Scottish & Southern Electricity Networks

Your Plan, Our Future: RIIO-T2

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Our innovation thinking for the future

Scottish Hydro Electric Transmission plc
RIIO-T2 Business Plan

April 2019

www.ssen-transmission.co.uk

Contents

The purpose of this document is to describe our Innovation thinking for the future, as developed with our stakeholders, and how innovation will be maximised through its implementation. The next step will be to develop and publish a Summary Innovation Strategy and an Implementation Plan that will describe how this Strategy is to be established into SHE Transmission. This plan will be consulted upon in summer 2019.

Foreword

Introduction from Rob McDonald

I am delighted to introduce SHE Transmission's Innovation thinking for the future.

Innovation – both technical and commercial – has been an important part of our way of working at SHE Transmission over the past decade. The GB electricity system has been transformed by the shift to renewable and decentralised energy. To keep pace with changing customers' needs we've had to innovate and move fast.

Our starting point for looking forward has been to look back. A comprehensive review of the 39 innovation projects that we have underway or completed shows that customers have benefited by £39 million to date, which is forecast to increase to nearly £100 million by 2026. These benefits derive from significant technical innovations, such as the Caithness Moray HVDC link, through to stakeholder-led commercial innovations, like our Scottish islands initiatives.

We have looked forward in collaboration with our stakeholders. Three of our five innovation values that we set out in this document are: support customer, user driven and collaborative efforts. We innovate to solve problems and create opportunities for our customers and cannot do this without their close involvement.

Building on what stakeholders have told us over the past nine months, we have developed this comprehensive document. It is wide ranging. While there is a significant, and justified, industry focus on the energy system transition, we understand that innovation across the range of our activities can be of benefit to our customers. This includes activities such as our approach to engagement, the reliability and resilience of the network, integration of 'big data', and health and safety. A robust, evidence-based cost benefit analysis (CBA) methodology will ensure that we prioritise those innovations likely to deliver the most valued benefits.

This Innovation Strategy builds on our strong track record of successful innovation. I am confident that, with the involvement of our customers and stakeholders, it sets us up to address the challenges ahead.

Rob McDonald
Managing Director
Transmission

Introduction

Scottish Hydro Electric (SHE) Transmission is the owner of the high voltage electricity assets in the north of Scotland. As the Transmission Owner (TO) we own the 400kV, 275kV and 132kV electricity network in the north of Scotland. Our network consists of underground and subsea cables, overhead lines on wooden and composite poles and steel towers, and electricity substations, extending over a quarter of the UK's land mass and across some of its most challenging terrain.

About us

As part of Scottish and Southern Electricity Networks (SSEN), which includes our sister company Scottish Hydro Electric Power Distribution (SHEPD) the owner of the adjoining low voltage network, our electricity network is responsible for ensuring a safe, reliable supply of electricity to around 770,000 homes and businesses (Figure 1). We also provide grid access for over 7 GW of generation, contributing around one third of GB's renewable energy capacity.

We power our communities by providing a safe and reliable supply of electricity. We do so by taking the electricity from generators and transporting it at high voltages over long distances through our transmission network for distribution to homes and businesses in villages, towns and cities.

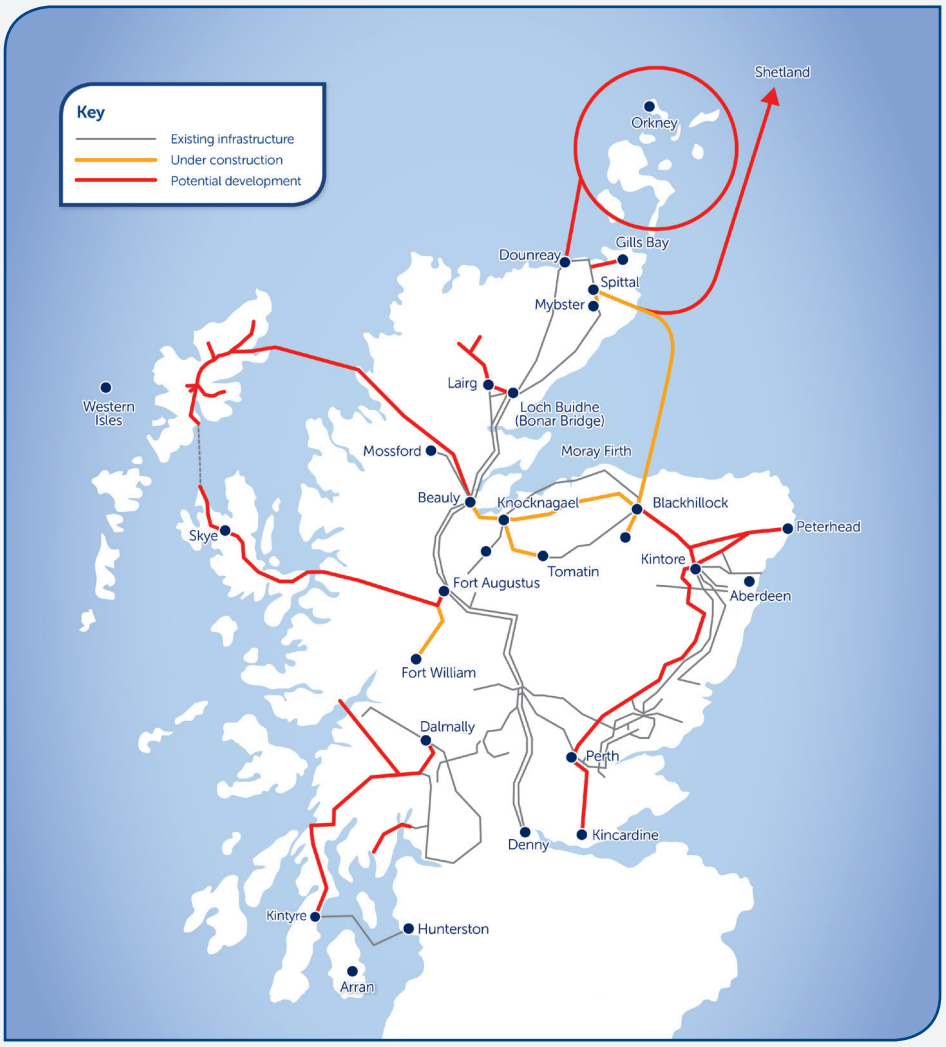


Figure 1: The North of Scotland electricity network, January 2019

Management of innovation

To deliver our Innovation Strategy, we will define an Innovation Implementation Plan that will focus on how we will implement our strategy in ET2. This will contain detail on structure, governance, processes and Cost Benefit Analysis (CBA) methodology. We will refine our Innovation Management System by aligning its implementation with our strategic objectives. We will be developing this plan in collaboration with our employees and stakeholders to ensure that it is fit for purpose and meets their reasonable needs and expectations.

We will refine our Innovation Management System by aligning its implementation with our strategic objectives. We will be developing this plan in collaboration with our employees and stakeholders to ensure that it is fit for purpose and meets their reasonable needs and expectations. This process will start with publication of our draft plan and a request for feedback through consultation in May 2019. Feedback received will be used to refine and finalise our plan which in turn will trigger the establishment of the Innovation Management System within SHE Transmission.

We will regularly revisit these steps to inform and update our Innovation Strategy and identify future strategic innovation areas.

Our publication

The development of this Innovation Strategy supports our Business Plan submission for our next price control, RIIO-ET2. For more information on the RIIO-ET2 process and our business plan development, please visit:
www.ssen-transmission.co.uk/information-centre/industry-and-regulation/riio-t2

This document outlines our historic innovation performance and defines our long-term approach to the planning and implementation of new technologies, processes and services into our business during RIIO-ET2, and beyond. Defining our appetite and culture for innovation are important foundations on which to build continuous improvement. This document also outlines our:

- Ongoing interactions with our customers and stakeholders on Innovation.
- Aspiration to be a Responsible Innovator by being agile and forward thinking.
- Alignment of Business as Usual (BaU) innovation activities with our strategic business plans.
- Mechanisms to categorise and optimise potential benefits from our innovations.
- Approach to collaborating closely with other industry stakeholders to optimise the delivery of our innovation portfolio.
- Approach for managing emerging scenarios as they evolve in an increasingly uncertain future.

Part 1

Developing our Stakeholder-led Innovation Thinking

In developing our innovation thinking, we were informed by our historic performance, our customers and stakeholders, emerging industry trends, the context of government policy, our historic performance and regulatory requirements. We have sought to understand the needs and views of our stakeholders and have used this to develop our strategy and inform our decisions on the materiality of different issues and to help determine our goals.

As we head towards the start of the next price control RIIO-ET2, we recognise that significant changes have taken place since the publication of our last Transmission Innovation Strategy[1] in March 2017. Figure 2 below charts the stages we progressed through to develop our strategy and implementation plans to account for these changes.

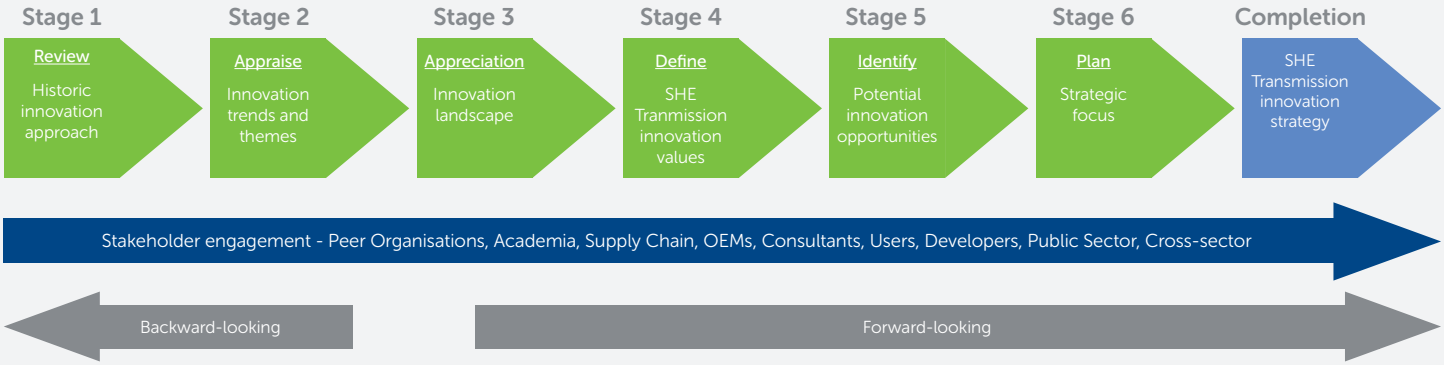


Figure 2: Innovation Strategy Development Plan

Our thinking is the result of extensive cross industry stakeholder engagement, because if it does not support our customers and stakeholders then it will not be effective. Our objectives for this engagement programme were to:

- Understand our historic innovation performance;
- Define what was important both now and for the future across the industry; and
- Obtain feedback on whether our developed plans were fit for purpose, both in terms of our own projects and interactions.

Outputs from this engagement helped us develop our innovation framework, which we then tested at a SHE Transmission ET2 Stakeholder Event, attended by representatives from the supply chain, the transport and heat industries, equipment suppliers, academia, directly connected customers, social enterprise organisations and charities, and cross-vector parties Scottish Government, community energy groups, and consultants and with our industry-wide User Group, in October and December 2018 respectively, refining it to account for stakeholder feedback following each engagement.

Our strategic themes were tested with invested parties at a stakeholder round-table event in February 2019. Attendees again covered the same sectors. The output from all these engagements defined the final document.

As a regulated monopoly and national infrastructure developer, SHE Transmission has a responsibility to many others beyond our shareholders. These include the communities we serve, whether geographically defined, urban or rural, domestic or industrial. We have recognised the needs of communities which are remote, including island communities; and those which have a high proportion of fuel-poor and vulnerable customers. Our relationship with those who use our transmission network, and ultimately pay for it, is typically a stakeholder one, rather than a direct contractual one.

Electricity bill paying consumers	Heavy Industrial Users	Generators and Developers	Peer Transmission Owners (TO)	Electricity System Operator	Distribution Network Operators	Government and the Public Sector
Industrial partners	Supply Chain	Small-Medium Enterprises	Academia	Energy Networks Association (ENA)	Energy Innovation Centre	Energy Systems Catapults

[1]https://www.ssen-transmission.co.uk/media/2095/transmission-innovation-strategy_updated.pdf

Table 1 below sets out some of the specific challenges raised by stakeholders and how we have revised our thinking and Business Plans to address these.

Issue Raised	Incorporation in Strategy
Stakeholders suggested broadening out the definition of innovation, as well considering it in the context of wider societal ambitions for a low carbon energy system and not just the transmission network.	Our broad definition of innovation validated with Stakeholders. Prediction and tracking of benefits and values will incorporate aspects of wider societal impacts.
SHE Transmission needs to ensure that a culture of innovation permeates across the company to help deliver innovations efficiently.	SHE Transmission has outlined a clear innovation framework identifying aims, objectives and ambitions – tested with internal users and external stakeholders and will implement this culture through an Innovation Management System.
Stakeholders reiterated the need to work collaboratively to help achieve innovation Ambitions.	Refined 'Collaborative Working' value to reflect better needs of users and wider stakeholders. Built into innovation framework so that innovation is developed through collaboration and third parties when it makes sense to do so.
If they (SHE Transmission) really want to support the customer here, they need to genuinely listen.	Framework expanded to include 'Support Customers' value, and 'Stakeholder-led' theme so that innovation is correctly tailored to customer's needs.
Funding innovation through 'business-as-usual' might hinder innovation.	Framework to have a principle on delivering efficiently which will include a consistent way of identifying benefits and the right funding source.
Fast pace of technological change poses risk so SHET should ensure customer money is spent wisely	Developing CBA methodology that uses Ofgem CBA to ensure value for money
There was a suggestion that the tender process needs to change to encourage suppliers to include sustainable innovations as part of their bids.	Procurement Strategy being revised for next price control period, including approach for tendering supply chain innovation and market wide innovation.
Whole system, energy system transition and using network flexibility all go hand in hand. Whole system approach is key to developing that innovation piece too. It is all about how the network develops and changes to move forward.	SHE Transmission participate in ENA Open Network Whole System working group. Multi-discipline internal workstream established to develop and implement our Whole System Approach.
More information about what the issues are would be good. For example, the kind of things you're doing around cybersecurity.	SHE Transmission will establish new methods of communicating issues, lessons learnt, successes and failures with external parties as part of our Innovation Management System. Resource will be allocated for management of stakeholders in this sphere.
I think network planning is important because if you want to do something dynamically you need to base it on consistent standards.	SHE Transmission are keen to pursue a change to probabilistic planning standards, but this requires wholesale industry changes. We will be engaged in working groups to investigate opportunity which defers investment where other methods are more efficient.
Smart asset management allows you to be able to communicate with your own and others equipment and informs what reinforcement goes where so it is important.	Multi-discipline internal workstream established to develop and implement innovation in integrated monitoring, smart asset management and machine-based network management
"I think new technologies are important. Devices help run the transmission network better. We need to work out way to apply these technologies as we are missing a trick not deploying them. This includes the digital evolution of your assets."	Multi-discipline internal workstream established to develop and implement innovation in digital substation evolution
The need for a clearer commitment to fighting climate change was expressed.	SHE Transmission has established a sustainable working group to address direct and indirect GHG emissions. As part of this activity we will investigate ways of reducing volumes of SF6 on our network, with a commitment that where there is a technically and commercially viable alternative, we will no longer install SF_6 on our network.

Table 1 - Accounting for stakeholder feedback

Our external engagement set out to identify industry trends and themes and potential themes for innovations. We targeted external events both in the UK and in Europe, covering industry, supply chain and academia and across different energy vectors. Some of these interactions are described in Table 2 below:

SHE Transmission engaged with the following * in development of our thinking:

*Across a number of events, one to ones and seminars we have also engaged directly connected customers, invested stakeholders, existing and future developers, members of our supply chain and trade bodies. These are not listed due to privacy restrictions.

One to One Engagement	Peers	Academia	Whole System / Cross-Sector	Conferences
Transport Scotland (Jan '19)	NG TO Innovation Workshop (July '18)	Manchester University (Sep '18)	Open Networks – Future Worlds Event (Aug '18)	EAT PlantX Expo (Jun '18)
Scottish Government (Feb '19)	ESO Customer Connection Seminar (Oct '18)	Newcastle University (Sep '18)	ESO Storage Workshop (Sep '18)	Low Carbon Network Innovation Conference (Oct '18)
Citizens Advice (Feb '19)	SPEN Innovation Strategy Consultation (Feb '19)	Glasgow Caledonian University (Oct '18)	Ofwat Round Table (Jan 19)	European Utility Week (Nov '18)
Baringa Consulting (Feb '19)		Strathclyde University (Oct '18)		Westminster Conference on Next Steps for Renewable Energy in the UK (Jan '19)
Ofgem (Mar '19)		Heriot Watt University (Oct '18)		Westminster Conference on Research and Innovation in Energy (March '19)
		MIT Boston (Nov '18)		

Table 2 - Stakeholder engagement forums

Across all of the engagement categories in Table 2, we built up a view of the challenges and drivers pushing and shaping our industry. From the one to one engagements and conference attendances we were able to understand how those drivers of change were being addressed through EU, GB and Scottish policy. Engaging with our peers and academia allowed us to understand what had been innovated upon to date and what each parties focus was for the future. We also investigated large strategic topics such as Whole System, Distribution System Operator (DSO) and storage to better understand how these were being developed by industry and how innovation could support that. Finally, the various SHE Transmission events allowed us to seek our stakeholders view and build up our plans accordingly as highlighted in Table 1 above.

Part 2

Our Innovation thinking for the future

The objective of this document is to define our approach to innovation activities. By embracing innovation, we aim to assist the transition towards a clean energy economy, whilst at least maintaining high levels of reliability in electricity supply and ensuring energy remains affordable for all.

How is our region changing?

Our industry is undergoing significant change driven by the need to provide affordable, clean and secure energy. These aspects have drastically increased the amount of large, small and Distributed Generation (DG), seeking to secure network capacity and earn extra revenue through new energy service markets. Additionally, new technologies are changing how consumers interact with the energy industry and has forced a rethink of the roles and responsibilities of current and future industry participants.

SHE Transmission has a strong record in developing and implementing innovations. This document formalises our commitment to work with our customers, stakeholders, and the wider industry, to understand and deliver what they need from our network.

Quantification of the possible magnitude and scale of future changes, specific to our license area, have been assessed through our North of Scotland Future Energy Scenarios[2] (FES). First published in August 2018 it identified several key energy trends across electricity, heat and transport in our licence across three scenarios (Cost Limitation, Proactive Decarbonisation and Local Optimisation).

Forecasting the key energy trends and policy drivers across electricity, heat and transport in the north of Scotland enables our business plan to address developing patterns of energy use, the changing nature of both industrial and domestic loads, and the evolution of the commercial relationships between energy generators, the transmission system and our end users.

We have an important and ongoing role in enabling the clean energy transition by supporting the industry changes necessary for decentralisation and decarbonisation. This will require the adoption of a **whole system[3] approach** to system planning, development, operation and maintenance to maximise consumer benefits and support decarbonisation.

When addressing these trends, as shown in Table 3, SHE Transmission has sought to understand how customers and stakeholders across our region will align with these emerging trends, allowing us to ensure our innovation thinking reflects the communities we serve - and how these may differ from the needs of the wider GB electricity system.

We recognise that we cannot, and should not, undertake innovation activity unless it has the potential to deliver benefits for customers as well as the wider energy industry. This document proposes our approach for monitoring benefits that might accrue through successful deployment of any innovative approach. Consistency in our analysis will allow the right innovations to be developed.

Decentralisation	Increasing distributed energy with onshore wind as the dominant technology.
Offshore Wind	By 2025/26, offshore wind generation capacity will reach 4,073MW in Proactive decarbonisation, 2,875MW of which is new projects connecting after 2021.
Onshore Wind	Across all of our scenarios, onshore wind represents the generation technology with the highest installed capacity by 2025/26.
Solar PV	Local optimisation has the highest levels of solar PV on the system by 2025/26 at 261MW, increasing by 220MW after 2021.
Island Connections	600MW interconnector connecting to Shetland in Proactive decarbonisation.
Flexibility	High proportions of variable intermittent renewable energy generation, will require additional flexibility services to maintain network integrity.

Table 3 - Emerging Trends – North of Scotland Future Energy Scenarios

[2]North of Scotland Future Energy Scenarios (FES) - https://www.ssen-transmission.co.uk/information-centre/industry-and-regulation/future-energy-scenarios/
[3]Ofgem propose a narrow Whole Systems definition, focusing on coordination of investment planning and operational delivery between the ESO, the GSO and the four network sectors (Gas Transmission and Distribution, and Electricity Transmission and Distribution). There will be potential for widening of scope.


Flying in composite poles for the connection of the Dorenell Windfarm

What does being 'innovative' mean to SHE Transmission?

Innovation is how we continuously improve the performance and management of our transmission network, to enable us to provide energy in a safe, reliable, sustainable, and economical way, ensuring delivery of long-term benefit for society, economy and environment.

Therefore, we see innovation, a view which is supported by our stakeholders, as a way of:

Identifying and proving new ways of working for the long-term benefit of our customers and stakeholders, and efficient operations

As a business, SHE Transmission takes a broad interpretation of innovation, and regards it as a fundamental business-wide activity, rather than a narrow specialisation focused on technology and engineering. This ensures opportunities for improvement can be targeted throughout the business and in our interaction with other actors in the energy industry.

We see innovation as doing something new to SHE Transmission that has the potential to add value to our customers and stakeholders and/or ourselves (without negatively impacting the other). We innovate to de-risk, to drive improvement in existing business activities, and to accommodate new requirements.

Why does SHE Transmission innovate?

SHE Transmission continues to recognise the opportunity to realise benefits for our customers and GB through innovation, and to enable future energy industry trends.

Having already connected 6GW of renewable generation of all scales and technologies to our transmission network, it indicates that we have already been successful in supporting the transition to the low carbon economy. We achieved this by working closely with customers and communities and, where cost-effective, using new technologies, deploying new ways of working and instigating industry change.

We innovate in our ways of working and apply innovations across all areas of the business, including commercial and service functions, as well as in the operation of our transmission network. Customers and stakeholders are at the heart of our plans; if it does not work for them it does not work for us. This approach includes the adoption of lessons learned and innovations which have been delivered elsewhere.

During the next price control period, we will continue to be agile and forward facing, managing innovation from concept through to BaU. We will work with our peer companies, supply chain, academia, industry experts and other trade bodies to react to emergent technologies (such as blockchain and peer-to peer trading), evolving commercial activities and any of our energy scenarios which begin to mature in this period.

How does SHE Transmission innovate?

Network Innovation under RIIO

We recognise the vital role that Ofgem has played in encouraging innovation in the networks industry from Transmission Price Control Review 4 (TPCR4), through to the Revenue = Incentives + Innovation + Outputs (RIIO) framework, where innovation is specifically mentioned. The Network Innovation Allowance (NIA) and Network Innovation Competition (NIC) funding incentives introduced by Ofgem in RIIO have been used to fund new technical, commercial, or operational projects that have the potential to deliver a range of benefits.

Through these funding mechanisms and BAU funding we have successfully delivered several innovations across our business that have had real benefits for our customers, stakeholders, consumers and ourselves. These benefits are covered in more detailed in our "What benefits have we achieved by innovating?" section of this document. SHE Transmission has successfully led, and collaborated with partners, on NIA and NIC projects. Further details on our projects are shared on the ENA's Smarter Networks Portal[4].

Ofgem propose three main aims for reforms to the innovation incentives, as laid out in the sector specific consultation[5], in the next price control: greater coordination with wider public sector funding; alignment of funding stimulus with the Energy System Transition (EST) and enabling increased third-party engagement. SHE Transmission support greater coordination with public funding if the funding requirements complement and do not conflict. We also agree with increasing third party engagement if the all network users, including those not part of any innovation trial, are not negatively impacted. However, we are cautious that innovation stimulus targeted solely at the changing nature of the energy system, would miss other beneficial reasons for innovation. Assessment of our current innovation portfolio and potential innovation focus areas indicates that investment in other areas, including improving construction methods, building smarter networks and improving sustainability performance, provide real value.

3 Transmission NIC Projects Led

- New Suite of Transmission Structures (NeSTS) - SSEEN03
- Modular Approach to Substation Construction (MASC) - SSEEN02
- Multi-Terminal Test Environment (MTTE) - SSEEN01

23 Transmission NIA Projects Led

Including (but not limited to):

- Composite Core (ACCC) Inspection - NIA_SHET_0021
- Transmission System Fault Level Monitoring - NIA_SHET_0022
- Line Inspections by Semi-Autonomous Systems (LISAS) -NIA_SHET_0023
- Partial Discharge in HVDC Cables - NIA_SHET_0024

[4]http://www.smarternetworks.org/
[5]https://www.ofgem.gov.uk/system/files/docs/2019/01/riio-2_sector_methodology_0.pdf

Transferring innovation to Business as Usual (BAU)

SHE Transmission has a proud track record of delivering innovation activity through BAU with technological innovations, such as high temperature low sag conductor, using modular composite structures and implementing a multi-vendor approach to digital substation evolution. These were all delivered without external funding whilst delivering benefits to customers.

Likewise, commercial innovation such as our Orkney Alternative Approach, has been driven by the needs of local communities. Developing these concepts first as innovation projects, allows the required time and space for new activities to be assessed and addressed in a structured framework, which benefits all stakeholders by identifying risks in first-of-a-kind deployments and providing a mechanism for managing them.

We continue to encourage the roll-out of innovative ideas and where possible innovation activities should align with delivery through BaU funding streams, but it is not always possible. BaU funding implies that SHE Transmission shareholders fund the activities, who require a return on their investment. Should the innovation have a low chance of success, i.e. a low Technology Readiness Level (TRL), or the benefits accrue to another party, then there is a reduced chance of them earning a return, so it would be unreasonable to expect them to fund. If there is no third-party funding available, then could limit innovation to short or medium-term projects that only directly benefit the network companies. Long term innovations and those with benefits accruing to others would not be developed.

Active Network Management (ANM) was successfully developed from TRL 1 through to delivery using innovation and BAU funding; as the benefits accrued to parties other than the network companies, this revolutionary technology could not have been delivered without a funding stimulus.

Our stakeholders believe innovation should be built in to all activities we do but felt funding all innovation through BaU might hinder innovation. Therefore, we continue to advocate for funding mechanisms for those specific innovations that are low TRL, or that have benefits accruing to parties other than the network companies, to be made available.

External innovation landscape

SHE Transmission continue to actively pursue options for close strategic work between cross-sector parties where mutually beneficial and where it adds value for our stakeholders. We are actively involved in numerous forums and we have success in 'fast-following' innovations which have proven successful elsewhere.

Within the GB energy industry, there are a range of bodies and funding platforms that are heavily involved in energy industry innovation. These bodies fund, plan, develop and roll out innovation projects. SHE Transmission supports alignment with the strategy and objectives of sources such as Scottish and National Government initiatives, Innovate UK[6] and the Energy Systems Catapult[7] through initiatives such as the Industrial Strategy Challenge Fund[8], the Engineering and Physical Sciences Research Council (EPSRC)[9] and European initiatives such as Horizon 2020.

SHE Transmission is vertically integrated with its sister company SHEPD who share a geographical area. The adjoined network and common interfaces have enabled strong collaboration opportunities during the RIIO-ET1 price control period. Accounting for the different functions we and SHEPD have around framework codes and planning standards, both businesses have been able to deliver whole system planning solutions across grid supply point boundaries. Innovation and the review of planning and operational standards will play an important role in the whole system approach with data storage, ownership, analytics and exchange being key for future coordination and management. In our work with SHEPD we have already gained valuable experience of this.

SHE Transmission is actively engaged in the transition towards a smarter electricity system, participating in the ENA Open Networks Project, and being an active partner in the Energy Innovation Centre (EIC). The EIC is an industry wide (electricity and gas) organisation setup to accelerate the discovery, development and deployment of innovation among the transmission and distribution network operators.

Third-party engagement

It is important that third-party engagement is encouraged to enable lateral thinking outside our current frameworks. We have good experience of supply chain led innovations being progressed to full deployment; a key example is the use of innovative composite poles for the delivery of the connection to Dorenell Windfarm.

We believe that third-party engagement is a valuable way of gaining access to disruptive innovations that network companies are less likely to identify themselves. Third-party sources may also enable access to user-groups and customers who historically do not engage actively with the TO. For example, SSEN was the first Distribution Network Operator (DNO) to deliver a large third-party led innovation project, with EA Technology and the NIC project My Electric Avenue.

[6]https://www.gov.uk/government/organisations/innovate-uk
[7]https://es.catapult.org.uk/
[8]https://www.gov.uk/government/collections/industrial-strategy-challenge-fund-joint-research-and-innovation
[9]https://www.epsrc.ac.uk/funding

What benefits have we achieved by innovating?

We have achieved real benefits through a broad portfolio of innovations covering our full spectrum of business activities. We aim to increase the benefits we deliver through innovation by implementing our thoughts.

In developing our plans for ET2 we initiated a retrospective review that looked to gather the lessons learned on the various innovations developed to date and the associated benefits that have been, and will be, delivered. To quantify the benefits, we started with the Ofgem cost and volumes CBA model to ensure consistency. We have had the CBA model reviewed by Baringa Partners LLP to ensure that the various potential benefit categories were consistently included. Working alongside Baringa, we then went through an exercise to build up the models to quantify the benefits accrued to date, to the end of ET1, ET2 and out to 2050. In summary we:

1. **Have achieved £14m of benefits to date in ET1**
2. **Forecast benefit of £29m[10] by the end of ET1**
3. **Forecast a total of £52m in ET2**
4. **Forecast a total of £420m by 2050**
5. **Have identified further intangible benefits e.g. knowledge transfer, easier market access for small scale DG and de-risking of future HVDC projects.**

[10]All figures correct at time of writing

The benefits have accrued over 39 projects, funded using a mixture of BaU or third-party funding. A broad range of topics were investigated across SHE Transmission. Across those projects we have collaborated with academia, other transmission and distribution network companies, our supply chain and other industry forums to identify and solve problems together.

Projects funded through the NIA almost exclusively delivered concept development benefits. That means they developed various innovation concepts up the TRLs to the point where they derisked larger innovation projects, or to BaU where monetary benefits start accruing. Topics covered across 23 projects included sustainable commercial modelling, asset management techniques, alternative tower construction assets, dynamic line rating, HVDC asset types, lightening protection, thermal imaging and new overhead line conductor types.

Innovations funded through the NIC were more developed, i.e. higher TRLs, and thus were used to derisk larger business deployments as well as delivering TRL advancement. There were three projects initiated in ET1 covering HVDC operation modelling, alternative approaches to building substations and overhead line tower construction types.

The National HVDC Centre

BaU funded innovation projects were where most of the monetary benefits started to accrue, some as standalone projects but others building on learning from previous lower TRL innovation projects. There were 13 projects in the portfolio that delivered efficiency, carbon reduction and avoided constraint costs savings. Topics covered included new designs for connecting generation and processes for allocating capacity, improved Sf6 performance, composite poles for overhead line circuits, composite overhead line conductors and HVDC capacity delivery via reinforcement.

Table 4 below contains details of benefits accrued to date, to the end of ET1, ET2 and 2050

	RIIO-ET1 Benefits (2013-18)	RIIO-ET1 Benefits (2019-21)	RIIO-ET2 Benefits (2021-26)	Total Benefits (2013-50)
TRL Increase	45 TRLs			
SHE Transmission Efficiency Savings	£9.1m	£3.1m	£16.9m	See all TO savings
SHE Transmission Carbon Savings	£2.3m	£2.9m	£3.2m	£31m
All TO Efficiency Savings	NA	NA	£26.6m	£219m
NGET Avoided Constraint Savings	£2.9m	£8.8m	£23.4m	£174m
Total Estimated Savings	£14.3	£14.8m	£52.8m	£421m

Table 4 - Innovation benefits

These innovations have all been delivered in line with SHE Transmissions Innovation Strategies published in 2013 and 2017. In 2013 the focus was Connections & Capacity, Reliability and Availability, Safety, Environment and Customer Service & Social Obligations. The was refined in 2017 where the focus shifted to Flexibility, Energy System Transition, Low Carbon Technology Readiness and Network Management Tools.

Though the delivery of the innovation benefits quantified above, SHE Transmission **has met the objectives of those strategies**. With this new strategy SHE Transmission aims to build on the benefits achieved to date and increase them in line with supporting the transition to the low carbon economy, in line with the company's strategic direction.

Part 3

Our Innovation Framework

Our Innovation thinking for the management of innovation and continual improvement consists of two core considerations:

i An Innovation Framework in which we have outlined our culture, attitude and approach to innovation, and shows **how** we deliver any innovation project.

ii Mapping and planning of innovation topics aligned with our business's strategic themes, covering **what** we will innovate on.

This approach drives continuous improvement in our business activities to meet current and future customer needs.

The following section of our document defines our innovation culture, approach and aspiration to be responsible, active and forward facing.

Our innovation culture and core principle

SHE Transmission fosters a culture where we strive to do things better. We are proud of our delivery in our innovation portfolio and continually seek out new ways of delivering on customer requirements efficiently.

We are indebted to our highly-skilled and effective teams who have the appetite and capability to drive new approaches and the implementation of new technologies. Our organisational structure makes use of a dedicated coordinating innovation function to identify, manage, and drive many innovative projects. This approach, and the rigour and governance we employ, has enabled SHE Transmission to trend much of our innovation activity towards Business as Usual.

In developing our thoughts, we engaged extensively across our business and our stakeholders to review how we have performed on innovation during the RIIO-ET1 period, and to steer our aspiration for future activities. This engagement has allowed us to refine our existing culture and to ensure that our aspirations are accurately targeted.

Underlying all innovation activity is the principle that SHE Transmission will be active and forward facing.

SHE Transmission is guided by our core business values of Excellence, Service, Safety, Efficiency, Sustainability, and Teamwork. Building on these values, we have established an innovation culture with a single innovation principle at its core of being a 'Responsible Innovator'. That principle is supported by five innovation values as shown in Figure 3.

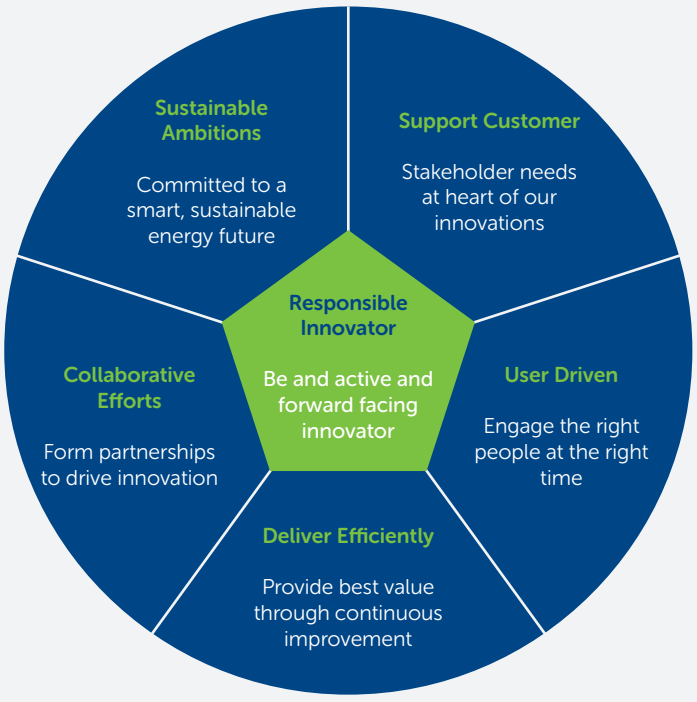


Figure 3: Innovation core principle and values

By being:

- 'Active', we passionately participate in Innovation activities and draw on experience from the wider innovation landscape to drive our continuous improvement.
- 'Forward-facing' we aspire to be dynamic in our approach and aware of future changes in the energy sector. We participate and share learning with our peers and other interested parties.

Our five Innovation Values

As a responsible innovator we justify each innovation undertaken by considering the five innovation values detailed below, ensuring risks are balanced by the potential benefits and that customers are at the heart of each decision. The five innovation values were derived from lessons learnt of what has been pivotal for successful delivery of innovation throughout RIIO-ET1. The core principle plus the supporting values form our Innovation Framework that sets out **how** we will innovate.

Support customer

Stakeholder needs at the heart of our innovations

Supporting the customer means that we need to be approachable and put the current and future needs of our customers at the heart of everything we do. We have a strong record in supporting our customers, focusing and delivering on their needs.

To inform our understanding of our customer and stakeholder needs, we will continue to regularly engage with them, giving them the opportunity to tell us what is concerning them, and for us to work together on how best to address that. In response to stakeholder feedback, we will engage early in our decision process, so our stakeholders can shape our decisions on key policy and process changes. We will keep those stakeholders updated with progress to ensure that the targeted outputs are fit for purpose.

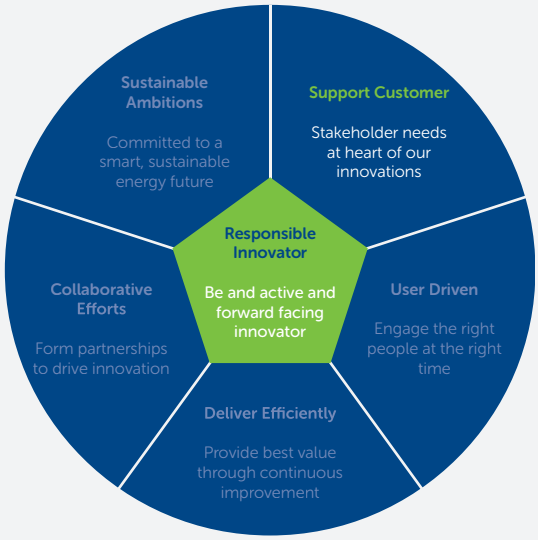
We will represent our customers' views at the relevant industry forums, to ensure that industry and regulators are reflective of SHE Transmission's customers and stakeholders needs. In the industry development of Whole System Approaches to transmission and development and the transition to a Distribution System Operator (DSO) model; we will work with industry to ensure that changes in network operation keep the customer at its heart.

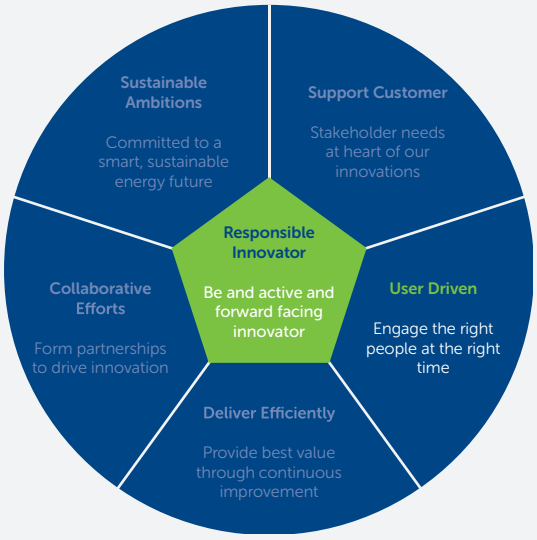
User driven

Engage right people at right time

From the outset any innovation projects must be delivered with the focus of the end-user in mind, whether that be a directly connected customer or our own operational staff. Critically, projects must involve the right people throughout the process from identification to prototype, through to testing and adoption. An internal framework that is spread throughout the business and not siloed, focusing on delivery ensures consistency of approach, whilst maximising engagement with the relevant subject matter experts, be they internal, in the industry or further afield. The whole life of any innovation is considered, including identification of compliance requirements to meet relevant standards, and working practices both internally and across the industry.

At SHE Transmission safety is our number one priority; as a high voltage asset owner, the safety of anyone in proximity to equipment is a primary concern. Fundamentally, if it's not safe we don't do it! This principle is deeply embedded, and safety is considered from the beginning for all activities we undertake. We will adopt innovative ways to improve the safety of our workforce and the public and use this principle to ensure all project outputs are fit for purpose.





Deliver efficiently

Provide best value through continuous improvement

Delivering efficiently drives us to know our asset base and industry governance structures inside-out: how they are performing, and how we can manage them to maximise productivity. This value is delivered through clearly identifying costs and benefits for every innovation activity proposed, enabling faster uptake using the correct funding mechanism.

The methodology used to consistently assess value of any innovation includes the value to our customers, stakeholders and ourselves. The output from this assessment allows a decision to be made on the best way to target that value, including potential funding route and innovation testing structure. The funding route selected can be any number of existing streams, and any project can involve different sources being leveraged to maximise benefits.

Innovation testing is performed such that the end product is targeted for successful adoption into BaU, optimising return from the funding and resources applied. Regular reviews of the benefits case during an innovation project will provide a route to end projects early if the benefits are unlikely to be realised.

Dissemination of our learning ensures the maximum consumer benefit is derived through uptake of innovations by others, or through learning from unsuccessful elements of our projects. Our stakeholders told us that it was important to learn from projects and pass on that learning.

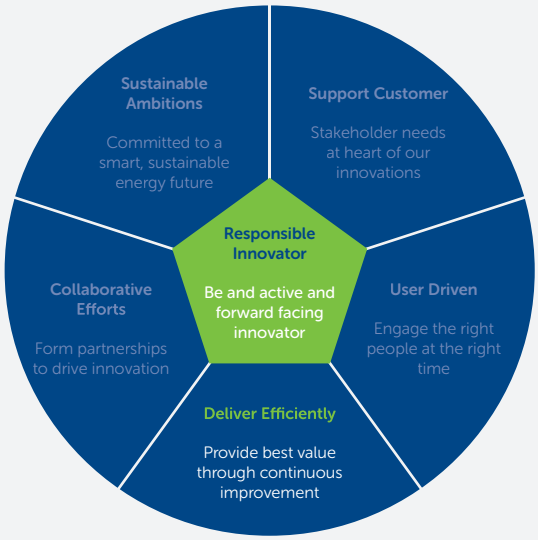
Collaborative efforts

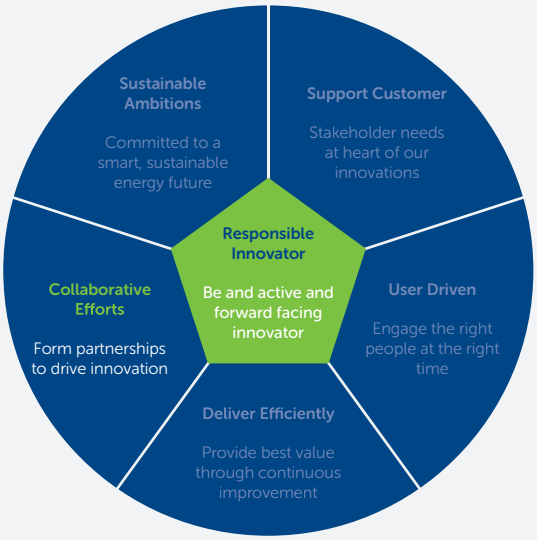
Form partnerships to drive innovation

Our approachable teamwork business value applies not only to our internal interactions, but also to the relationships we form with other peer network owners, the Electricity System Operator (ESO) and collaborative institutions (both inside and outside the electricity supply industry), and the innovations which we develop together. We work together with our customers, stakeholders, suppliers and others to better understand the issues we face as an industry and how best to address them.

We review our own and other innovations from inside and outside our industry. Through established partnerships across industry we aim to build on past innovation successes, adopt learning to improve business operation, and facilitate successful innovations to move into BAU and transfer benefits to our customers and stakeholders.

We will continue to engage with academia and markets on emerging technologies and trends. Cross-sector engagement with other utilities and global outreach to other partners are fundamental to identifying the best way to address any challenge.





Sustainable ambitions

Committed to a smart, sustainable energy future

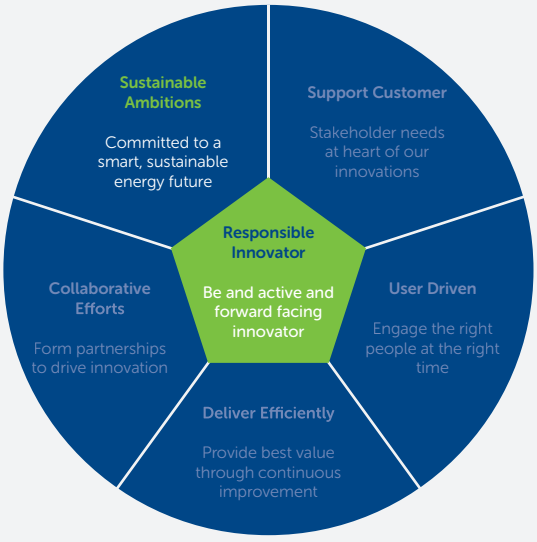
Our Sustainability Strategy[11] outlines our strategic purpose to enable the transition to a low carbon economy. The sustainable ambitions goal published in that strategy underpins our commitment to improving our environmental and societal performance.

We have due regard for natural assets, such as land and materials, and work to identify new ways in which we can lessen the impact of our business operations and assets on the environment, whilst improving our position in society. Where we use materials, which have the potential to damage the environment (such as Sulphur Hexafluoride (SF6) gas used in high voltage equipment), we commit to their staged replacement with a less harmful product.

Innovation proposals are not only assessed on their economic benefits but also on supporting our sustainable ambitions. We will target ways to minimise losses and waste, reduce emissions, improve the management of our assets, and defer asset upgrade or replacement where justified.

Collaboration with our supply chain and industry experts will be fundamental to delivering on our sustainable ambitions; our stakeholders recognised this need as vital to ensure we do not just move our impacts further along the chain but achieve an improvement across the full chain.

Our methodology assesses not only financial benefits, but also societal benefits of innovations. We take a holistic view to maximise local and national benefits including environmental, employment, and aesthetic impacts.



[11]https://www.ssen-transmission.co.uk/media/2701/sustainability-strategy.pdf

Part 4

Our strategic innovation themes and roadmap

In the previous section we have defined our culture, attitude and approach to innovation that forms our Innovation Framework that details **how** we will innovate.

This section of our document defines how we will categorise and prioritise our innovation topics, ensuring that we are focusing activities in areas which are aligned with our strategic business direction, effectively detailing **what** we will innovate on.

Our strategic objective

Stating our position on emerging trends, evaluating industry-wide themes, our strategic objective and mapping potential innovation opportunities are necessary to consistently select what areas we will innovate in. This approach drives continuous improvement in our business activities to meet current and future customer needs. Our Emerging Thinking paper[12], published in February 2019, defines SHE Transmission's four strategic themes, and our innovation activities are aligned with these themes.

These themes are presented below:

Stakeholder-Led Strategy

Taking a Whole System approach to network operation and development to meet current and future Customers' needs

Safe and Secure Network Operation

Use data efficiently to understand, predict and get the best network performance

Sector Leading Efficiency

Integrated approach to whole life development and operation, using risk-based engineering to deliver value

Leadership in Sustainability

Trusted partner of Customers and communities, realising long term benefit for society, economy and environment

Figure 4 - SHE Transmission Strategic Themes

SHE Transmission will innovate on strategic choices within these areas as directed by our stakeholders and from the implied focus of external funding bodies and industry forums and from wider technology trends. These emerging trends will bring their own challenges that will require assessment and quantification as to how best support these changes.

Our structure and approach enables SHE Transmission to focus on areas where new technology or procedures may deliver a benefit, yet still be agile enough to investigate emerging trends and focus areas. We will review these focus areas regularly to incorporate changes to themes, drivers and policy.

Each theme is expanded below in more detail, explaining the key considerations for each theme, examples of our recent activities and a road map for where we feel further investigation is required. Within each strategic theme, we have also mapped and categorised sub-themes and challenge areas where targeted investment in innovation activities is required. These sub-themes all feed into the SHE Transmission Strategic Themes so delivery of an innovation in a sub-theme will progress the company towards its strategic themes and in turn the strategic objective.

[12]Emerging Thinking paper - https://www.ssen-transmission.co.uk/media/3219/she-transmission-riio_t2-emerging-thinking-paper.pdf

Theme 1: Stakeholder-led Strategy

Energy networks are built and operated to meet the needs of current and future customers, and so customers' needs must be the drivers of all activities.

Sub themes

1.1 - CUSTOMER ENGAGEMENT
1.2 - COMMERCIAL EVOLUTION
1.3 - WHOLE SYSTEM APPROACH
1.4 - SUPPORT THE ENERGY SYSTEM TRANSITION
1.5 - FACILITATING CONNECTIONS
1.6 - UTILISE NETWORK FLEXIBILITY IN CONNECTIONS

Key considerations

There will be far reaching changes to the energy sector during our next price control period and beyond. One of the biggest changes being the flexibility revolution. DG, electric vehicles, demand side response and energy storage are transforming the sector, giving customers access to new products and services from a new range of providers.

A more holistic energy approach to system planning, development, construction, operation and maintenance, is needed to bring our customers, stakeholders and consumers benefit. We recognise that a key factor in unlocking those benefits will be to understand and enable customer choice. In future, we will continue to be flexible in our transmission connections approach, assisting demand and generation connection by employing new connection types, managing headroom in installed capacity and providing faster, more efficient connections.

Our sister company SHEPD is at the forefront of transitional innovation, as the traditional DNO businesses transition into active DSOs. SHE Transmission is actively preparing the transmission network for this transition, analysing how the transmission network may interact with DSOs during RIIO-ET2 based on a range of scenarios referred to as "worlds". Our current methods of managing and planning for future investment in our transmission network will have to adapt to accommodate DSO as defined in our paper on the impacts on TOs of the DSO transition[13].

SHE Transmission has re-focused our existing Whole System approach, identifying and developing new working practices which apply to our transmission system in a Whole System manner. We focus on how we maximise consumer benefit from adopting whole system approaches through collaboration and co-ordination, stakeholder engagement and innovation.

There is scope for even further change and refinement with emerging blockchain transactions and new energy market platforms driven by data. Ongoing engagement and continual communication with external parties, and regular repositioning of our strategic objectives will be fundamental for delivering future flexibility effectively.

Case Study – Orkney Alternative Approach[14]

Our remote island customers have told us that industry codes and governance were a barrier to them connecting, and we evolved new ways of working between ourselves, SHEPD and the ESO to address those challenges, called the Alternative Approach.

Establishing a credible queue and quantifying the cost and outputs associated with reinforcement has proven challenging. SHE Transmission has developed, using BaU funding, the Alternative Approach that looks to identify and address some of the industry frameworks that act as a barrier to viable projects.

The lessons learned here are being fed into the wider industry to ensure that maximum value can be gained for all customers and stakeholders.

[13]https://www.ssen-transmission.co.uk/media/3167/dso-transition-impact-on-she-t-final-002.pdf

Innovation opportunities

INNOVATION OPPORTUNITIES

SUPPORTING OUR CUSTOMERS

SUB-THEME 1.1

CUSTOMER ENGAGEMENT

- Enable Customer Choice
- Improved Service Delivery - Faster, Easier, More Efficient
- Provide Relevant Network Information
- Improved Outage Planning Coordination

E.g.

- Improved Service Delivery
- Heat and Capacity Maps
- Connection Estimate Tool

SUB-THEME 1.2

CUSTOMER ENGAGEMENT

- Alternative Approaches to Connection Queue Management
- Facilitate DSO Transition
- Support New Commercial Models
- Visibility of Commercial Arrangements

E.g.

- Alternative Approach
- Revised Charging Codes
- New Markets

WIDER ENERGY SYSTEM CHANGES

SUB-THEME 1.3

WHOLE SYSTEM APPROACH

- Facilitate Connection of Decentralised Technologies (inc. Low Carbon Generation and Storage)
- Whole System Investment Planning & Decisions
- Demand Side Response
- Understand flexibility in use of DERs

E.g.

- Annual FES
- Collaboration and Sharing
- Leading/Participation in industry Working Groups

SUB-THEME 1.4

ENERGY SYSTEM TRANSITION

- Coordinate management of Electric Vehicle penetration in North of Scotland
- Facilitate decarbonisation of heat
- Support development of a hydrogen Economy
- Successful collaboration across energy vectors

E.g.

- Improved Forecasting
- Drive Optimised Whole System Solutions
- Cross-sector engagement

ENHANCED CONNECTION APPROACHES

SUB-THEME 1.5

UTILISE NETWORK FLEXIBILITY IN CONNECTIONS

- Accelerated Connections
- Managing
- Active Network Management (ANM)
- Tailored Customer Solutions

E.g.

- Use of Data in Planning, Control and Operation
- FACT Devices and Fault Level Management
- Enhanced Ancillary Services in support of Network Operation

SUB-THEME 1.6

FACILITATING CONNECTIONS

- Implement Smarter Connections
- Wide Area Network Management
- Manage Consequences of Changing Network Conditions
- TO/DNO Interface across Grid Supply Points

E.g.

- Local ANM
- Constraint Management
- Investigate new Constraint optimisation Approaches

Table 5 - Stakeholder-led strategy innovation opportunities

Theme 2: Safe and Secure Network Operation

Energy networks, and especially the high voltage transmission motorways, must be reliable, available and resilient to changing circumstances, be these opportunities or threats.

Sub themes

2.1 - NETWORK PLANNING
2.2 - DATA-DRIVEN NETWORK DEVELOPMENT
2.3 - NETWORK RESILIENCE
2.4 - NETWORK OPERATIONS & CONTROL
2.5 - SMART ASSET MANAGEMENT
2.6 - SYSTEM MONITORING & PERFORMANCE

Key considerations

SHE Transmission is obligated to support our stakeholders' commercial needs whilst ensuring our network is fit for purpose. Our responsibility is to find the best way to develop, manage and operate our network assets. Innovation will play a significant role in the development of SHE Transmission and its role within an ever changing industry.

The changing nature of the electricity network, including the increase in low carbon technologies, introduces new challenges for the safe and secure operation of the transmission system. These include lowered fault levels, reduced system inertia, impact of widespread power controllers and an impact on power quality. In the face of those challenges we continue planning and developing our system whilst ensuring near 100% network reliability is achieved. Through rigour in the day-to-day operation and maintenance of the network assets and making investments in the right thing at the right time, we strive for a robust, reliable and resilient network for sustained customer benefit and maintaining transmission of electrical power.

The long-standing deterministic planning standards are conservative in nature, designed to cover any forecasted network peak flow. A move to probabilistic standards could have a radical, and beneficial impact on efficient network design and operational standards but would require a shift in engineering principle not only for us, but across the GB electricity industry.

Effective system and condition monitoring within asset management plays a significant role in improving the performance, reliability and longevity of electrical and mechanical assets. Implementation of an integrated condition monitoring system will allow an improved understanding of the behaviour of the network and key assets. This will lead to the implementation of preventative and condition-based maintenance along with improvements in specifications for future installations. We are also looking to establish a data analysis function to enable effective proactive maintenance to take place based on this improved understanding.

The increased penetration of connected intelligent devices in our infrastructure has the potential to give rise to increased incidences of cyberattacks. Our network must be resilient to unplanned emergency events, manage vulnerabilities and risks to our system. To ensure that our assets are as safe as possible from this threat, we will invest in substation technology, including third party testing of our Cyber Security Framework, and would also address elements of technology obsolescence.

Case Study – Smart Monitoring

The supply of secure and diverse communications is critical to operation of our electrical system. With the rapid increase in data quantity and capture, and the rise of Internet Protocol (IP) based networks being drivers of change. There are opportunities to provide a resilient backbone for the communications network by implementing a dual, diverse network. Further extension of secure IP networks communications into all substations would enable remote access to plant and system monitoring elements and help confirm our aspirations to be a responsible and world leading asset owner.

Innovation opportunities

INNOVATION OPPORTUNITIES

PLANNING AND DEVELOPMENT

SUB-THEME 2.1

NETWORK PLANNING

- Optimise Grid Design and Development
- Develop Probabilistic Planning Tools
- Detailed Network Modelling
- Capacity Management, Generation and Demand balancing

E.g.

- Probabilistic Assessment
- Real-Time System Simulations
- Multi-Vendor FACTS interactions

SUB-THEME 2.2

DATA-DRIVEN NETWORK DEVELOPMENT

- Smarter Network Development
- Combined Network Development and Stability Reinforcement
- Enhanced Data Analysis
- Artificial Intelligence in System Modelling

E.g.

- Power system simulations in a Multi-Core Server environment,
- Dynamic Network Management
- Digital Twins

ASSET AND NETWORK MANAGEMENT

SUB-THEME 2.3

SECURITY AND RESILIENCE

- Network Reliability and Resilience
- Countering Physical Threats
- Black Start Capability
- Extreme Event Planning and Contingency Management

E.g.

- Grid resilience mobile substation including "plug and play" transformers
- Online Condition Monitoring Systems
- Extreme Event Planning and Contingency Management

SUB-THEME 2.4

SMART ASSET MANAGEMENT

- Modernised, Enhanced Control Room
- Power Quality Measurement
- Developments in Operational Technology
- Network Controllability

E.g.

- Management of Data from Edge Devices
- Adpative Maintenance Regime
- Enhance Cyber Resilience

NETWORK MONITORING AND OPERATIONS

SUB-THEME 2.5

NETWORK OPERATIONS & CONTROL

- Condition Based Risk Management driving asset intervention
- Smart Condition Monitoring
- Interactive and adaptive maintenance regime to reflect modern supply/demand network operating model
- Robust defence to cyber threats

E.g.

- Real time monitoring of flexible connections
- Predictive management based on network data
- Dynamic Network Management

SUB-THEME 2.6

FACILITATING CONNECTIONS

- Grid Monitoring Strategy
- Enhanced Transmission Fault Interface
- Enhanced Network Stability Analysis
- Remote Monitoring of Assets

E.g.

- Artificial Intelligence
- Smart Monitoring Control Room
- Automatic machine-based network management

Table 6 - Safe and Secure Network Operation innovation opportunities

Theme 3: Sector-leading Efficiency

Energy networks must be affordable to consumers, and we must be open about the trade-offs between cost and investment for local and national benefits to achieve the clean energy transition.

Sub themes

3.1 - TRANSFORMATIONAL HEALTH & SAFETY
3.2 - PROCUREMENT POLICY
3.3 - INTEGRATION OF NEW TECHNOLOGIES
3.4 - EFFICIENT NETWORK MODERNISATION
3.5 - TRANSPARENT AND ROBUST DECISION MAKING
3.6 - EFFICIENT PROJECT DELIVERY

Key considerations

SHE Transmission must plan the long-term development of our network to meet future customers' needs, finding the most efficient solution to the benefit of all GB consumers. In Scotland, fuel poverty rates (measured by low incomes, high energy prices and energy inefficient housing) are higher than the national average. We are obligated to keep costs down for our customers, and we are keen to collaborate across industry to redefine what we should adopt to become a sector leader, through maximisation of consumer benefit.

In our activities we drive efficiency through optimal use of resources (time, materials, people and money). Our primary target is to ensure all future investment decisions are assessed against a CBA framework which also includes social, environmental and economic aspects, with appropriate engagement to inform decisions on trade-offs between different factors.

SHE Transmission uses site and asset specific information to determine the asset risk held on our network using a tool called Condition Based Risk Management (CBRM) to calculate our asset risk. The CBRM tool will be rebuilt to align with Ofgem's new methodology and this approach will be implemented ahead of for RIIO-ET2.

A significant focus will be the need for a smarter, more flexible network. Across the industry, there is significant focus on maximising the benefit of information that is captured in a number of places including at Digital Substations. Leveraging on the potential value from capture, processing, analysis and extraction of 'Big Data' will be a critical development, enabling intelligent real-time network decisions and driving artificial intelligence and machine learning -based automation. Importantly, data and analytics in the management and operation of the network create an opportunity to reduce cost to customers in the long term. Additionally, digital substations create a safer work environment, minimising cabling between equipment while reducing the costs for building, land, engineering, commissioning, operation and maintenance of the system.

It is important that we manage our system responsibly to ensure a reliable and cost-effective operation, which maximises customer value. The adoption of new technologies, equipment and processes, and implementation of smarter adaptive technology offer many strategic benefits. Leveraging these elements will drive significant change across our network, with vast transformation in our BaU practices.

Case Study – Multi-vendor digital substation

SHE Transmission network protection and control systems are driven by the need to gather consistent and better-quality data and reduce site commissioning by improving the efficacy of factory testing, thereby improving safety. Coupled with a need to limit the risk that the decline of older technologies may bring.

SHE Transmission has completed four major substations using two system integrators where traditional substation control and data acquisition is performed using Ethernet networks whilst maintaining an acceptable multi-vendor set of equipment suppliers and redundancy. Development and integration on live substation builds has presented challenges but the focus on learning rapidly within projects has resulted in significant improvements.

Innovation opportunities

INNOVATION OPPORTUNITIES

SUPPLY CHAIN EFFICIENCIES

SUB-THEME 3.1

TRANSFORMATIONAL HEALTH AND SAFETY STRATEGY

- Continue to drive safe practices and effective safety solutions
- Continuously improve our approach to Process Safety, The Environment, Crisis Management and Driving
- Transform our approach to Contractor Safety, Operational Safety, Safety Family and Occupational Health and Wellbeing
- Minimise human intervention through use of data and analytics

E.g.

- Robust, Simple Systems of Work and new practices
- Contractor Education and Mindset
- Occupational Health and Wellbeing

SUB-THEME 3.2

DATA-DRIVEN NETWORK DEVELOPMENT

- Demand Plan analysis
- Direct supply chain engagement to negate technical non compliances
- Licence to Operate
- Responsible buyer of sustainably & ethically supplied goods & services

E.g.

- Category Plan Optimisation
- Market Wide Innovative Proposals
- Compliant procurement

MODERNISING OUR NETWORK

SUB-THEME 3.3

INTEGRATION OF NEW TECHNOLOGIES

- Consider novel technologies and materials
- Drive development of a Smarter T-Network
- Strategic Digital Substation Evolution
- Develop and Implement TRL 4-7 technologies for future use

E.g.

- Non Conventional Instrument Transformers
- Hybrid Equipment
- Alternative technology assessment and TO approval

SUB-THEME 3.4

EFFICICENT NETWORK MODERNISATION

- Drive staged development of a Smarter T- Network
- Big Data Management
- Pro-active Network Stability Reinforcement
- Efficient Network Modernisation

E.g.

- Optimisation of IT and data management / analytics
- Enhanced Data Analysis

NETWORK MONITORING AND OPERATIONS

SUB-THEME 3.5

TRANSPARENT AND ROBUST DECISION MAKING

- Maximise value of existing assets
- Engage Customer Earlier in Optioneering Stage
- Supplement in-house capability with market ready platforms
- Demonstrate efficiency in outcomes

E.g.

- Network Finance Modelling Tool
- Strategic Optioneering Methodology
- Implement design and viualisation tools

SUB-THEME 3.6

EFFICIENT PROJECT DELIVERY

- Evaluate new Construction Methods
- Alternative Access Arrangements
- Bespoke Network Solutions
- Reduced On-Site Testing / Commissioning

E.g.

- Smart Device & Connectivity
- Adaptive Protection
- Portable / Movable Technology

Table 7 - Sector-leading Efficiency innovation opportunities

Theme 4: Leadership In Sustainability

Energy networks must be trusted by the customers and communities they serve demonstrating long-term benefit for society, economy and environment.

Sub themes

4.1 - SUPPORTING THRIVING COMMUNITIES
4.2 - CONNECTING FOR SOCIETY
4.3 - ENERGY EFFICIENCY AND OPTIMISATION
4.4 - CARBON SAVING INNOVATIONS
4.5 - PROMOTING NATURAL ENVIRONMENT
4.6 - OPTIMISING RESOURCES

Key considerations

Our sustainability ambitions provide a framework for establishing trust, transparency and legitimacy, as we strive for a smart, sustainable energy future. Infrastructure for the transportation of low carbon electricity will be essential to delivering the Scottish Government target for 50% of Scotland's heat, transport and electricity consumption to be supplied from renewable sources by 2030.

Our experiences, and our stakeholders' views, show that the environment is an increasingly important focus area. It highlights the need for us to expand our ambitions beyond standalone decarbonisation aims, and to ensure that our activities are mindful of other social, economic and environmental issues. We have built these broader considerations into broad and bold sustainability ambitions through which we will deliver that overarching aim.

Supporting this document, we are investigating ways of aligning ourselves with these national and international targets, including reviewing the electricity usage in our substations, minimising our business carbon footprint, promoting diversity and our natural environment and investigating ways of optimising resources to maximise sustainability. All whilst ensuring that we improve local communities and grow careers to boost our impact on society.

We are making progress in the identification and implementation of a replacement for SF6 gas. Due to its insulation properties this gas is used across the industry and in our Gas Insulated Switchgear but is a potent greenhouse gas with a high global warming potential. We have been at the forefront of installing a SF6 alternatives as a first in GB, collaborating with several manufacturers.

Many of the resources that we use in building electrical infrastructure are non-renewable resources, such as steel, aluminium and copper. Increasing material scarcity, the environmental impact of manufacturing these resources and inconsistency in local end-of-life material solutions, for example recycling facilities, mean that we need to work harder to ensure we are making best use of these resources. In line with circular economy principles we will seek to keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.

Case Study – Sulphur Hexaflouride (SF_6) Alternative

SF6 is an excellent insulating medium which SHE Transmission uses in our high voltage assets as an insulating medium and to extinguish electrical arcs. However, it is around 23,500 times more harmful to the environment than carbon dioxide.

We have been working with equipment manufacturers to test alternatives to SF6 and we are currently in trial stages for two new technologies. These projects have progressed without innovation mechanism funding, demonstrating our willingness to engage with contractors and suppliers where there are clear environmental benefits.

Innovation opportunities

INNOVATION OPPORTUNITIES

MAXIMISE BENEFIT TO OUR CUSTOMERS

SUB-THEME 4.1

SUPPORTING THRIVING COMMUNITIES

- Remove barriers to local community low carbon technology
- Realise social & economic benefit from our investment
- Small-Medium Enterprise engagement

E.g.

- Open Procurement Frameworks
- Resilient Communities fund
- Community Engagement Forum

SUB-THEME 4.2

CONNECTING FOR SOCIETY

- Promote decarbonised and decentralised economy
- Review wider societal expectations of our investment
- Consider affordability for electricity consumers and generators
- Deliver low carbon energy connections

E.g.

- Cost Benefit Analysis framework
- Accelerate LCT connections
- Carbon offset from connected LCT

MITIGATING CLIMATE CHANGE

SUB-THEME 4.3

CARBON SAVING INNOVATIONS

- Design energy efficient substations
- Implement an energy efficiency programme for existing substations
- Losses Policy & Methodology
- Decrease Equipment Losses

E.g.

- Tackle our carbon emissions
- SF_6 Management, replacement and Specificaiton in new assets
- Carbon embodied in assets (PAS 2080)

SUB-THEME 4.4

ENERGY EFFICIENCY AND OPTIMISATION

- Set and Deliver on our Science Based Targets
- Develop and implement SF6 Strategy
- Embedded carbon considerations
- Reduce direct (Scope 1) and indirect GHG emissions (Scope 2 +3) from our activities

E.g.

- Optimised Asset Losses
- Green Supply of Substation Load Demand
- Install metering at all existing substations

REDUCING OUR ENVIRONEMENTAL IMPACT

SUB-THEME 4.5

PROMOTING NATURAL ENVIRONMENT

- Considerate Environmentally sensitive
- Consider visual impact of new infrastructure
- Positively contribute to the UN and Scottish Government Biodiversity strategies
- Collaborate on our approach to measuring biodiversity net gain

E.g.

- 'Net Gain' in Biodiversity
- Assessing natural capital approaches
- Using 3D visualisation technology

SUB-THEME 4.6

OPTIMISING RESOURCES

- Life Cycle and Cost Benefits
- Promote Circular Economy Principles
- Waste Minimisation Initiatives
- Asset Replacement Strategy

E.g.

- End-of-life solutions designed in from outset
- Hot Spot Mapping for resource use/waste
- Trialling alternative/ sustainable materials'

Table 8 - Leadership in Sustainability innovation opportunities

Part 5

Our methodology for making strategic decisions

Embedded in our business plan are solutions to some of the expected challenges that we will face over the next decade – and by our definition, innovation and continuous improvement pervades across many of the business activities that we undertake.

SHE Transmission normal business operation covers a broad range of activities, meaning the scope of potential innovation is very broad. Decision making is therefore key to ensure the innovations targeted are the most effective use of innovation funding. The methodology for doing so is a two-stage process that starts with assessing the innovation for alignment with the innovation themes. If the potential innovation aligns under one of the four themes, then it aligns with what our stakeholders need from our network and thus the company's strategic direction. Therefore the next step is to assess the extent to which to take the innovation. If the innovation does not align, then the topic and outcome are noted and focus moves to the next potential innovation.

Innovations that are aligned are assessed on a case-by-case basis to identify the extent to which they should be progressed. This involves an exercise covering relevant internal and external stakeholders, to quantify the **effort** in developing and delivering an innovation, along with the **benefits** that could be achieved, versus the **risk** of undertaking innovation activity (balanced against the potential risk to the business of not undertaking that innovation activity).

We will employ a quantification that allows SHE Transmission to optimise innovation development across three distinct categories, wherein projects could each be treated differently in terms of funding, governance, metrics and resources:

Requires least effort and has least risk. Its focus is on current customer and stakeholder needs and ensuring best current practise is followed when delivering benefits.

A more proactive view of what is needed for future customers and looks to drive industry towards that.

An ambitious view where regulation and national policy is challenged where it has potential to cause issues for or limit the potential of future customer activities.

Figure 5 - Levels of innovation categorisation

Any potential innovation topic will be reviewed in this context by our Innovation Delivery Team – an informed decision (based on relevance for SHE Transmissions assets, customer requirements, any upside, or immediacy) on whether the innovation should progress, and to whether to optimise, enhance or disrupt confirmed by senior management.

There is no expectation that there will be a certain proportion of projects in each category – innovation opportunities will be judged on an individual basis. This approach to innovation will be governed by internal procedure and supported by the business. A robust business case for innovation will be used to select the most appropriate funding route, with testing of potential benefits and ongoing monitoring throughout any project to ensure ongoing alignment with the business strategic direction.

Example innovation roadmap

As an illustration of the potential delivery of innovation as BaU, Table 9 below outlines direction of travel in specific and identifies optimised, enhanced and disruptive approaches where, SHE Transmission will place focus during the next price control and beyond. **These examples have been chosen for presentation in response to stakeholder feedback, however the methodology will be applied across all innovation topics.**

	Increasing Effort and Risk →		
Maturity	High	Medium	Low
Timeframe	Short-term	Medium-term	Long-term
THEME 1 - STAKEHOLDER-LED STRATEGY			
SUB-THEME 1.3 - Whole System Approach SHE Transmission foresees long-term benefits in adoption of a Whole System Approach, facilitating faster and efficient connections, efficiency in invest-ment, timely investments and ensuring future security of supply.	**OUR INCREASED PARTICIPATION IN ENERGY SYSTEM TRANSITION**		
	Explore whole system solutions within a single energy vector, e.g. Electricity T&D	Explore whole system solutions within closely coupled energy vectors, e.g. Electricity and Gas T&D, Transport, Heat, etc.	Explore whole system solutions beyond closely coupled energy vectors, and including wider societal impact
THEME 2- SAFE AND SECURE NETWORK OPERATION			
SUB-THEME 2.5 - Integrated (Smart) Condition Monitoring SHE Transmission will implement an integrated condition monitoring system to allow an improved under-standing of the behaviour of the Network and key as-sets. Our investment will to the implementation of preventative and condition-based maintenance along with improvements in specifications for future installations	**OUR INCREASING DATA-DRIVEN EVOLUTION**		
	Use of current systems, data and software to enhance asset condition monitoring.	Addition of asset monitoring systems already installed but islanded. Roll out of asset monitoring for units requiring observation during RIIO ET2 price control for potential replacement in ET3.	Smart monitoring system data analytics; machine learning and Asset Management Control Room
THEME 3 - SECTOR-LEADING EFFICIENCY			
SUB-THEME 3.3 – Strategic Digital Substation Evolution SHE Transmission are planning the further development of IEC 61850 solution, extending the ethernet implementation to all HV equipment plant. We are collaborating with SPEN to bring together lessons from the SHE Transmission implemented sites and the FITNESS trial to implement the "process bus" elements of IEC 61850.	**OUR INCREASING EFFICIENCY EFFORTS**		
	Refinement of station bus	Digitalisation of signals and use of fibre	Digitalised substation including Non-conventional transformer and digital data merging
THEME 4 - LEADERSHIP IN SUSTAINABILITY			
SUB-THEME 4.4 – SF6 Replacement Strategy In RIIO-T2, where there is a technically and commercially viable alternative, SHE Transmission will no longer install SF6 on our network.	**OUR INCREASING SUSTAINABILITY COMMITMENT**		
	Install SF_6-free equipment on new (132kV) projects where commercially and technically ready.	Remove X% of 132kV SF6 air insulated Circuit Breakers and replace with SF6 free alternatives where technically and commercially ready	Remove X% of 132kV SF6 air insulated Circuit Breakers and replace with SF6 free alternatives at all voltages where technically and commercially ready

Table 9 - Example innovation roadmap

Delivering benefits from our innovations

Having defined the potential different levels of innovation development for a particular innovation, a decision needs to be made on which level to develop it to; CBA is used to support this decision. The TRL of the proposed innovation drives the level that the CBA will go to, with table 10 below reflecting the varying focus and detail depending on the TRL.

TRL	High TRL	Medium TRL	Low TRL
Project type	Trialling a product or approach that is sufficiently mature to be rolled out within the business (subject to successful trial)	Trialling a specific intervention but where the benefits and costs are only known at a high level with large uncertainty	Research, exploratory work around a key concept but where the value is unknown
Example	Trialling a device with a supplier to test technical and commercial viability	Development of a prototype, or developing an idea that works in principle	Infrastructure requirements for DSO transition
Overall CBA approach	Detailed cost and benefit line items, including confidence. Converted to scenarios. Key variables highlighted and presented on cover sheet	Quantify assumptions where possible. High-light the level of confidence in each element, and include placeholder for unknown costs and benefits	Focus on the overall benefits of enacting that concept
Time horizon	Typically, multi-year, covering a number of price controls, and showing the effect of discounting (align to Green Book). Ensure "end effects" do not hide costs or benefits.	Focus on short term (e.g. single year) but note ways in which the CBA would change (e.g. saturation of market, policy change)	Highlight the points in time (or key triggers) where the concept may be required, but do not attempt to quantify trajectory of benefits

Table 10 - Varying focus of CBA versus TRL

With a decision made on the level of development for the innovation, CBA is used throughout the project as an integral project management tool. Key assumptions are kept updated with information as the trial progresses. Where the targeted benefit changes from what was originally identified then a decision can be made as to whether to continue the project or not. The figure below shows CBA is used through the lifetime of the innovation project.

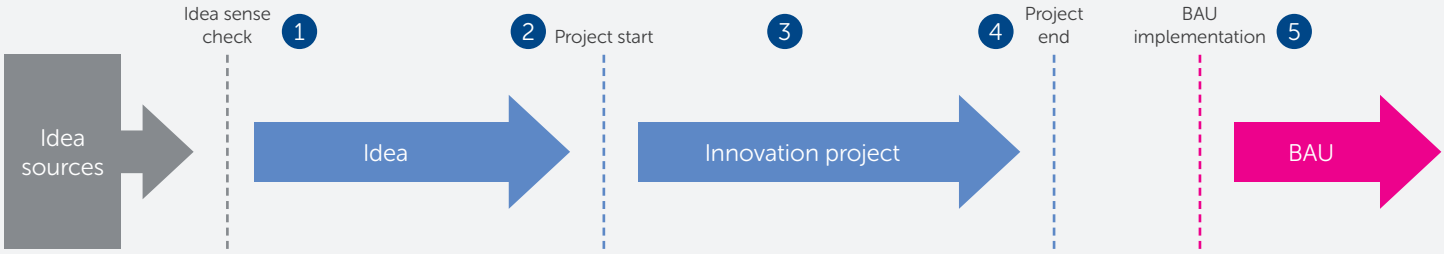


Figure 6 - CBA throughout the project lifecycle

1. Assess the TRL of project and identify suitable CBA approach. Start collecting data to undertake CBA
2. Undertake the CBA. Identify key variables which the trial will assess performance against and forecast that performance in CBA
3. Monitor the outturn performance against the key variables in the trial and re-run CBA during the trial
4. Re-run CBA at the end of the trial based on final results. Compare the results to those forecast
5. Monitor outturn results of roll-out to check that impact is similar to that observed in the trial

By employing CBA in this way then we can efficiently identify innovations to develop and ensure that the project is kept focused throughout the lifetime of the project.

We want to hear from you

We welcome any comments and feedback on our innovation thinking for the future

This document and future revisions will be hosted on
www.ssen-transmission.co.uk

To find out more about our RIIO ET2 plans visit:
https://www.ssen-transmission.co.uk/news-views/RIIO-T2

If you would like to get in touch with the team to ask questions, and provide feedback and comments then please email us at
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We are a Living Wage Employer

FairTax