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RIIO-T2 Innovation Strategy 2021-2026

Stakeholder Consultation

SP ENERGY NETWORKS

Foreword

Over the past decade SP Transmission has led the way with its innovation activities, developing new technologies and solutions to address the challenges of the energy system transition. Our strategy is to use innovation as a tool to help deliver the needs of our customers and wider stakeholders.

Jim Sutherland
RIIO-T2 Programme Director

SP Energy Networks (SPEN) owns and operates three regulated electricity network businesses in the UK: SP Transmission plc (SPT), SP Distribution plc (SPD) and SP Manweb plc (SPM). Our transmission (SPT) and distribution (SPD) network in Scotland covers an area of almost 23,000km² in central and southern Scotland. In our licence areas we are the point of contact for all enquires relating to the electricity network. The safety and security of electricity supply is paramount to our day-to-day operations. We are dedicated to delivering a safe and reliable electricity supply to all of our customers 24 hours a day, 365 days a year.

SPEN plays a significant role in low carbon transition in GB. In our licence areas 4.7gigawatts (GW) of thermal plant has closed in recent years. Over a similar period we have connected around 7GW of renewable generation a significantly higher proportion compared to rest of the UK. In the UK we are a leading Transmission Network Owner (TO) in facilitating the connection of new renewable energy. SP Transmission owns and operates 154 substations and 4000km of overhead lines and cable network. Over the last decade SP Transmission has led the way with its innovation activities, developing new technologies and solutions to address the challenges of the energy system transition. Our strategy is to use innovation as a tool to help deliver the needs of our customers and wider stakeholders.

We are now in the process of developing our business plan for the next price control period for transmission (RIIO-T2). Our Business Plan will be submitted to the GB energy regulator Ofgem by the end of 2019. Ofgem has played a significant role in promoting innovation within the energy sector through various network innovation stimuli such as network innovation allowance (NIA), network innovation competition (NIC) and innovation roll-out mechanism (IRM) in the RIIO-1 price control. Our plans will ensure that the benefits of this activity are fully realised in future price control periods as per the expectations of our stakeholders' expectations.

Our innovation strategy stakeholder consultation provides an overview of the energy system transition challenges faced by GB transmission owners (TO) and electricity system operator (ESO) in the coming decade and our plan to use innovation to mitigate these challenges in RIIO-T2. We also provide examples of innovation projects funded through the RIIO-1 innovation stimulus that we have successfully delivered, or are in the process of delivering, that we plan to roll-out in RIIO-T2 to generate benefits to our customers and achieve GB's low carbon targets. We would like to hear from our stakeholders regarding our innovation ambition in RIIO-T2 through the consultation questions provided at the end of this document. We will appreciate your feedback and it will greatly help us in our development of innovation strategy for RIIO-T2.

Why We Innovate
Summary

"Innovation is the key to resolving our network challenges, as an industry we have embraced innovation as we know what faces us cannot be solved by doing things the same way we did a decade ago."

The UK government expects energy companies to play a leading role within the journey to a low carbon economy. Ambitious targets have been set by UK and Scottish governments to accelerate this journey.

Scotland's electricity supply today is largely decarbonised. In 2017, renewable electricity generation was equivalent to approximately 68% of Scotland's electricity consumption[1]. New innovative approaches have enabled more renewable generation to be connected to the network, and facilitated the closure of larger thermal generations to be accelerated. The energy system transition towards our low carbon future can be seen in the rapid uptake of electric vehicles (EVs), electric heating, increased distributed and renewable generation, as well as the emergence of disruptive technologies. We understand and are committed to realising the benefits of this transition.

We are also aware that the pace of this change is faster than ever before and brings in new challenges. We mitigate these challenges associated with it by thinking differently, by being innovative in our day-to-day business.

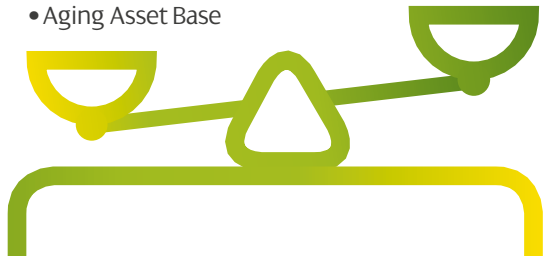
Innovation is the key to ensuring that the energy system transition is seen as an opportunity and not as a threat and we keep pace with it to continue improving and modernising our infrastructure and day to day operations under the constraints of regulatory obligations, ageing assets and economic fluctuations with the ultimate goals of delivering benefits to GB customers and maintaining security and reliability of supply. In RIIO-T2 we will continue to make effective investment in our network and continue to innovate to maintain and improve the reliability, resilience and service of our network for the benefit of our customers.

[1] Scottish Government Energy Strategy

Balancing the changes and constraints through innovation

Constraints
- Economy
- Regulation
- Aging Asset Base

Changes
- Energy Landscape
- Generation
- Demand



Energy System Transition Challenges for the Transmission Network

Decarbonisation

Digitalisation

Integration of New Technologies

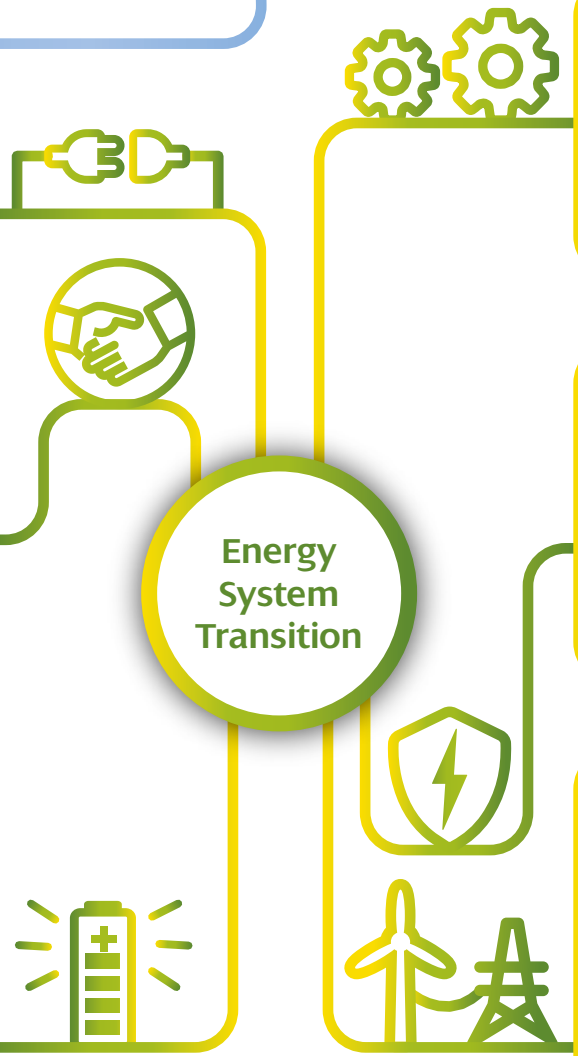
The developments brought by the information and communication technology (ICT) sector to the whole society and economy is also impacting the power system. RIIO-1 innovation projects brought in diverse forms of data, protocols for integration, types of data models and analysis platforms. There is now greater need for standardisation of digital technologies for power system applications and developing digital skill-sets within our organisations. Innovation is a key driver and solution to challenges and opportunities introduced through digitalisation and ensuring cyber security of digital systems.

Overcoming TO-DNO Boundary Restrictions and Our Vision of DSO

SAs a transmission and distribution network owner SP Energy Networks is increasingly aware of the need to overcome the transmission and distribution network visibility boundaries and create more synergies between both networks. The rise in amounts of renewable, intermittent generation that are being incorporated into the transmission system, creating a need for new, flexible operating capability, and more importantly to the TO-DNO interface. The focus of innovation in this area now and over the next decade will create more visibility of the distribution network and to develop solutions to generate network flexibility.

Challenges related to Black Start

Black Start is the process in place to reenergise the system in case of the low probability event of large discrepancy between generation and demand and loss of power supply in large areas or the complete network otherwise known blackout. Blackouts are very low probability but extremely risky events that we cannot control but we need to be ready to perform a role if it does happen. The availability of conventional Black Start service providers will decrease as part of the shift away from conventional thermal generation. We are exploring new and innovative avenues to increase network resilienceand efficiently manage Black Start through suitable alternative measures.



Evolution of Our Network

Our network has a critical role to play in decarbonisation. As a TO and a DNO it is our responsibility to unlock low carbon economic growth by ensuring our investment plans align with the future network requirements and by maintaining a resilient network in an uncertain future. The changes in government policies and the drive to minimise costs to consumers require innovation to introduce more cost effective reinforcement options and where possible avoid reinforcement through innovative solutions to make more of our existing asset base.

System Security and Stability Challenges

The stability of an interconnected power system is its ability to maintain equilibrium during normal conditions and to return to normal or stable operation after having been subjected to power system disturbances. The rapid increase of non-synchronous renewable generation and fast decline of conventional generation connected to transmisison network over the last decade has led to a shortage of dynamic and immediate responses to system disturbances, decrease in system strength and reduction in dispatchable generation for management of network parameters such as frequency and voltage.

Increased Grid Dynamics and Interactions

Increasing level of renewable generation and HVDC inter-connectors have increased penetration of converter based technologies in our network which behave differently as compared to synchronous generation. The major challenge associated with converter based technologies is requirement for accurate modelling and experience in operating such systems over longer durations and different network conditions to accurately predict its behaviour, performance and interactions with other network assets. Innovation is key to accurately studying the behaviour of converter based generation during system planning and enhancing dynamic visibility of grid interactions in real-time.

Decentralisation

Innovation Clusters and Themes

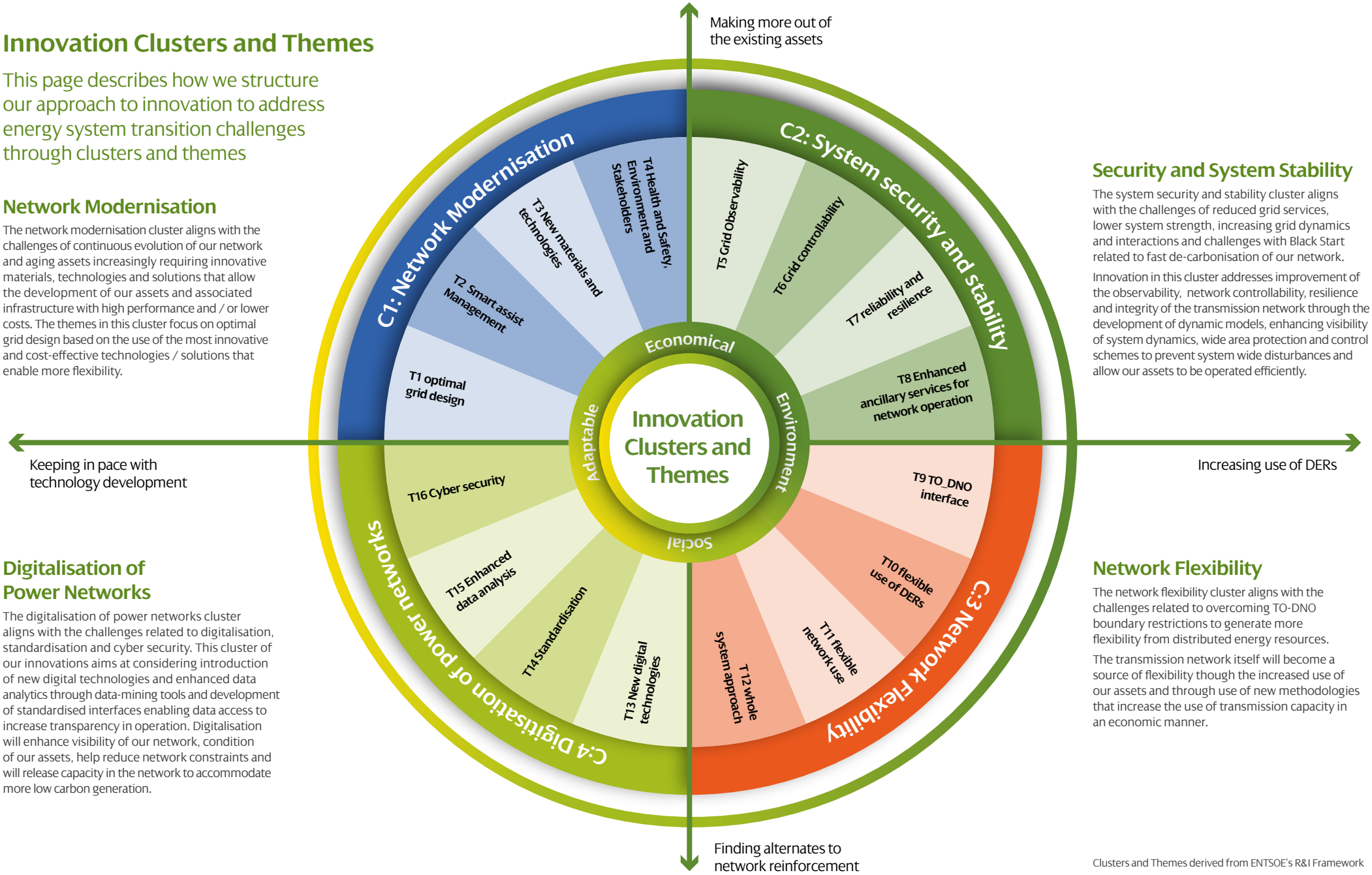
This page describes how we structure our approach to innovation to address energy system transition challenges through clusters and themes

Network Modernisation

The network modernisation cluster aligns with the challenges of continuous evolution of our network and aging assets increasingly requiring innovative materials, technologies and solutions that allow the development of our assets and associated infrastructure with high performance and / or lower costs. The themes in this cluster focus on optimal grid design based on the use of the most innovative and cost-effective technologies / solutions that enable more flexibility.

Digitalisation of Power Networks

The digitalisation of power networks cluster aligns with the challenges related to digitalisation, standardisation and cyber security. This cluster of our innovations aims at considering introduction of new digital technologies and enhanced data analytics through data-mining tools and development of standardised interfaces enabling data access to increase transparency in operation. Digitalisation will enhance visibility of our network, condition of our assets, help reduce network constraints and will release capacity in the network to accommodate more low carbon generation.



Security and System Stability

The system security and stability cluster aligns with the challenges of reduced grid services, lower system strength, increasing grid dynamics and interactions and challenges with Black Start related to fast de-carbonisation of our network.

Innovation in this cluster addresses improvement of the observability, network controllability, resilience and integrity of the transmission network through the development of dynamic models, enhancing visibility of system dynamics, wide area protection and control schemes to prevent system wide disturbances and allow our assets to be operated efficiently.

Network Flexibility

The network flexibility cluster aligns with the challenges related to overcoming TO-DNO boundary restrictions to generate more flexibility from distributed energy resources.

The transmission network itself will become a source of flexibility though the increased use of our assets and through use of new methodologies that increase the use of transmission capacity in an economic manner.

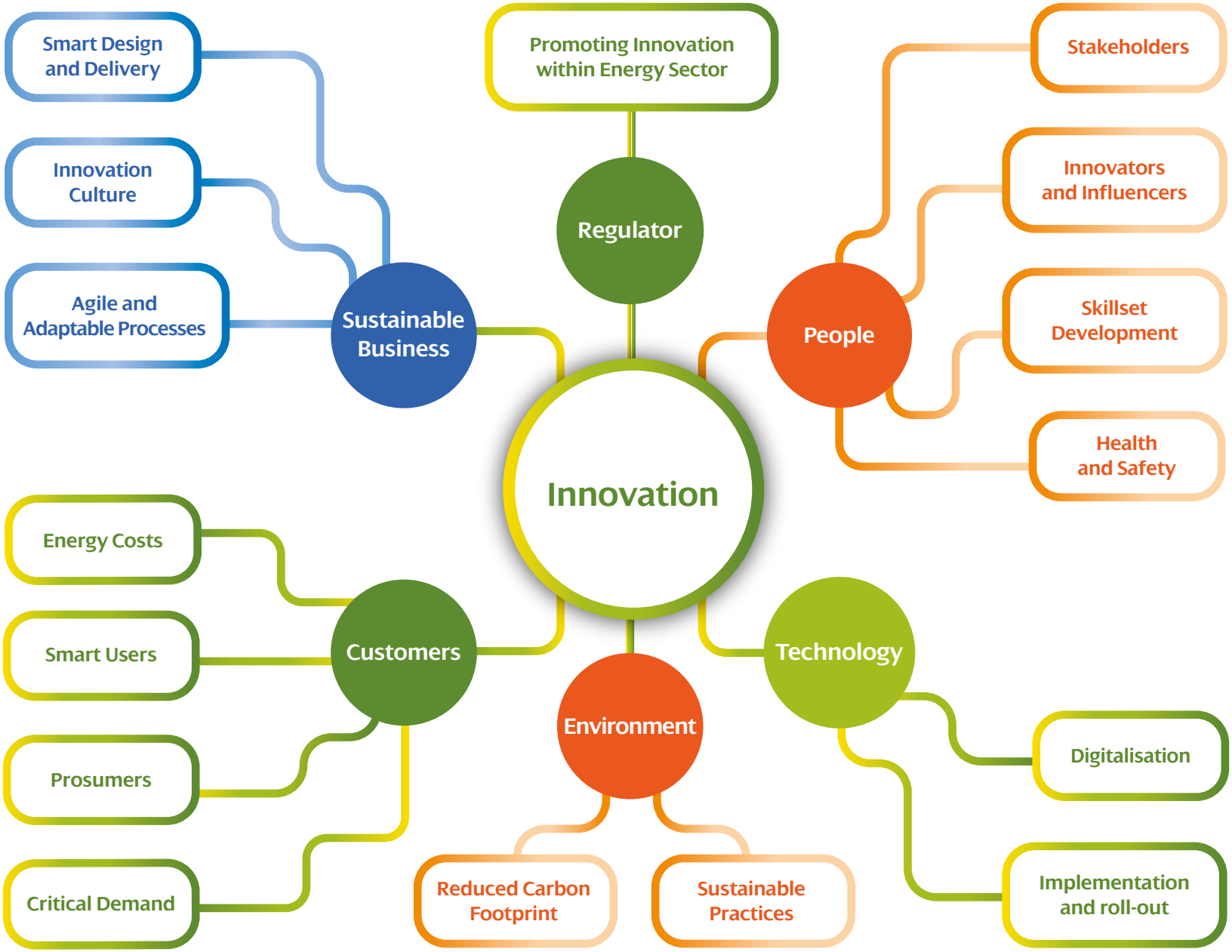
Clusters and Themes derived from ENTSOE's R&I Framework

Innovation is More Than Technology

Innovation in essence is the result of innovators thinking differently and coming up with new and alternative solutions to reduce cost, improve efficiency, drive down carbon footprint and improve sustainability. The innovation incentive in RIIO-1 has been successful in building a culture of innovation and driving changes through network owners and operators' businesses. The nature of any regulated business with a high priority to maintain security of supply is "risk averse". Innovative projects and pilot trials stimulate "out of the box" thinking and open up the prospects of tackling day-to-day challenges with new techniques and methods. Innovation is not just about applying these techniques and methods but the perception and willingness to change and do our day-to-day job differently to drive efficiencies and meet the emerging challenges on our network.

Our experience from the innovation process in RIIO-1 shows that **innovation is not only about introducing new technology but is also a huge driver for cultural and process change to be a sustainable business, develop skill-sets, reduce environmental footprint and deliver benefits to GB customers.**

SPEN supports Ofgem's decision to retain dedicated innovation funding in RIIO-2 and is working through Ofgem's consultation process to help introduce the innovation reforms proposed for RIIO-2.



Examples of Innovation Opportunities and Challenges

Cluster 1 Network Modernisation

Alternatives to SF_6

SP transmission aspires to identify measures to improve overall business carbon footprint where appropriate. It is self evident that due to the harmful effects of SF_6 on climate acting as a potent greenhouse gas we need to reduce the use of SF_6 on our network with suitable alternatives. SP Energy Networks is collaborating with manufacturers and other network operators to identify and standardise environmental friendly alternatives to SF_6. Lister drive 132kV Gas insulated switchgear ((GIS) in our SP Manweb (Lister Drive) and SP Transmission (Kilmarnock South) will be delivered with GE Grid solutions innovative SF_6 alternative product g3. In RIIO-T2 this solution will be rolled out for wider transmission network including solutions for GIS and gas insulated busbars (GIB).

Reduction in

36k

tonnes of CO_2 over 40 years corresponding to reduction of 1.4 tonnes of SF_6 on one circuit

High Temperature Low Sag Conductor

In 2016, we reported on plans to re-conductor two 275kV overhead line routes in the south-west of Scotland using a new High-Temperature Low-Sag (HTLS) conductor system. The system has been designed to operate at higher temperatures than conventional conductors to offer greater transfer capacity. The HTLS technology has directly replaced 'Zebra' and 'Rubus' conductors without the need for tower reinforcement. The two routes are the Kilmarnock South to Coylton 15.5km double-circuit (known as the XY Route), and the Coylton to Mark Hill 49.5km single-circuit (known as the YY Route). Coupled with the over-arching 'South West Scotland' project, the work is expected to increase the total export capability from Coylton to the wider 275kV and 400kV network and contribute **1.7GW by 2021 (and 2.1GW by 2023) of additional renewable generation to the GB system, representing 40% of the onshore wind generation in Scotland.** This was completed in 2016, 8 years earlier than the business as usual alternative of developing new routes and constructing new towers and lines.

C2 System Security and Stability

VISOR – Visualisation of real-time system dynamics using enhanced monitoring

VISOR (Visualisation of Real Time System Dynamics using Enhanced Monitoring) is our flagship collaborative NIC project between system designers, operators, developers and researchers. **The project demonstrates the first Wide Area Monitoring System (WAMS): a nationwide IT infrastructure combining synchronised measurements from all three GB Transmission Owners (TOs) sent over high-speed communication links to the GB Electricity system operator (ESO).** VISOR is truly revolutionising the real-time monitoring of the transmission system; providing GB-wide real-time visibility of dynamic system behaviour, enhancing network resilience, increasing network capacity and delivering savings to customers. The improved system visualisation also helps protect against system events that could result in a complete or partial blackout of the GB system. VISOR project will be rolled-out in RIIO-T2 to continue monitoring of grid dynamics. The project will also enable dynamic modelling to ensure system security and stability. WAMS will be integrated with EMS system in RIIO-T2 providing dynamic visibility to our operators greatly reducing risks of blackouts.

Great Britain's

1st

GB's 1st wide Area Monitoring System across all TOs and the ESO

Phoenix

Phoenix seeks to develop and demonstrate the deployment of a - hybrid synchronous compensator (H-SC). This technology will allow greater use of renewable power from windfarms, solar arrays and batteries whilst maintaining security and stability of supply against a background of recent and planned closures of conventional generation plants.

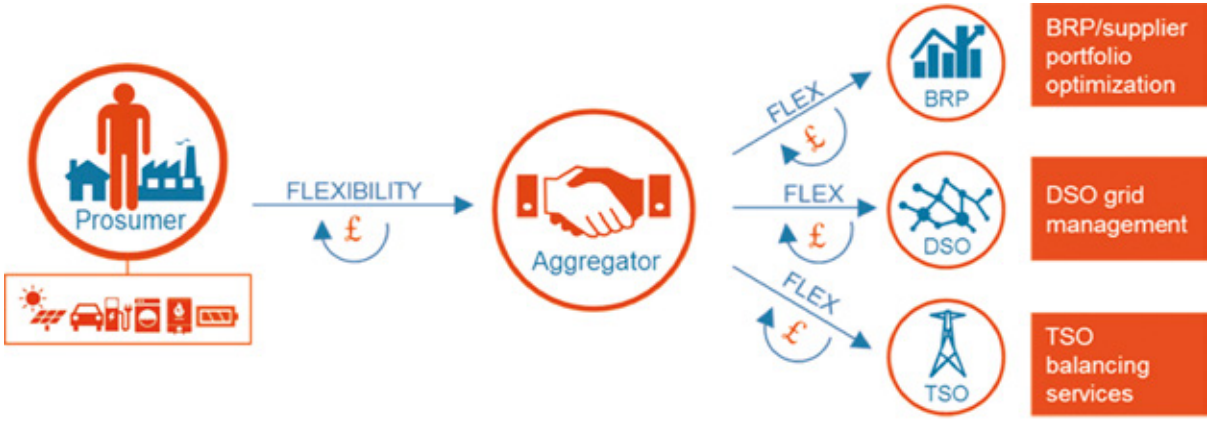
Through the trial, the project will address the overarching technical, engineering, commercial challenges that currently perceived as the main barriers for wider scale adoption. A successful pilot and subsequent roll-out of H-SCs will have substantial environmental and benefits for our customers as they backfill essential grid services and security offered by large conventional synchronous generators as we move to a low carbon supply of electricity.

C3 Network Flexibility

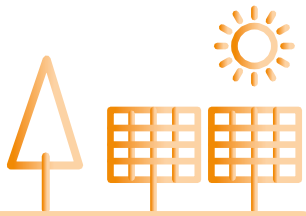
FUSION

The UK faces high load growth from increasing low carbon technology (LCT) uptake and strategic regional developments. Conventional reinforcement can no longer provide the only efficient means to meet evolving customer needs. Geographically local demand-side flexibility is a valid alternative, however its application is currently immature and has been tested only in bilateral agreements. In response to current policy developments, FUSION seeks to implement a local competitive, open and structured flexibility market in East Fife, Scotland, as a network management tool to mitigate local network constraints and complement national balancing requirements within the existing regulatory framework.

The project will demonstrate the commoditisation of local demand-side flexibility in East Fife through a structured market-based framework to address local and national electrical network congestion. **In RIIO-T2 flexibility generated at distribution network level will also provide the TO and ESO with essential grid services moving towards a whole system approach.** FUSION is a five-year (£5.7M) Distribution System Operator DSO-transition project funded by Ofgem's 2017 Network Innovation Competition (NIC).



Generating network flexibility through Whole System Approach



Black Start from DERs

The project on Black Start from Distributed Energy Resources (DER) proposed by GB Electricity System Operator (GB ESO) in collaboration with SP Energy Networks is an important and timely initiative that will ultimately lead to significant benefits for electricity customers in Great Britain (GB) by reducing costs for Black Start services, and will also inform research and development in other countries. Black Start services need to evolve in line with changes in the energy landscape and support the transition to a low carbon, decentralised future.

SPEN is at the forefront of industry activity on the integration of distributed energy resources and the development of new approaches to restoration of the power system following a black out event. SPEN as both a Transmission Owner (TO) and Distribution Network Owner (DNO) is already trialling various initiatives relevant to this project. The geographic regions served by SPEN in southern Scotland and north Wales are rich in renewable energy resources and on our networks the growth in DER occurred earlier, faster and to a greater extent than most other parts of the country. The areas for study identified in SPEN network areas under this project include a mixture of synchronous and non-synchronous generation and will provide valid learnings for GB-wide roll-out in RIIO-T2.

The Black Start from DER project is an important step towards an innovative whole system approach that adds flexibility, improves resilience, and reduces future costs of critical grid services.

C4 Digitalisation of Power Networks

FITNESS

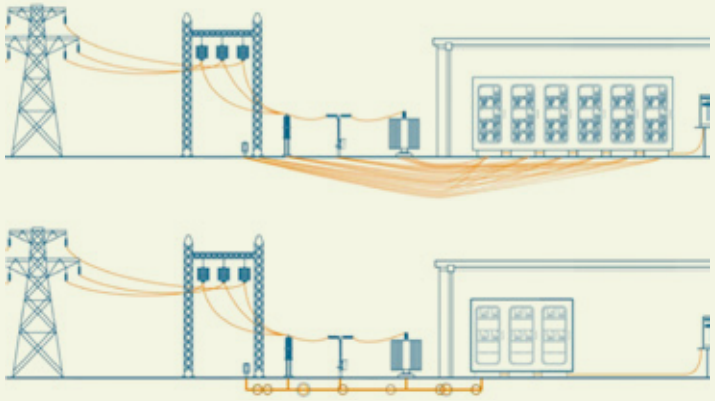
Project Fitness (Future Intelligent Transmission Network Substation) delivers a globally innovative state-of-the-art digital substation design. FITNESS project is the first multi-vendor digital substation automation, protection and control system demonstration in Great Britain (GB) led by SP Energy Networks (SPEN). The project is currently live at the Wishaw 275kV substation in Scotland.

FITNESS demonstrates use of digitised measurements for protection, control and monitoring instead of traditional copper wiring and conventional measurement equipment. FITNESS addresses several areas where operational costs can be reduced through reduction in the number and length of planned outages. Digital substations require considerably shorter outage windows for commissioning, operation and maintenance increasing operational flexibility and reducing costs to GB customers.

Digital substations also reduce substation CAPEX costs related to civil works, project management and design in new build or complete replacements by reducing footprint and reducing engineering effort and enhance substation safety.

In 2015 £8.3m of funding was awarded by Ofgem for project FITNESS. The adoption of digital substations by TOs will allow the payback of this investment in RIIO-T2 through benefits generated for GB customers.

FITNESS is at the forefront of International standardisation for IEC61850 and is recognised as an international success in digital substations trials.



- Smaller substation foot print
- Increased Safety
- Driving digitalisation and standardisation to reduce operational costs

Consultation Questions

1. Has SP Transmission adequately identified energy system transition challenges to be faced by the transmission network owners in the next price control period? Are you aware of any other challenges that we should include in our list?

2. In your opinion do our innovation clusters and themes cover all aspects of innovation you would like us to focus on in RIIO-T2? If not, can you provide suggestions for additional clusters and themes?

3. What kind of innovation projects would you like SP Transmission to undertake in RIIO-T2? For e.g. customer facing, market focused, integration of new technologies.

Please send your responses to
RIIO_T2@spenergynetworks.co.uk