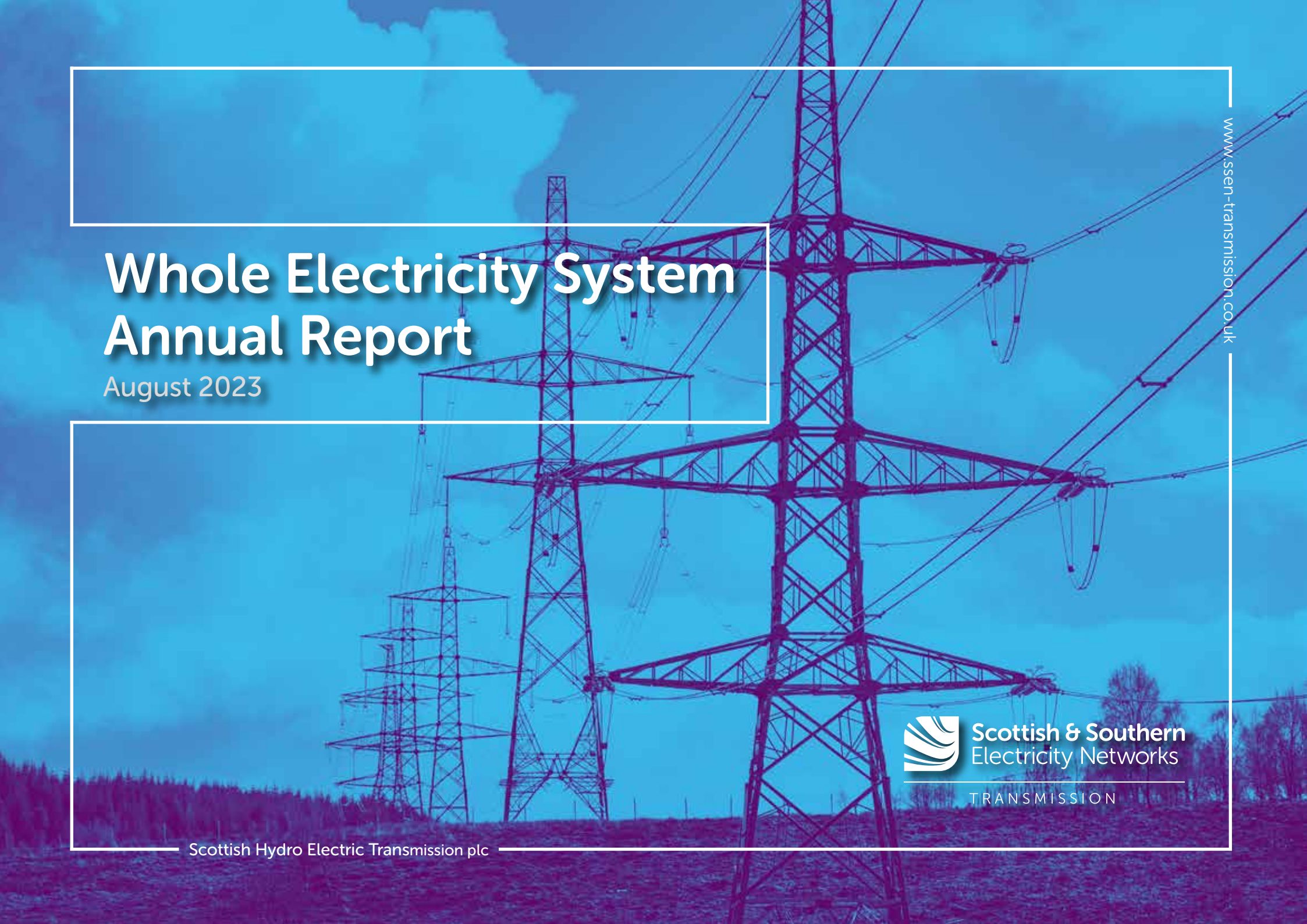


Whole Electricity System Annual Report

August 2023

www.ssen-transmission.co.uk

Scottish & Southern Electricity Networks

TRANSMISSION

Scottish Hydro Electric Transmission plc

Contents

1. About this report

This report provides an insight into the work we have done in the 2022-23 financial year around whole system and how this approach is an integral part of our investment decision making process.

For us, the whole energy system is essential to deliver Net Zero and create value for GB Society, with consumer behaviour being a major driver of that system.

Components refer to devices that either take energy from, or give energy to, the transmission network and the digital technology components that facilitate supply, management, and consumption of energy. We look beyond the bill payer and consider the overall costs and benefits to the GB society, environment, and the economy.

We have done a lot to ensure that whole system is understood across the business and by our stakeholders, which is critical to enable us to operate and develop a network for Net Zero.

The report begins with a statement from our Head of Whole System emphasising the importance of a whole system approach in how we plan, develop, and operate the network and, how our strategy enables us to do so. For us, whole system is about creating value for our stakeholders and the communities where we operate and, in this report, we show how and where we create that value.

2. Foreword

Andrew Urquhart
Head of
Whole System

We are delighted to bring you the 2023 edition of our Whole System Annual Report. This year, we share with you our stakeholder-led endeavours to meet national and global decarbonisation objectives. In this, we reaffirm our belief that a whole system approach is essential to deliver Net Zero in the most technically resilient and economic way.

We remain committed to ensuring a Just Transition to Net Zero. As the Transmission Owner in the North of Scotland, we will continue to develop, build, maintain, and operate a network that can reliably transport the abundant renewable energy in our resource-rich area to the rest of the UK.

Reforms to technical codes and the electricity market structures are inevitable stops on our journey towards Net Zero and they accompany the changes in our electricity network as we prepare to connect more generators at various points. Through our active engagement with the National Grid Electricity System Operator and other stakeholders, we ensure that these reforms meet system safety and efficiency objectives by considering all parts of the system to arrive at optimal costs to customers and consumers.

We believe that clear and relevant information on other parts of the system is critical to arriving at viable whole system solutions. A major highlight of this year's report is the series of joint efforts with other Great Britain's Transmission Owners to anticipate and address future challenges on the transmission network and to align and standardise the way we estimate, store, and report data on emissions, energy consumption, and waste. Data exchange and visibility on Net Zero plans and network investments from stakeholders have also improved our whole system solutions on network infrastructures for our islands and cities.

As SSEN Transmission, we are incorporating whole system approaches into our 'Business as Usual' activities and hope to continue to consolidate the gains that we have made so far. We are grateful for your suggestions on how our whole system practices can be improved and thank you for your contributions and collaborations. We'll still love to hear from you, so please do not hesitate to let us know what we can do to improve our whole system approach.

2.1 Strategic Themes

Our strategic objective is to enable the transition to a low-carbon future. We will achieve this strategic objective by:

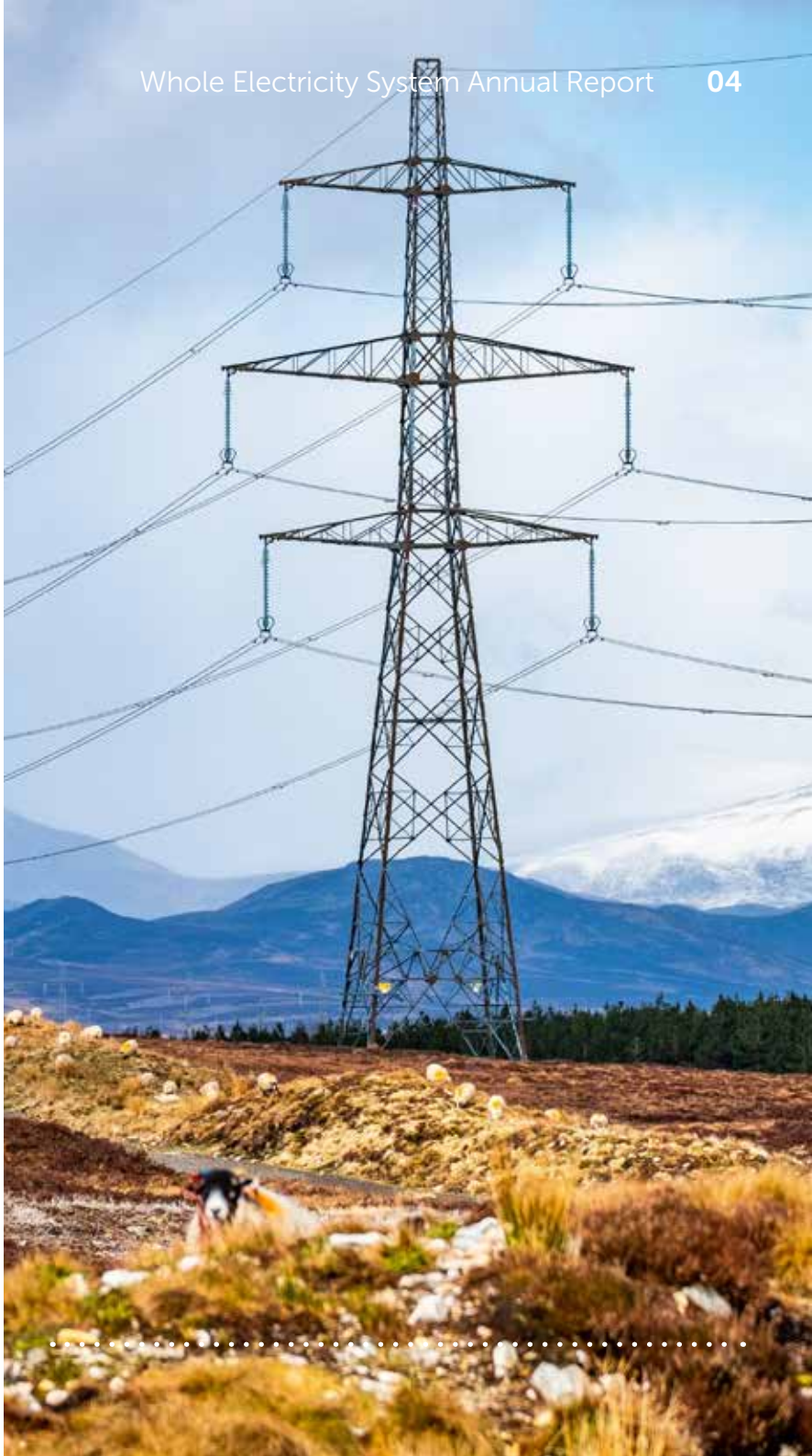
- **Taking a whole system approach to network operation and development to meet current and future customers' needs**
- **Using data efficiently to understand, predict and get the best network performance**
- **Integrated approach to whole life development and operation, using risk-based engineering to deliver value**
- **Trusted partners of customers and communities, realising long-term benefit for society, economy, and environment**

3. Introduction

Over the past year, our whole system strategy has been increasingly critical to how we demonstrate our Net Zero commitments over the past year, supporting more integrated and effective solutions to network planning and development. It has informed more fruitful collaborations and engagements with other Transmission Owners (TO), the National Grid Electricity System Operator (NGESO), other network licensees, local authorities, our customers, consumers, and other stakeholders. Sharing ideas, data, processes, and methodologies with other stakeholders helps us to improve the way we do things and enhances a just and holistic transition to a low-carbon future.

The significant volumes of applications for connection that we receive from low-carbon generation compels further network planning and development that must be delivered in a timely and cost-efficient manner. We remain committed to engaging with our stakeholders to identify where our actions may impact them and to take steps to mitigate these impacts. Our whole system approach ensures that we reduce customer exposure to risk and helps us to deliver our RIIO-T2 customer value proposition of £350 million.

This report will describe some of SSEN Transmission's whole system activities, starting from April 2022, in the drive towards a safe and reliable future for Net Zero. This will include our demonstration of whole system planning for the islands and eastern cities in the north of Scotland, our engagements on market and code reforms, and our collaborations to mitigate future network challenges. As is our custom, this report goes above and beyond our whole system regulatory requirements to complement the whole system coordination register that we published in May as part of our licence condition.



4. Whole System Enablers

For us to establish whole system thinking within our business and with our stakeholders we had to identify initiatives that would enable us to effectively engage stakeholders, collaborate with other network licensees and develop innovative ways to improve our investment decision making. Here we describe the enablers of whole system which start with our people and structure followed by the development of processes and tools to enable them to carry out whole system activities.

4.1 People

At SSEN Transmission, we understand the significant benefits of the whole system approach and continue to demonstrate our seriousness in this direction. We are consolidating our leadership in the industry by growing and restructuring our Whole System team to ensure that all relevant factors, policies, and innovations are considered in whole system approaches across the business.

The Whole System Strategy Group (WSSG), composed of representatives from SSEN Transmission and SSEN Distribution, promotes whole system activities by developing strategies on policy and regulatory positions for projects involving both network licensees. This group oversees the Whole System Development Forum (WSDF) who are responsible for, among other tasks, identifying areas of improvement in existing processes where a whole system approach can have a positive impact.

4.2 Processes and Tools

Our whole system approaches are the methodologies and processes through which we engage with other stakeholders and carry out whole system activities and tools, through which we implement whole system tasks. We are particularly pleased with the improvement to our whole system processes as we plan for RIIO-T3. We have continued to capture whole system activities[1] and record them in the Coordination Register for publication on our website, as required by the Transmission Licence Condition D17. We are in the process of automating some of our processes, to provide more seamless experiences for our stakeholders.

For our whole system network planning, we have improved the way we identify optimal whole system options, adopting a seven-step process that incorporates technical, commercial, environmental, and regulatory considerations across all relevant stakeholder inputs. This has enhanced the determination of the most viable infrastructure options to proceed with, for example, for the Orkney Islands over the year. The process has also given us insights on further developments to the Whole System Cost Benefit Analysis (WSCBA) tool, which we had helped develop through the ENA Open Networks Project Workstream 4.

We have now moved into a new phase of the Net Zero Investment Process, and are now developing a platform to ensure the timeliness, consistency, and accuracy of the data that we share with and receive from our stakeholders. This will include generation and demand data as well as those relating to the conditions of our assets. We believe that this is an important step in arriving at efficient and economical investment solutions, improve overall compliance to standards at our transmission-distribution interface, and ultimately lead to better connections reforms.

[1] See the most recent publication here

5. Whole system projects and activities

At SSEN Transmission we use Stakeholder Engagement, Work Collaboratively, and Innovate to Improve as building blocks in our network development approach. These are building blocks from our Whole System Strategy, which was first published in 2019. We will describe some of collaborations on emissions, data sharing, network planning and the electricity market, and our innovations to address current and future challenges with the transmission network.

5.1 Whole System Network Planning for Islands and Cities

5.1.1 Orkney

The Orkney Islands are currently supplied by two 33kV cable circuits that connect to mainland infrastructure at Thurso South Grid Supply Point (GSP). There is no transmission infrastructure on the island. Renewable generation is in abundance on Orkney. Due to the extent of generation on the islands, an Active Network Management (ANM) system, the first of its kind in the UK, was developed to ensure that customers could continue to connect but would be managed to ensure that SSEN Distribution's distribution assets could be operated within safe operational limits.

The demand on the Orkney Islands has also increased steadily over the decades. To ensure that SSEN Distribution maintains the security of supply standards under the P2/7 security of supply standard, Kirkwall Diesel Power Station remains connected to the network to support the demand in the event of loss of one of the 33kV cables to the mainland (i.e., an N-1 event). A single 33kV cable cannot support the full demand on Orkney, so the power station is required to provide additional support should one of the two distribution cables fail.

To reduce the UK and Scotland's greenhouse emissions and help towards achieving the legally binding net-zero target, higher levels of renewable generation, up to 182MW, are expected to connect to the UK network from Orkney Island. This level of additional generation cannot be accommodated on the existing ANM system and the resulting increase in energy exports will far exceed the capacity of the island distribution network and the cables to the mainland.

What we are doing about it

We took a whole system approach to the development of solutions for the island infrastructure as well as the connection back to the mainland to enable the export of the renewable generation on Orkney. The efficient solution for the island export capacity was conditionally approved by Ofgem in 2019.

Given the ongoing renewable generation activity on Orkney, we undertook further work on the development of an efficient whole system on-island reinforcement solution to enable the harvest and export of renewable energy from the island, enhance the reliability of supply to the island and enable SSEN Distribution to decarbonise their network assets through the decommissioning of Kirkwall Diesel Power Station.

[1] https://www.ssen-transmission.co.uk/globalassets/documents/whole-system-hub/wsr23.pdf

Stakeholder engagement and collaboration

Following fruitful engagements between us as SSEN Transmission and SSEN Distribution on the costs and benefits of viable technical options, we identified the best whole system options. The recommended options involve establishing a new Grid Supply Point (GSP) at Eday and constructing a transmission link from Eday to Finstown with a connection to the local network on Eday to improve the security of supply.

We continue to engage with the SSEN Distribution, developers, local councils, and communities on applications and planning permissions to ensure that the recommended whole system options are implemented.

Innovate to Improve

We developed a seven-step approach to identifying the best set of on-island infrastructure.

1. Determine technically viable Distribution and Transmission options
2. Analyse the security of supply on Orkney according to T&D standards
3. Identify equipment, assets and processes necessary to implement each viable technical option
4. Estimate the costs of the equipment and process
5. Identify the benefits of the project and the options
6. Evaluate the costs and benefits
7. Identify the best reinforcement option

Benefits

The benefits of the project are as follows:

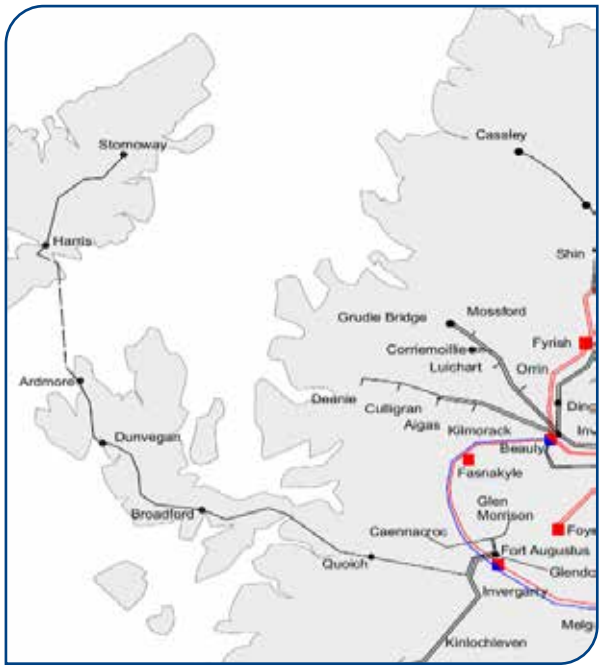
- Reduced social and environmental impacts through the construction of fewer transmission and distribution infrastructures on the island from the recommended whole system options.
- Enhanced security of supply for consumers through a connection to the local network.
- Reduction in overall connection costs, through qualitative of social and environmental impacts, and long-term sensitivities to generation growth.
- Enhanced connection of renewable energy required to meet Net Zero in an efficient and economic manner.

Project Status

The whole system options have been presented to stakeholders. We will continue to coordinate with them to ensure that the recommended whole system options are implemented.

5.1.2 Western Isles

The Western Isles are well located to harness renewable generation, particularly from wind and marine sources. Interest from developers is considerable and the Transmission Entry Capacity (TEC) of contracted schemes significantly exceeds the capacity of the existing single 132kV radial transmission circuit, which is fed from the Fort Augustus Super Grid Substation (SGS).



Peak demand from the customer base on the Isles of Lewis and Harris can also exceed the current capacity of the existing radial circuit. This is due to the limitations of the SSEN Distribution's 33kV land and sea circuits which are sandwiched between 132kV networks on the Western Isles and Skye. The shortfall in capacity is met by using diesel generation at Arnish and Battery Point embedded Power Stations.

A reinforcement of the existing 132kV transmission circuit is therefore essential to harvest forecasted renewable generation and thus aid Net Zero ambitions. It also ensures that SSEN Transmission stays compliant with its statutory license obligations as the Transmission Owner in the north of Scotland to provide timely and efficient connections for developers, whilst ensuring value for the GB consumer.

What we are doing about it

We are assessing the electricity network infrastructure needs for the Western Isles to ensure that they meet whole system requirements. We are doing this by reviewing the existing network and relevant proposed investments across SSEN Transmission and SSEN Distribution to determine their alignment, costs and benefits, and viability, relative to that required to meet generation and demand forecasts for Net Zero.

We will then make recommendations for actions required to ensure that an optimal solution — which considers costs, benefits, technical viability, and planning challenges — is implemented for us and SSEN Distribution as network licensees, the developers, the local community, and the consumers.

Stakeholder engagement and collaboration

We are engaging with Project, Planning, Whole System and Design teams across SSEN Transmission and SSEN Distribution to identify, assess and exchange information on ongoing projects for whole system alignments. Our analyses to determine the best options to implement will follow a detailed coordinated analysis across the teams and businesses. We plan to communicate our findings to the developers and local communities before proceeding to project implementation.

Benefits

The benefits of the project are as follows:

- Enhances project alignment due to the whole system approach.
- Facilitates more robust analyses as inputs across multiple stakeholders, such as social and environmental impacts are considered.
- Reduces overall connection costs, through qualitative evaluations of social and environmental impacts, and long-term sensitivities to generation growth.
- Significantly reduces the pollution from the island's diesel generation.
- Enhances the security of supply to communities and more secure connection of renewable generation to the grid.

Project Status

We are rounding up our findings on the whole system needs for the Western Isles and will be communicating the recommended options to all stakeholders.

5.1.3 Shetland

The Shetland islands electricity network currently operates as an isolated distribution system owned and operated by SSEN Distribution — with no connection to the GB electricity network. The Shetland area possesses significant renewable resources and currently there is 683MW of contracted generation and an additional 17MW has been offered connection. There is also 400MW of battery storage import capacity that has been offered a connection and awaiting acceptance. This volume of generation exceeds the capacity of the Shetland 600MW HVDC link which is currently under construction. Generation permitted to connect to the system above the 600 MW link rating will be provided with network access managed by an Active Network Management (ANM) scheme.

A series of partnerships and coalitions have been set up to integrate harnessed offshore and onshore wind to the grid and establish an energy hub on Shetland to generate hydrogen and enable the electrification and decarbonisation of oil and gas installations.

What we are doing about it

We have set out to identify an efficient and economical whole system solution on the island. This identification is critical and requires a joint effort across Transmission, Distribution, and all stakeholders in Shetland. As a first step, we have set out the scope, deliverables, responsibilities, and timeline to develop an efficient coordinated and economical whole system network design for the Shetland Islands.

Stakeholder engagement and collaboration

We have engaged with SSEN Distribution and agreed on the initial scoping of the whole system activities and deliverables for all parties. We are now coordinating with them on the viable transmission and distribution network options and the costs of these options.

Benefits

The benefits of the project are as follows:

- Reduces overall connection costs, through qualitative evaluations of social and environmental impacts, and long-term sensitivities to generation growth.
- Enhances the coordination of Net Zero activities in the Shetlands.
- Enhances the security of supply for consumers.
- Facilitates the connection of renewable energy require to meet Net Zero in an efficient and economic manner.

Project Status

We will continue to engage and collaborate with stakeholders on energy scenario planning, and the assessment of options, to identify the most efficient and economic whole system options for Shetlands.

Ultimately, we will identify funding mechanisms for the recommended options arising from this work and develop a whole system network for the Shetlands, actively engaging with Ofgem and all stakeholders as we do so.

5.1.4 Aberdeen and Dundee Cities

The Eastern Scottish cities of Aberdeen and Dundee have set their sights on meeting the Scottish decarbonisation efforts by 2045. To this end, the local councils of both cities have respective plans for a greener city through investments in people and infrastructure.

Last year, we reported on the whole system strategy that we had developed for Dundee city, identifying the drivers of the network investments required to meet their Net Zero targets to be condition of the network assets and their demand and generation growths. Given the level of insights that we had garnered from this strategy, we have taken a step further to determine the investment drivers for Aberdeen City.

What we are doing about it

We are working with SSEN Distribution and the local councils of Aberdeen and Dundee for these cities as we move into a new price control period. By actively identifying the asset conditions, the demand and generation forecasts, and local council plans, we ensure that our investment decisions are holistic and cost-effective and that they reasonably address short, medium, and long-term infrastructure requirements in the Eastern cities.

Stakeholder engagement and collaboration

We coordinated with the SSEN Distribution, the Dundee and Aberdeen local councils, and across our internal teams to identify the investment drivers in the Eastern cities of Dundee and Aberdeen. By exchanging ideas and data with stakeholders impacted by our work within these areas, we are developing a comprehensive engagement plan to understand and learn their views, overcoming challenges along the way.

We have also undertaken stakeholder profiling and mapping exercise for each of the cities to identify key stakeholders and strategies of engagement and how the feedback will inform the project design.

Innovate to Improve

We are developing a platform for data exchange and visualisation, aligning data across multiple sources into one standard and accurate source.

We expect that the consolidation of data on load and non-load drivers of investments will inform Net Zero plans that our stakeholders develop and guide our investment decisions.

Benefits

The benefits of the project are as follows:

- Increased consideration of a higher number of factors influencing network investment, potentially increasing the ability to make investment decisions that will result in a reduced cost to customers and consumers.
- Increased security and reliability of electricity supply to homes and businesses in the city of Aberdeen and Dundee.
- Enhanced network capacity to support the growing electricity demand and generation to meet the city's net-zero emissions targets through electrification of heat and transport.
- Enhanced network capacity will allow SSEN Distribution to connect its customers to their network who require transmission access.

Project Status

Our strategies for both eastern cities will inform our justification for investments in RIIO-T3. To this end, we will be looking to incorporate feedback from stakeholders, and obtain all necessary approvals.

5.2 Anticipating and Addressing Future Network Challenges

We expect more and more power electronics to be deployed somewhere between the points of generation and demand, as we increase the volume of sustainable energy production transmitted across our network. Power electronics increase the efficiency of energy usage and allow us to better control our system as we integrate more renewable energy sources (RES). However, the significant volumes of these devices that will be deployed can impact our systems in ways that are currently not well understood. These can manifest as new forms of system disturbances or as lower but more prolonged fault current spikes than we currently know how to deal with conventionally.

What we are doing about it

We are working with the National Grid ESO, academia, vendors, manufacturers, and other TOs, across several projects, to develop methodologies and tools that will improve our understanding of future network challenges, along with ways to address them.

We will be describing some of the projects in the following sections.

Innovate to Improve

We demonstrate our commitment to innovation across all aspects of our activities by developing new ways, through holistic research and development efforts, to mitigate the challenges that will impact the reliability of our future network. By doing this, we accelerate the drive towards a decarbonised energy future.

5.2.1 Preferred Solutions to Perform for Lower Levels of Fault Current on AC Networks (PSL-FC)

Fault levels are traditionally regarded as an indicator of the strength of a power system, and protection systems have been designed to disconnect when faults rise to a predetermined level. However, as we deploy more powerful electronic devices on the decarbonisation journey, fault levels are becoming lower and more prolonged, resulting in a decreasing operational reliability of Protection and Control (P&C) equipment. The current measure to mitigate this challenge is to use expensive Synchronous Condensers that can mimic traditional fossil fuel power sources.

What we are doing about it

To improve our understanding of the P&C equipment we needed to address the anticipated marginal but prolonged fault currents challenges. We are coordinating with the National HVDC Centre and the University of Strathclyde to investigate the effectiveness and reliability of our current Protection and Control (P&C) equipment in the future electricity network. We are doing this via a combination of network simulation and open-loop device trials.

We are also developing tests and validation processes for P&C equipment in the future transmission system, along with new operating processes and protocols necessary for a seamless transition of our network towards Net Zero.

Stakeholder engagement and collaboration

We are actively engaging with partner academic and research institutions — University of Strathclyde and National HVDC Centre — and sharing critical network information that is needed for the development of viable P&C equipment that address potential fault currents issue.

Results will be disseminated via the Energy Networks Association (ENA) Smarter Networks portal and at the Conseil International des Grands Réseaux Electriques (CIGRE) P&C conferences and papers.

Benefits

The benefits of the project are as follows:

- Can lead to the development of P&C equipment that can be produced and installed for around £200k — a fraction of the cost of a Synchronous Condenser which costs £15m and has associated challenges.
- Reduces potential disruptions to the future supply of electricity through an increased understanding of the protection and control requirements for a network with a high penetration of RES.
- Leads to more efficient planning, design, and development of the network to deliver a net benefit to consumers and stakeholders as we transition towards Net Zero.

Project Status

The project is currently in progress. We plan on replicating real-time field data on the simulation network to provide confidence in the project outputs for incorporation into our Business as Usual (BaU) operations.

Innovate to Improve

Current P&C processes assume that there are conventional fossil fuel generation contributing high levels of current that can be detected by P&C equipment during a fault. However, there is a growing concern that P&C equipment in their present state cannot detect the low-level fault current that will be prevalent in the future power system.

This project develops robust models that test P&C equipment ability to function in the future power network, along with innovative ways to modify existing P&C protocols.

5.2.2 Transmission Owner Tools for Electromagnetic Transient Modelling (TOTEM)

The electricity transmission system will evolve as we seek to achieve our Net Zero targets. This means that our current planning assumptions, models, and methods in delivering a safe, secure, and stable operation will be put to the test. We are already witnessing changes in system behaviours with the replacement of conventional large scale synchronous generators (SG) with RES interfaced to our network through power electronic devices.

It is important that new and emerging technologies, which underpin our energy transition, are adequately represented in the modelling of the electricity transmission system to enhance our planning for long-term network security and stability.

What we are doing about it

Working with the ESO and other TOs, we have set out to deliver a Power System Computer Aided Design (PSCAD) tools that allows us to carry put electromagnetic studies of the whole GB network.

We will continue to develop and test the electromagnetic (EMT) based Great Britain (GB) system model, building on the foundations that were laid in the last price control period.

Stakeholder engagement and collaboration

We are actively collaborating with the National Grid ESO and other TOs to develop and validate a GB solution. We are exchanging knowledge and learning with the other stakeholders, to avoid duplication. This ensures that we have a well-thought-out model that addresses the electromagnetic transient problems in the future electricity system.

Benefits

The benefits of the project are as follows:

- The output is a valuable modelling tool which allows us, the ESO, and other TOs to understand the requirements of and to design a future-proof electricity transmission system.
- It facilitates an optimisation of knowledge and learning through communication of ideas between the three TOs and the ESO.
- It can provide valuable learning to the Distribution Network Operator (DNO)

Project Status

We are in the process of validating the model through a study of its response to actual field disturbances. The validation process will establish how we need to improve the model to ensure its readiness for deployment into our BaU activities. The results of this endeavour will be distributed on the ENA portal.

Innovate to Improve

Simulation tools with much higher processing power than is currently obtainable are needed to address the potential challenges of the future electricity network. By implementing this project, we develop innovative tools for network reduction and equivalencing, introducing a new way of modelling the electricity transmission system, coupled with a different way of interoperation.

5.3 Sharing Ideas and Data

Visibility on other parts of the systems is critical to arriving at robust and well-thought-out whole system options that are beneficial to all stakeholders and our consumers. Across the Great Britain (GB) transmission network, a lack of coordination across stakeholders on how Transmission Owners (TOs) evaluate the impact of emissions can lead to differences in benchmarking our decarbonisation efforts.

What we are doing about it

As SSEN Transmission, we are collaborating on a series of projects with other TOs — i.e., Scottish Power Energy Networks (SPEN) and National Grid Electricity Transmission (NGET) — to exchange information, expertise, and experience. These are described below.

5.3.1 Carbon Asset Database

Understanding the contribution to carbon emissions of specific assets is critical to achieving the UK's Net Zero targets. However, the carbon emission data, for example, on greenhouse gas intensity factors, are either unavailable, inaccurate, or disparate across different TOs. This can lead to discrepancies in how we measure how well we have met our Net Zero targets.

What we are doing about it

We are collaborating with other TOs, SPEN and NGET, to develop a master Carbon Asset (CAT) database which contains greenhouse gas intensity factors for specific assets. This database will be updated regularly with any new emission factors received by the supply chain. We are also developing a consistent methodology for calculating embodied carbon emissions in transmission projects.

We expect that this allow for more accurate reporting on embodied carbon emissions and ensure that carbon emission data are available, aligned, and accurate.

Stakeholder engagement and collaboration

We understand that emissions and how we measure them are critical to a UK-wide achievement of Net Zero goals. We are therefore actively partnering with SPEN and NGET to set up and update the shared CAT. We are also exchanging methodologies for estimating emissions across assets and emissions data with our partners to ensure that our emissions data are available, aligned, and accurate.

Benefits

The benefits of the project are as follows:

- Provide necessary data to report on project level embodied carbon emissions.
- Improves the consistency in our reporting and estimation of carbon emissions, with regular updates that allow opportunities to share learnings.

Project Status

We are in the process of merging the current master CAT database spreadsheet with add-ins provided by each of the TOs and circulate for final validation. This live version will then be uploaded to the Supply Chain Sustainability School site which all TOs can access.

5.3.2 Substation Energy Consumption

We expect to construct more and more substations as we connect offshore and onshore RES to our network. The energy consumed in operating substations are a considerable part of operational emissions. However, the methodologies for evaluating substation energy consumptions vary across TOs, with limited knowledge sharing between us. Understanding, improving, and standardising our estimations of substation energy consumption is critical to the quantification of how well the UK has achieved its net-zero targets.

What we are doing about it

We are part of a working group of TOs, composed of ourselves, SPEN and NGET, that has been set up to collaborate and share knowledge on substation energy consumption. This will help to standardise and explore new methods of estimating the energy consumed at substations as a critical step in the determination of our total operational emissions.

Stakeholder engagement and collaboration

As SSEN Transmission, we have been engaging with SPEN and NGET on this project by mutual exchange of knowledge and ideas on substation energy estimation. We intend to take this further by actively sharing data and methodologies and are coordinating with the other TOs to make this happen.

Benefits

The benefits of the project are as follows:

- Improved coordination and standardisation of carbon emission estimation and reporting across the three TOs.
- Enhanced opportunity to create feasible and robust methodologies through exchanges of data, ideas, and experiences.

Project Status

We are currently sharing our knowledge with the other TOs and reviewing our reporting requirements.

5.3.3 Project Waste

Data collection on waste is not consistent across the three TOs and considerable administrative efforts are expended by supply chain partners in this direction.

What we are doing about it

We are working with SPEN and NGET to promote data collection and reporting consistency on waste. Our focus has been on improving the ways that we administer the waste data collection process and on standardising reports on wastes. We are doing this by sharing knowledge on existing reporting requirements and by discussing potential requirements that be explored further with other GB TOs.

Stakeholder engagement and collaboration

We are actively engaging with SPEN and NGET by sharing knowledge on waste data collection and reporting and how we may standardise the process. Our engagements with our partner TOs have resulted in the development of waste reporting templates that are acceptable to all parties.

Benefits

The benefits of the project are as follows:

- By working together with other TOS, we now have an improved sense of the accuracy of our current methodology. This has provided us with potential alternative methods which can be further explored.
- Increased potential of standardising the data collection and administrative processes across GB TOs.

Project Status

We are advancing in the coordination process for this activity and are currently exchanging information on more detailed descriptions of new methodologies to achieve our objective.

5.4 Reforms to Codes and Markets

We are rethinking the codes that govern the electricity markets and network operations, as the electricity network evolves to meet Net Zero requirements. Current codes and market arrangements are proving inadequate to address the challenges of the rapidly changing structure of the electricity transmission and distribution systems. We believe, as do the government and many stakeholders, that revamps to electricity codes and market arrangement is necessary to deliver on our decarbonisation targets without compromising on the affordability and security of supply.

5.4.1 Technical Code Modifications

It is important to ensure the safety and security of supply as we pursue our decarbonisation goals. We have therefore considered it critical to monitor and evaluate the effectiveness of the current technical codes in the face of an evolving structure of the power system, and modify, if necessary, to guarantee the continued reliability of supply.

What we are doing about it

We are taking a coordinated whole system approach to carrying out modifications to the Connections and Use of System Code (CUSC), the Security and Quality of Supply Standard (SQSS), the System Operator Transmission Owner Code (STC), and the Grid Code.

By aligning positions with stakeholders such as NGET, SPT, ENA, and the users of the electricity network, we ensure that updates to the technical codes meet the objectives of a safe and reliable electricity systems that provides net benefits to consumers and enhances our ability to meet Net Zero goals.

Stakeholder engagement and collaboration

We are part of the Steering Group that oversee modifications to the code. The code modifications resulting from our engagements are available in an annex of a monthly publication of the ENA Open Networks Steering Group Report.

Benefits

The benefits of the project are as follows:

- Improved alignment of positions with other stakeholders', with more opportunities to learn from other TOs and users of the electricity transmission system.
- Higher potential to achieve the objectives of code modifications along with the achievement of more efficient governance procedures.

Project Status

We are maintaining our activities and utilising learnings from modifications to the technical codes to inform further activities on reforms to the energy code. This will ensure that our advocacy positions are informed by useful experiences that we have garnered from this activity.

5.4.2 Electricity System Restoration Standard

It has become necessary to establish new procedures for restoring the electricity supply when there is a partial or complete failure of the national electricity system, to successfully realise the UK's decarbonisation ambitions. Towards this end, a new Electricity System Restoration Standard (ESRS) has been developed by BEIS and DESNZ, obligating the ESO to have the resources and plans in place necessary to restore all Great Britain's electrical demand within five days.

Regional implementation of this is also necessary, with a 24-hour intermediate goal of 60% of regional demand being met. By no later than December 31 2026, the ESO must guarantee that everything is in place to comply with this standard.

A particular challenge on implementing the ESRS has been on how to send market signals to new and developing technologies in order to maintain a fair playing field in the ESO's commercial approach to Restoration Service Providers.

What we are doing about it

As SSEN Transmission, we are supporting the ESO in the identification of innovative ways to restore the electricity system, including utilising distributed restart and Distributed Generation (DG) for restoration services.

We are also helping to develop markets and fundings arrangements for the ESRS.

Stakeholder engagement and collaboration

Our collaborations have been through work groups and delivery groups, providing responses to the ESO's proposals on the ESRS. We believe that the process must be coordinated across the whole system to ensure effective data sharing and operational practices are in place. This also ensures that there are market and funding mechanisms for such services to avoid any unintended consequences.

Benefits

The benefits of the project are as follows:

- Facilitates more efficient and coordinated restoration of the system, such as the introduction of new requirements that the GB network should be restored to 100% within 5 days and 60% within 24 hours.
- Prioritises safety, reliability, and economic operation of the transmission network.

Project Status

We believe that it is important to monitor and feed into any changes that may affect the safe, reliable, and economic operation of the transmission network. Therefore, we will continue to monitor the progress of this work as it is incorporated into the Grid Code. Small and Medium Enterprises (SMEs) are expected to provide input and support where appropriate.

5.4.3 Review of Electricity Market Arrangements

In July 2022, the government opened a consultation on a review of the current arrangements in the electricity market to identify reforms needed to transition to a decarbonised, cost effective and secure electricity system. This was necessary to ensure that the UK has a long-term solution to the current energy crisis — on account of our reliance on fossil fuel fired generation — and to take advantage of our inexpensive, locally available, and abundant renewable energy. The challenges presented by the rapid decarbonisation efforts are expected to be addressed by changes to the current market structure under the Review of Electricity Market Arrangements (REMA).

What we are doing about it

We provided a response to this consultation, as SSEN Transmission and as part of the SSE wider group, stating, for instance, that we mostly agree with the REMA's overarching vision of delivering security of supply while facilitating a just transition to Net Zero but that we would like that the reforms effectively address the challenges of the modern electricity market. It was also part of our position that impacts and costs to all parts of the system be considered on a whole system basis, to ensure that we all reach Net Zero efficiently at least cost.

We will continue to monitor and track the effect that market changes can have on the operation of our transmission and distribution networks.

Stakeholder engagement and collaboration

We are actively collaborating with industries and wider stakeholders, by providing our positions on proposed changes to the market through responses to key government consultations such as BEIS REMA consultation and Ofgem's Call for Input.

This ensures that proposals within REMA enable and align with the UK Government's wider growth plan and regulatory policy for future networks growth such as National Grid ESO's Pathway to 2030 document, Holistic Network Design (HND) proposals and BEIS/Ofgem's network acceleration workstreams.

Benefits

The benefits of the project are as follows:

- Enhances stakeholder engagement, leading to more robust market reforms.
- Considers impact on future network planning by key organisation stakeholders such as BEIS and Ofgem.

Project Status

We will continue to contribute to key consultations that consider market arrangements and ensure that their impacts on the transmission network, and indeed the whole system, are accounted for. Grid charging, access and markets play a vital part of ensuring that we can deliver our business plan efficiently. It is important for us to continue to monitor changes in this area and advocate, where appropriate, the requirements for our business, stakeholders, and the wider society.

6. What we have learned

We are delighted to find that our awareness of whole system activities is improving across the business. We are proud of the progress we have made, given that this is only the second year that the whole electricity system concept has been formally introduced to the Transmission and Distribution licensees.

As we seek to incorporate whole system practices into our BaU activities, we understand that there will be challenges. However, these challenges present us with the opportunity to lead and be part of the energy transformation that will benefit our customers and stakeholders.

We have gained several insights from our activities over the years, encountering new forms of challenges on our whole system journey in addition to the ones we described last year. We have also seen improvements in some aspects of our whole system practices and are becoming more informed about how to address issues that hinder the achievement of our Net Zero objectives.

We will describe some of our lessons and what we are doing about them in this section.

Increasing Whole System understanding

Considering all parts of the system to arrive at an efficient and economical solution for all parties sounds like the right thing to do but it can be hard to achieve in practice.

At SSEN Transmission, we are proud of the progress we are making on adopting whole system practices, with a dedicated team putting the structure in place to ensure that we lead by example. However, there is still more to do to make the adoption of whole system practices more feasible.

We will continue to collaborate and engage with other stakeholders in the ENA and other relevant industries concerned about a Net Zero future to determine solutions that benefit one and all.

Improved data collection

Our NZIP identification of load and non-load investment drivers and our whole system studies on the investment needs across the islands and cities of the north of Scotland are highly relevant to our planning for the next price control period. However, the data to carry out these studies are often hard to find and disparate across several sources.

We have described how we are collaborating with other TOs across the industry and standardising data collection, estimation, and reporting on wastes, carbon emission, and substation energy consumption. In addition to this, we are also developing a platform for aligning data from multiple sources into a single source of truth.

Need for probablilistic network planning methods

The transmission network requires ongoing investment to meet changing generation and demand patterns. Network requirements have traditionally been determined using methodologies based on deterministic rules to assess network performance and compliance. The increasing volume of intermittent and variable renewable generation means that the deterministic approach is becoming insufficient to fully assess network reinforcement requirements and, consequently, is unable to provide a firm basis to justify network investments. Techniques that consider the variable characteristics of renewable generation output and demand side flexibility will help underpin network investment decision making in the future by using probabilistic approaches to modelling generation and demand.

The ESO uses elements of a probability-based approach to sample for generation output within its BID3 tool that is used to determine the level of network constraint as part of the NOA process for strategic network investment. However, this technique is not currently employed for local networks. We are seeing an increase of variable small-scale generation including batteries seeking to connect to these local networks and the use of deterministic planning methods is not effective as it does not allow connection of these new technologies ahead of network reinforcement thereby creating barrier to net zero. This presents us with the opportunity to try other innovative ways that will benefit our customers and stakeholders.

Need to improve the Whole System CBA tool

Under the ENA Open Networks Project Workstream, we had supported the development of the WSCBA tool as a tool for assessing economic, environmental, and social benefits. We are currently discussing ways to improve the tool and will be engaging with other stakeholders on how we can make this happen. We are currently working on a probabilistic planning methodology to be used in such cases which can be scaled for wider industry use.

Misaligned Transmission and Distribution planning standards

Transmission and Distribution networks are governed by different planning standards and codes. Whilst the spirit behind these standards and codes is that they work to complement each other, changes to one could affect the others. Since these planning standards and codes have different governance frameworks, changes are unlikely to occur simultaneously. This can result in misalignment which can act as a barrier to whole electricity system.

For example, Distribution's Recommendation P2/7 now includes the use of flexibility services like demand side response to contribute to demand security, but this is not explicitly stated or referenced in Transmission's Security and Quality of Supply Standards (SQSS). We have expressed our concern on these issues to relevant parties and will continue to work with stakeholders to ensure that necessary changes are made to the planning standards and codes so that they do not pose barriers to implementing whole system solutions.

7. Next steps

Following the publication of this report, we commit to carrying out the following activities:

- We will continue to improve our governance procedures to incorporate whole system practices into our business as usual activities. This will also include engaging in activities that will improve whole system awareness across our business.
- We will engage with other stakeholders in the ENA to drive further development to the whole system CBA tool to ensure that the costs and benefits of our whole system options are properly evaluated.
- We will carry out whole system studies on disruptive technologies, such as hydrogen and heat pumps, that can support the realisation of our Net Zero targets.

Scottish & Southern Electricity Networks

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8. We want to hear from you

We thank you for your collaborations and commitment to a Net Zero future. Our resolution to ensuring that whole system practices are engraved into our BaU remains steadfast. As we have shown in this report, we will continue to find new ways to deliver value to our stakeholders and communities, including holistic whole system approaches into our projects from conception.

Your views on how whole system activities are important to us, especially on areas that need improvement as well as on the value that we may render to the system to deliver our Net Zero targets.

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