series Compensation to balance interconnector flows across the east and west circuits, pre-fault. The anticipated cost for this SMART zone development is £2.5m spread over a number of years.

Dynamic Rating of Overhead Lines

Dynamic Rating may be deployed to maximise the thermal capacity of the transmission and distribution overhead line system in a number of ways, e.g. by maximising the connection of windfarms with minimum connection infrastructure, and also by maximising the capacity of the main transmission system in order to minimise Scottish constraints etc. Dynamic rating uses information on wind-speed, temperature and solar gain to increase the overhead line conductor rating, ensuring safe ground clearances are achieved, whilst realising a significant enhancement in capacity. The diagram below provides some indication of potential line ratings compared to current seasonal limits.



SPT wish to develop an overhead line weather enhanced rating system for the main interconnected transmission system for

commissioning in 2015 when it is predicted that that there will be a significant increase in thermal constraints. The system will use a network of strategically placed weather stations in conjunction with Met Office area weather forecasts. The weather information will be input to a database containing composite circuit thermal rating models to provide the GBSO with real time and predictive circuit ratings. The anticipated cost for engineering, weather stations, hardware and software is £1m

Some other technology trials and demonstrations that we have identified as of being beneficial include:

- Further embedded HVDC control strategies to optimise dynamic performance, boundary capacity and minimise system losses.
- New techniques for the testing of the condition of Aluminium Core Steel Reinforced (ACSR) conductors.
- Non intrusive health monitoring of transformers and other primary plants.
- Condition based asset monitoring and maintenance.
- New protection technologies and communication standards.
- Improving visual amenity through alternative methods such as alternative tower design.
- Safe clearance policy for wind turbines within the proximity of transmission lines
- Promotion of IEC 61850 protocol for fault recorders and associated equipment
- Solar Geomagnetic Induced Currents (GIC) modelling and system monitoring

Some of these initiatives are developments or a continuation of existing IFI projects while others are completely new. We anticipate other projects will emerge over time that can help to deliver value for customers whilst aiding the transition to a low carbon economy. All of these projects and any other potential projects will be subject to our internal governance and approvals process to ensure that they deliver sufficient benefits and are achievable. With this variety of projects, we believe that 1% of revenue allowed for the Innovation Allowance is appropriate.

5. Network Innovation Competition

In terms of the Network Innovation Competition, we believe this is an opportunity to trial more radical innovation, which could transform the way we operate the network. SPT has already held initial discussions with National Grid to discuss potential projects to progress under the NIC as well as the IA. Given the nature of the transmission system, SPT believes it is key that these are undertaken collaboratively with SHETL and National Grid in its capacity as the system operator as well as TO. Some of the key themes include:

- Energy storage: understanding the opportunities and implications of storage technologies on the network. This may lead to improved usage of renewable generation as well as creating arbitrage opportunities to help the electricity market.
- DC technology; development of technology including voltage source convertors and network configuration strategies. Developments in DC technology will greatly aid the transmission of electricity and reduce costs through research of the equipment.
- Demand side management and visibility of aggregated demand/embedded generation; to understand the implications on network flows and possible reverse power flows, impacting DNOs.
- Other alternative technologies such as superconductors.
- Developing initiatives identified in the IA to be extended to form larger, integrated projects.

SPT will develop these various themes under the Network Innovation Competition, with key partners in order to improve the transmission network, aiding the transition to a low carbon economy and helping to deliver value for money to customers. We believe it is vital that network companies; both transmission and distribution companies, are at the core of any of these projects.

We recognise that the role of innovation extends beyond the activity itself, and only once the technology or technique has been embedded within the business is the project a true success and we will be aiming to achieve this in order to maximise the benefits from all of this work. We have a dedicated team to lead on innovation activities as part of our Network Development Section, and this team will be focussed on embedding these technologies within the business.