Whole System Strategy

August 2022

www.ssen-transmission.co.uk

Scottish & Southern Electricity Networks

TRANSMISSION

Scottish Hydro Electric Transmission plc

About us

We are SSEN Transmission (the trading name for Scottish Hydro Electric Transmission) and are part of the SSE plc Group. We are responsible for the electricity transmission network in the north of Scotland, maintaining and investing in the high voltage 132kV, 220kV, 275kV, and 400kV electricity transmission network. 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.

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.

Our strategic objective is to enable the transition to the low carbon future, and this is supported by the fact that over 80% of the connected generation capacity in our area is renewable generation and we export around two-thirds of it to the rest of GB. We expect more than a three-fold increase in generation from the current levels to about 30 GW by 2030. This will be a big change in less than 10 years that will need a whole system approach to efficiently deliver the huge amount of network reinforcement required to connect the generation to the grid.

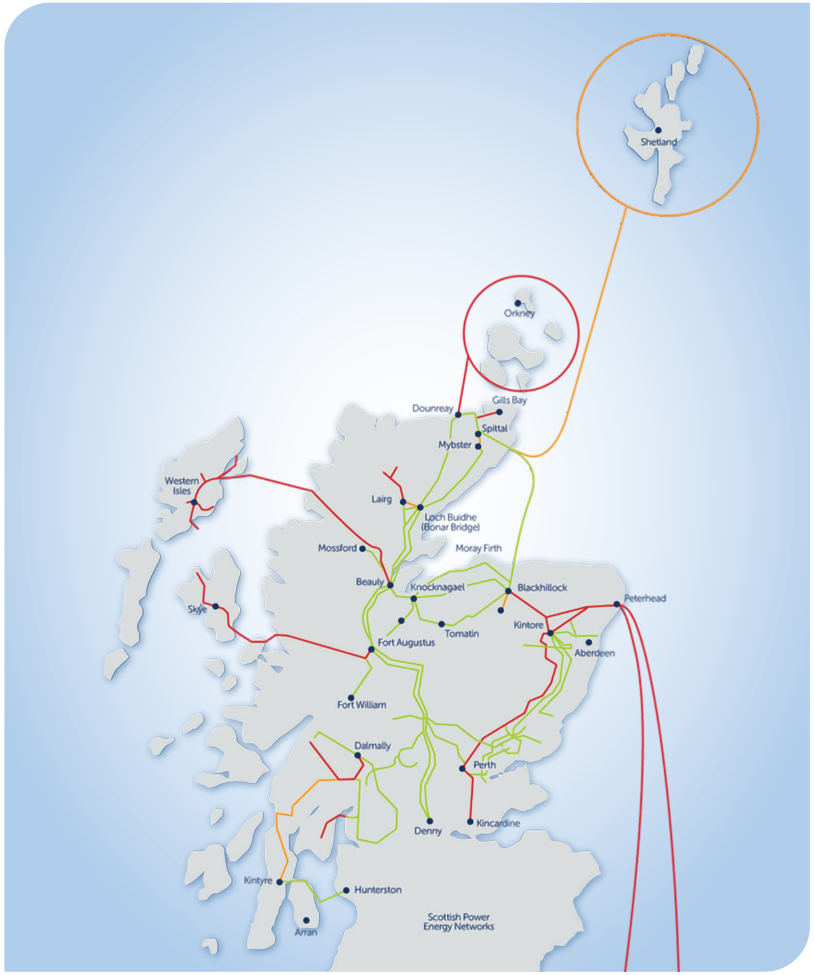

Figure 1 The SSEN Transmission network and operating area

About this paper

In 2019 we published our first whole energy system strategy, in which we outlined our plan to establish whole system working. Since then, we have made significant progress in instilling whole system thinking within our business and with our stakeholders. We articulate this in our whole system annual report which we published in April this year[1].

A whole system approach to network operation and development is an integral part of our company strategic objective. This approach will enable us to deliver our ambitious stakeholder led RIIO-T2 business plan as well as mitigate risks and support justification of uncertain investments driven by large volumes of potential renewable generation connections required to meet net zero.

We believe that taking a whole system approach in developing and operating the network will contribute to protecting vulnerable consumers, as it ensures that overall costs and benefits, as well as risks, are properly assessed and justified. The electrification of heat and transport will mean that many people will rely on the electricity grid for their energy needs more than ever before. This is likely to increase the vulnerability of consumers especially those on the fringes of our network and hence the need to enhance network reliability and resilience.

For us to do this we need to focus on meeting the needs of our customers and stakeholders and understanding how consumer behaviour will affect what we do on the network going forward. In this strategy we explain what we will do to create that value and how we will ensure success. We use three building blocks: engaging with stakeholders; working collaboratively across the industry; and employing innovative ways, as we believe that this will enable us to achieve our goals of supporting a just transition to net zero. Figure 2 gives a summary of our approach.

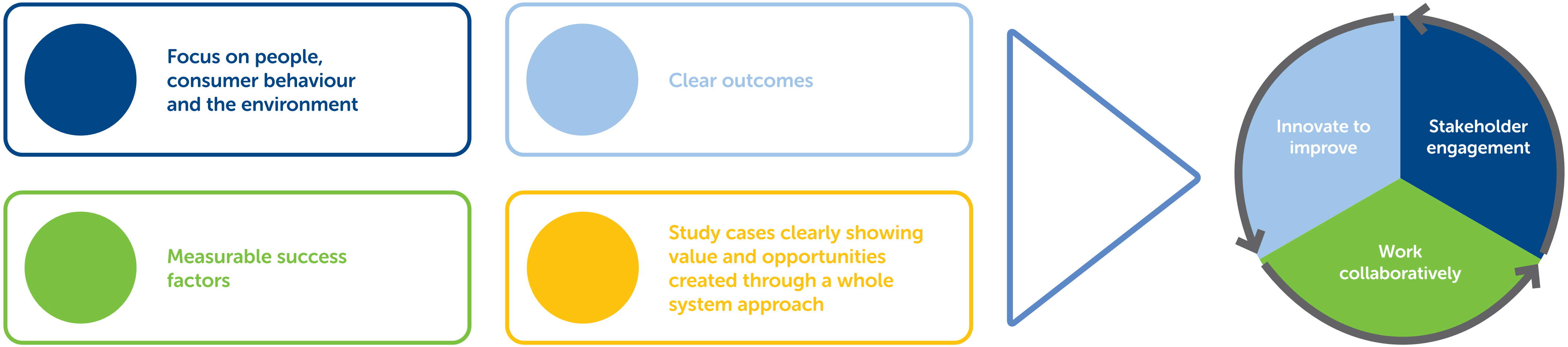

Figure 2 Creating value through a whole system approach

[1]https://www.ssen-transmission.co.uk/media/6524/2022-whole-system-annual-report-final-report.pdf

Next steps

Following the publication of this whole system strategy document, we commit to carrying out the following activities.

- The growth in renewable generation coupled with the need to decarbonise heat and transport will require significant network investment. However, there are currently wide variations in projections of generation and demand and so we will focus on identifying, quantifying, and finding measures to mitigate these uncertainties so that we can more efficiently invest in the network. As a minimum we expect this to cover strategic network development requirements to support ScotWind, storage (e.g. batteries and pumped hydro), hydrogen, heat pumps, electric vehicles, railway electrification, ports, and aviation.
- A whole system approach requires holistic quantification of costs and benefits of investment proposals to determine the true value of network development. We are developing a whole system cost benefit analysis tool, jointly with Workstream 4 of the ENA Open Networks Project, that will incorporate social and environmental costs and benefits of projects.
- At the end of each financial year, we will publish our annual whole system report which will outline the progress against the outcomes in this paper and clearly show the value that has been created by taking a whole system approach in investment decision making.
- This whole system strategy will be reviewed at least every two years unless there is a significant change in policy or regulation requiring us to review the strategy earlier.

We want to hear from you...

In this document we have outlined our commitment to how we will deliver value to our customers and stakeholders through a whole system approach in developing and operating the network. We would like to thank our stakeholders for supporting us in developing this strategy through the feedback we received during the consultation period.

We are a stakeholder-led organisation, and we welcome your feedback on this whole system strategy paper. You can do so by contacting us through the following ways.

- Email: **WholeSystemTransmission@sse.com**
- Twitter: **@SSETransmission**
- LinkedIn: **www.linkedin.com/company/ssen-transmission**

Contents

1 What is the whole energy system?

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.

| 1.1 Whole system definition

In order to develop whole system working it's important to start with a clear definition. We believe:

"The whole energy system comprises electricity, gas, heat and transport networks and components that serve GB society and the environment."

This definition recognises that there are many parts to the energy system and through co-ordination it should be possible to achieve better outcomes for consumers. We also recognise that the way consumers use energy is changing and will continue to do so.

Figure 3 Consumer and environment

The consumer will have more power to make choices as to how they use energy, and these choices, or behaviours, in addition to the need to improve the environment (Figure 3) will influence how we develop and operate the network. As such, we need to develop and operate a network that will evolve and respond to changing consumer behaviour.

Currently, the GB energy system operates largely as standalone elements. Our interest is in identifying and working with those other elements that impact on the economic development of the north of Scotland electricity transmission system.

| 1.2 Gas, heat, and transport

Gas-fired generation participates in the electricity wholesale market to supply energy and provide ancillary or balancing services. These carbon intensive generation technologies will need to be replaced by clean alternatives if the ESO is to operate a fully decarbonised electricity system by 2035. Such clean technology includes long duration storage like pumped hydro which can be used to store energy from renewable resources such as wind. Developers are keen to invest in pumped hydro storage in our area and we will need a whole system approach to ensure timely investment in order to meet these decarbonisation targets.

Gas is also used as primary fuel for heating buildings. One option for the decarbonisation of heating is through electrification. This would increase the load on the electricity networks. Likewise, the planned electrification of transport will increase electrical load and require extra electrical infrastructure being available to charge electric vehicles, power electric trains, and potentially aviation. Both have value for wider society through delivering decarbonisation, however if approached in isolation, rather than through consideration of the whole energy system, there is a potential for inefficient outcomes.

| 1.3 Components

Components refer to devices that either take energy from, or give energy to, the transmission network. This includes all types of generation from solar through to gas-fired generators, as well as interconnectors between international jurisdictions. It also includes energy storage devices, encompassing electrical energy storage or 'energy vector shift' technologies like hydrogen electrolysers. Installation of these devices drives energy system infrastructure cost, however once installed they can drive infrastructure savings. It is important to carefully consider these technology types on a whole system basis to optimise where they are installed and how they plan to operate.

Components also refer to digital technologies that facilitate supply, management, and consumption of energy. Energy digital platforms like virtual power plants (VPPs) and aggregators, will allow more participation of individual consumers in the energy market, significantly changing how the power flows on the network and what we need to do to support this change.

| 1.4 GB society and the environment

The critical aspect of our definition of the whole energy system is the recognition of the value, or benefits, that the whole system serves to GB Society. In this context, we look beyond the electricity bill payer to the overall costs and benefits to GB society and the environment. For example, greenhouse gas (GHG) emissions reduction, increased biodiversity and other sustainable criteria are benefits.

We also ascribe a time value. For example, the Committee for Climate Change[2] recommends that "many networks will need to be upgraded in a timely manner and future-proofed to limit costs and enable the rapid uptake of electric vehicles and heat pumps," i.e., delayed action can inhibit benefits realisation elsewhere in the whole energy system.

[2]www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

2 Why we need a Whole Energy System Strategy?

The energy trilemma is based on the interdependence of security, affordability, and sustainability of energy. These three are interactive in a way that doing more or less on one thing could affect the others and hence getting the right balance is critical. For example, to increase the electricity networks security of supply might require building new infrastructure, hence impacting affordability and potentially the environment. Striking the balance between security, affordability and sustainability requires understanding current and future consumer needs and government targets to meet net zero. Our Strategy allows us to consider each part of the trilemma and come to a judgement on what to do to deliver best value.

| 2.1 Taking a whole energy system approach is the right thing to do

We believe that taking a whole energy system approach is the right thing to do. That is why whole system is an integral part of our company strategic objective to enable transition to a low carbon economy **(Figure 4)**. A whole system strategy will ensure that we have the right resources, processes, and tools to enable us to meet this objective.

Strategic themes

How we will do things to achieve our strategic objective

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

Using 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 partners of customers and communities, realising long-term benefit for society, economy and environment.

Figure 4 Our strategic objective & whole system

| 2.2 Creates value for consumers

Our Whole System Strategy will enable us to deliver our customer value proposition of £350 million in the RIIO-T2 period and timely cost-effective investments required to meet net zero.

We also need a whole system approach to mitigate risks of uncertain investments. Through stakeholder engagement and collaboration, we can identify what needs to be done now and, in the future, to meet the current and future needs of consumers at the least cost possible.

The scale of network development to facilitate the connection of huge amounts of renewable generation to the grid to meet net zero is unprecedented and we are aware that if not done properly there is a risk that this could erode consumer or customer value. Having a robust Whole System Strategy will enable us to avoid this trap and deliver solutions that maximise benefits for consumers.

| 2.3 Protecting vulnerable consumers

Decarbonisation of heat and transport will mean that people will rely on the electricity network for more of their energy needs than ever before. This will put pressure on electricity networks thereby increasing vulnerability of consumers, especially those on the fringes of our network. Loss of supply could significantly impact people as they will not be able to travel, heat or light their homes. A whole system approach is therefore required to ensure timely and efficient investment to enhance network reliability and resilience.

3 Emerging challenges in the electricity system in the north of Scotland

At a high level, a whole system approach is the same for every part of GB, what differs is how that high level definition and approach translates for each area. When compared with the rest of the UK there are some key differences as outlined below. What this highlights is that the north of Scotland is different to the rest of GB, as, for example, south Wales is different to the midlands, thus whole system approaches must be tailored to those local considerations rather than adopt a GB-wide model. By focusing on developing the best whole system approaches for the north of Scotland needs, we can then inform the wider development of whole system across GB and so contribute to the best overall outcomes for GB society.

| 3.1 Electricity consumption and generation trends

Our North of Scotland Future Energy Scenarios[3] show a downward trend in electricity consumption since 2014/15 **(Figure 5)**. This is attributed to efficiency improvements in homes and appliances. In the same period, we have seen a drastic increase in generation such that by 2020/21 the volume of electricity generated was about three times the amount consumed meaning that around two-third of the generated electricity was exported to the rest of the GB.

Looking into the future, demand for electricity will start to increase due to electrification of heat and transport. Heat pumps, EVs and electrolysis (hydrogen production from water) will drive demand growth in the north of Scotland. However, generation growth will far outweigh this demand growth such that by 2030 generation could be about three times greater than the current levels **(Figure 6)**.

This wide gap between generation and demand is due to the large levels of renewable energy resources in the North of Scotland versus the low average population density. This surplus renewable energy, essential for delivering Net Zero, thus must travel further to demand centres in the south. This will need a huge amount of network investment which will require a whole system approach to ensure that the intended benefits are fully realised.

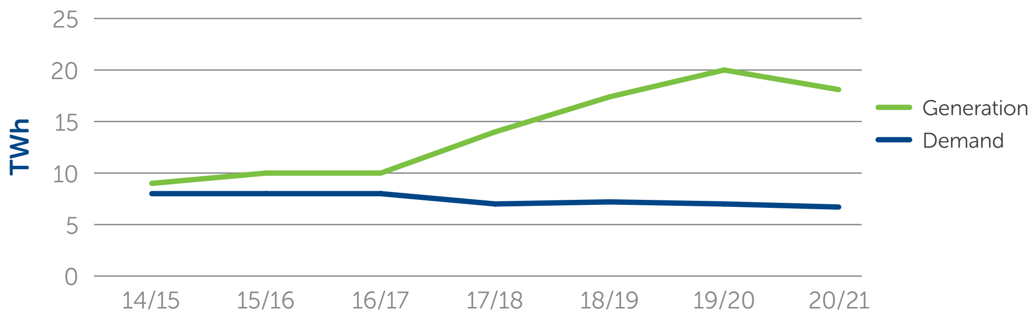

Figure 5 North of Scotland historic demand and generation trend

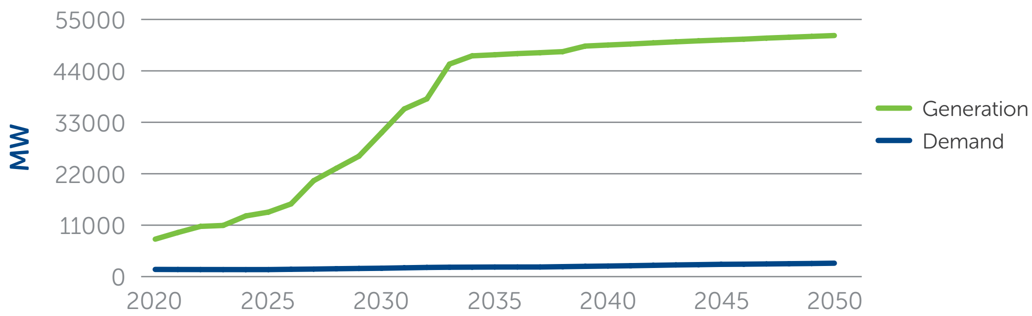

Figure 6 North of Scotland future generation and demand scenario*

[3]https://www.ssen-transmission.co.uk/media/6567/north-of-scotland-future-energy-scenarios-summary-report-2022.pdf
* Green economy scenario

| 3.2 System operability challenges

By 2030 offshore wind will be the dominant generation technology in the north of Scotland **(Figure 7)**. This coupled with other renewable generation technologies present network operability challenges and there are concerns that this could lead to system instability and affect the quality of supply for consumers.

The reason for this is that the current inverter-based technologies used in, for example, wind turbines do not provide adequate system stabilisation during disturbances, which could put system security at risk. Mitigating these emerging issues will require additional investment on the network and we are engaging and working collaboratively with other network licensees, the ESO and Ofgem to find lasting solutions that provide the greatest benefits to consumers.

Proportion of wind generation in north of Scotland (Green Economy)

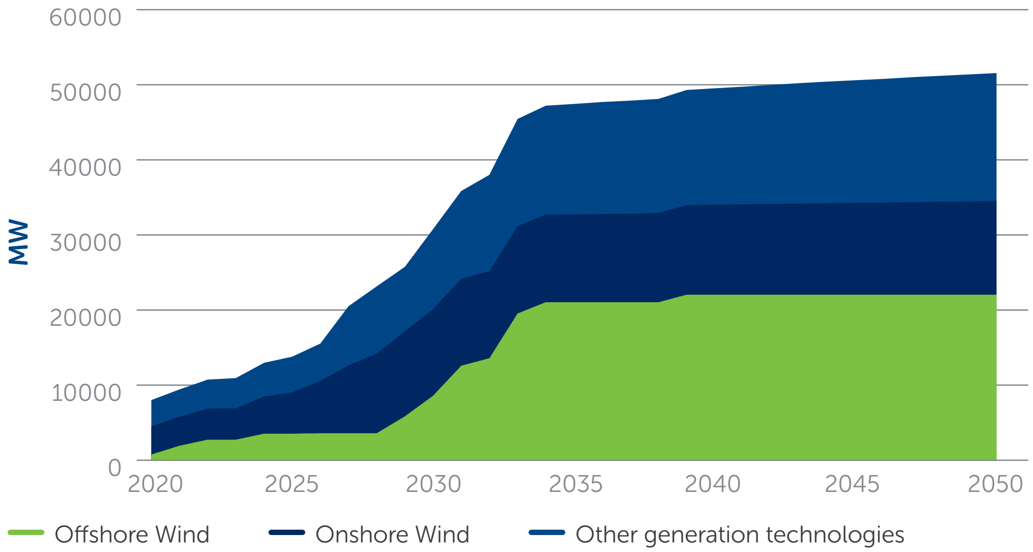

Figure 7 Offshore and onshore wind generation future trends

| 3.3 Gas consumption

Gas consumption in North of Scotland is lower as compared to the rest of GB although the downward trend is similar across the board. There are about 63% homes using mains gas as compared to about 85% in GB, for heating and cooking.

The North of Scotland has one of the highest proportion of people in GB who are not connected to the gas grid. The government decarbonisation plans will see an increase in the number of consumers switching to electric heating, which will impact our local electricity networks. There are, however, uncertainties on how the impact of rising energy prices, UK Government plans to grant new oil and gas licences and phasing out Russian gas imports[4] will affect the pace at which consumers switch to electric heating. Hence the need for a whole system approach to better understand these dynamics and ensure efficient investment decision making.

[4]British energy security strategy - GOV.UK (www.gov.uk)

| 3.4 Electrification of heat

Heating contributes 18% of GB emissions and this figure rises to 21% in Scotland potentially due to colder seasons requiring more heating. To meet the 2045 net zero targets, the Scottish Government has a vision to convert 1 million homes and 50,000 buildings to zero emissions heating technologies like heat pumps and heat networks by 2030[5]. We project that heating will be a significant contributor to electricity demand growth in the north of Scotland. Demand will increase by about 60% in 2045 of which 25% will be from heating **(Figure 8)**. Local electricity networks and grid supply points will be mostly impacted by the rise in demand due to heat pumps. We are working collaboratively with SHEPD, the distribution network operator in the north of Scotland, and engaging local area authorities on their local heat energy efficiency strategies (LHEES) to determine local infrastructure requirements. This collaboration is necessary for us to develop whole system solutions that support local decarbonisation plans and align them with other network investment drivers like asset replacement to ensure efficiency.

North of Scotland demand by technology type (Green Society scenario)

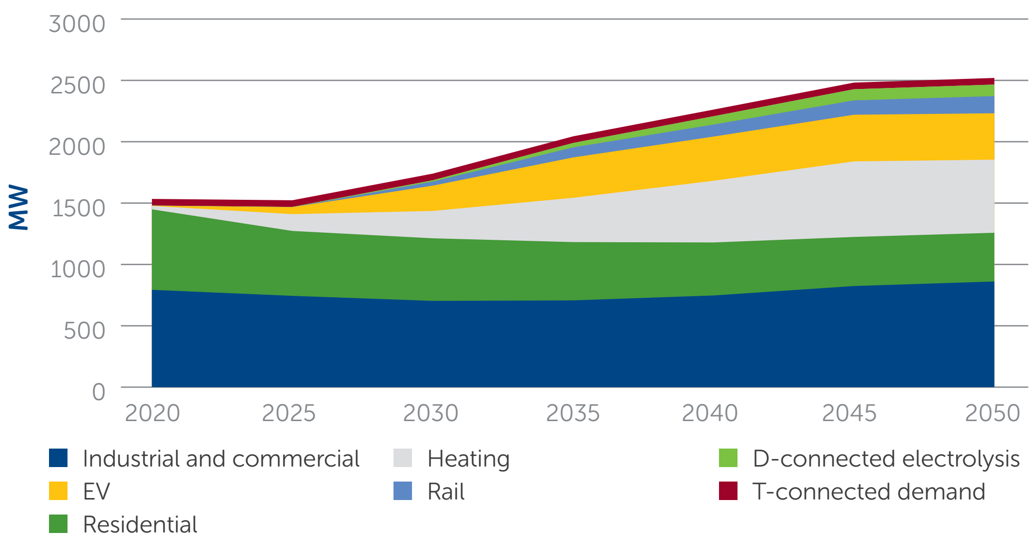

Figure 8 North of Scotland electricity heating demand projection

| 3.5 Electric vehicles

Transport is currently the largest contributor to greenhouse gas emissions in Scotland. The Scottish government is committed to reducing emissions by 75% of 1990 levels by 2030 and net zero by 2045[6]. It also has ambitions to phase out the sale of new petrol and diesel cars and vans by 2032. Some of the Scottish Government initiatives include the £45 million investment to grow accessible public electric vehicle charging network aka ChargePlace Scotland[7].

The uptake of EVs in the North of Scotland is lower than the rest of GB. Between 2019 and 2020 the number of EVs increased by 57% in the north of Scotland compared to 63% in GB **(Figure 9)**.

By the end of 2019, there were a total of 3065 battery EV cars and 2879 plug-in hybrid EV cars in the North of Scotland representing about 0.7% of all vehicles in the licence area[8]. We are likely to see an increase in the uptake of electric vehicles as government policy comes into effect and technology improves to provide more confidence to late adopters.

At the local level, the urban areas like Aberdeen, Dundee and Perth have a higher uptake of EVs compared to other local authorities in the north of Scotland. Our analysis shows that the overall increase in total electricity demand in the north of Scotland due to electric vehicles could be in the region of 13-14% in the next 10 years and is unlikely to significantly impact on the main interconnected system in our area where generation is much higher than demand. However, the impact on some of the grid supply points **(Figure 10)** could be pronounced and understanding the demand profiles of different EV charger types and how this interacts with generation and distributed energy resources (DER), like battery energy storage, is essential to inform efficient and economic network investment decisions. We will continue to engage and work collaboratively with the distribution network operator SHEPD, the ESO and local authorities to develop solutions that will support electric vehicle charging infrastructure to meet local and national transport decarbonisation plans.

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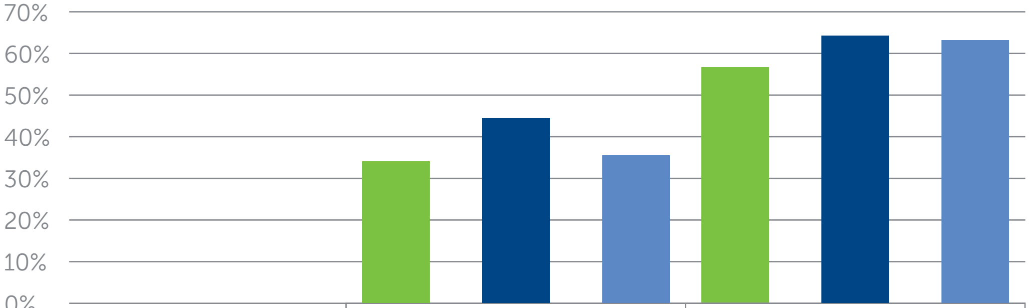
[6] https://www.transport.gov.scot/our-approach/national-transport-strategy/national-transport-strategy-takes-climate-action/
[7] ChargePlace Scotland is a government funded project which installs charging points for electric vehicles - https://chargeplacescotland.org/about-us
[8] SSEN DFES: https://www.ssen.co.uk/WorkArea/DownloadAsset.aspx?id=20283

Historic trend in electric vehicles in north of Scotland compared to the rest of GB



	2018/19	2019/20
NoS	34%	57%
Scotland	44%	64%
GB	36%	63%

Figure 9 Historic increase in number of EVs. Source: DVLA Table VEH0131

Top 10 grid supply points with highest EV demand in north of Scotland (Leading the way scenario)

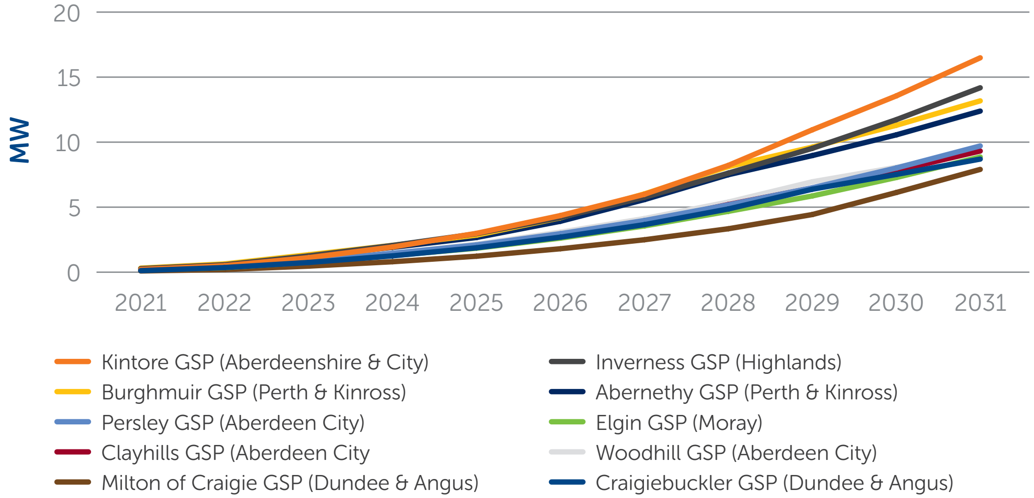


Figure 10 Top 10 GSPs with the highest peak EV demand

| 3.6 Railway electrification

The current rail network in the north of Scotland is not electrified, unlike the rest of Scotland and GB. In its Rail Services Decarbonisation Action Plan, Transport Scotland has set out plans to decarbonise the rail network in Scotland. By 2045 the rail network connecting major cities in the north of Scotland like Perth, Dundee, Aberdeen, and Inverness will be electrified **(Figure 11)**. This will require reinforcements of our network to supply power to rail substations tracks. A whole system approach is required to facilitate this work alongside other network investments driven by the need to connect renewable generation and replace ageing and poor performing assets. We will engage and work collaboratively with Network Rail, Transport Scotland, and other stakeholders to ensure that the developed solutions meet whole system needs.

2020

- Electrified network
- Non-electrified network

2045

- Electrified network, the electrification of some freight only lines may be subject to review
- Alternative traction - permanent solution

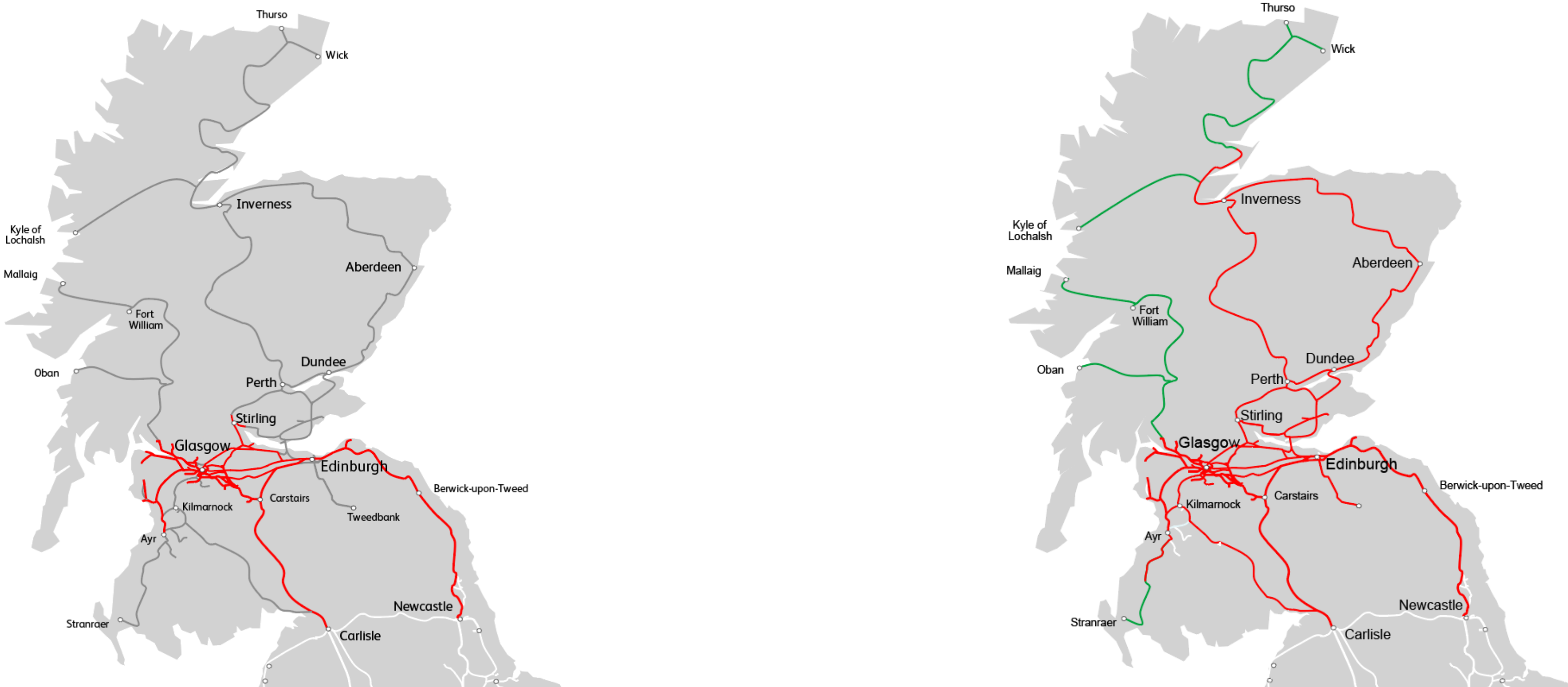


Figure 11 Rail services decarbonisation plan. Source: Transport Scotland

| 3.7 Energy storage

The need for energy storage has never been greater than now as the electricity system is being dominated by intermittent generation sources like wind. Storage can be used to supply demand at the time when there is less renewable energy on the system. Storage facilities are used to store energy at times when demand is low, and supply is high. Due to its quick response characteristics, storage can also be used to provide grid stability during sudden loss of generation allowing the ESO to maintain system security.

There is generally an increase in energy storage across GB. While most of these are small-scale short duration storage facilities, in the north of Scotland we anticipate connection of large scale long-duration storage, like pumped hydro which will require significant network reinforcements. Coire Glas pumped storage for example has a potential capacity of 1500 MW and would more than double the current storage capacity in GB[9].

Currently sitting at 300 MW capacity, pumped hydro is expected to grow to 2464 MW by 2030. As of 1st April 2022, we had about 2500 MW of pumped hydro contracted to connect to our network representing 56% of the total contracted storage (Figure 12). An additional 3400 MW pumped storage capacity is in the connection process. We also have about 2000 MW of contracted battery storage and an additional 5400 MW in the connection process. Our North of Scotland future energy scenario predicts that based on the Green Society Scenario, battery storage will grow from the current installed capacity of 16 MW to about 2000 MW by 2030.

Our aim is to provide efficient and economical solutions to connect storage to our network. To do this we will need to take a whole system approach recognising that different storage technologies may require bespoke solutions in order to maximise overall benefits for our customers and stakeholders. Under the Regional Development Programme, we are working with the ESO and SHEPD to develop efficient network design for battery storage in our area. We explain this in section 5.3.

Energy storage contracted and in connection process in north of Scotland

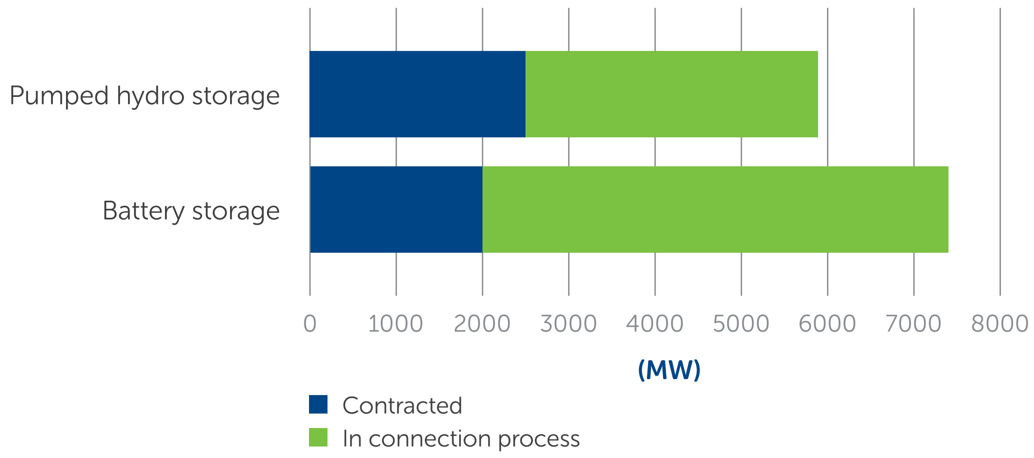


Figure 12 North of Scotland energy storage

[9] https://www.coireglas.com/project

| 3.8 Hydrogen development

Hydrogen has the potential to be one of the energy vectors that could contribute significantly to the decarbonisation of heat, transport, and hard to decarbonise industries like cement and chemical factories. In the electricity industry, excess, or curtailed, renewable electricity can be used to produce hydrogen which can then be used to power the grid at times of peak demand or low supply, titled green hydrogen. The UK Government has published the Energy Security Strategy where the capacity for hydrogen development has been doubled from 5 GW to 10 GW by 2030[10]. The Scottish Government ambition is to have 5 GW of installed hydrogen production capacity by 2030 and 25 GW by 2045[11].

In the north of Scotland there are a number of hydrogen production and end user projects which are currently in development. These projects include the Acorn Hydrogen Project, Aberdeen Hydrogen Centre, and the Orion Project[12]. The hydrogen project produced in these projects will be used for land and sea transport as well as heating homes. These are both blue and green hydrogen projects. Blue hydrogen is produced from fossil fuels like natural gas in a chemical process known as steam methane reforming (SMR). Most of the carbon produced is captured and stored underground rather than letting it out into the atmosphere using carbon capture and storage (CCS). Green hydrogen is produced from water through an electrochemical process called electrolysis powered by renewable energy with no harmful emissions produced. Electrolysis uses a significant amount of electricity, and the capacity of electrolysers will increase as the technology improves. Our future energy scenarios show that under the Green Economy scenario, significant electrolysis demand will start appearing on our network in about 2030 and, by 2050 it will be about 30% of the total peak demand **(Figure 13)**. The impact on the electricity network will depend on where and how these electrolysers are connected to the grid as well as the operation regime of the electrolysers and co-located generation **(Figure 14)**. Fully networked electrolysers with no direct connection to renewable generation and drawing electricity directly from the grid will require network infrastructure to supply them. If the network capacity between generation supply and the electrolyser is limited, reinforcement may be required. The same applies to partially networked electrolysers which require additional supply from the grid. However, non-networked electrolysers which are co-located with renewable generation and do not require additional supply from the grid are unlikely to need additional network capacity other than that required to export excess generation from the collocated generator to demand centres.

It is currently uncertain as to how hydrogen will be deployed on our network as well as how the development of blue hydrogen could affect deployment of electrolytic hydrogen. In the recently published British Energy Security Strategy, the UK Government will design new business models for hydrogen transport and storage infrastructure required to grow the hydrogen economy[13]. We look forward to seeing how the new business models will influence the development of electrolytic hydrogen in our area. We will engage and work collaboratively with the government, developers, research organisations, ESO, and other stakeholders to better understand how hydrogen production could develop in our area so as to make efficient, economic, and timely network investments.

Electrolysis demand in north of Scotland (Green economy scenario)

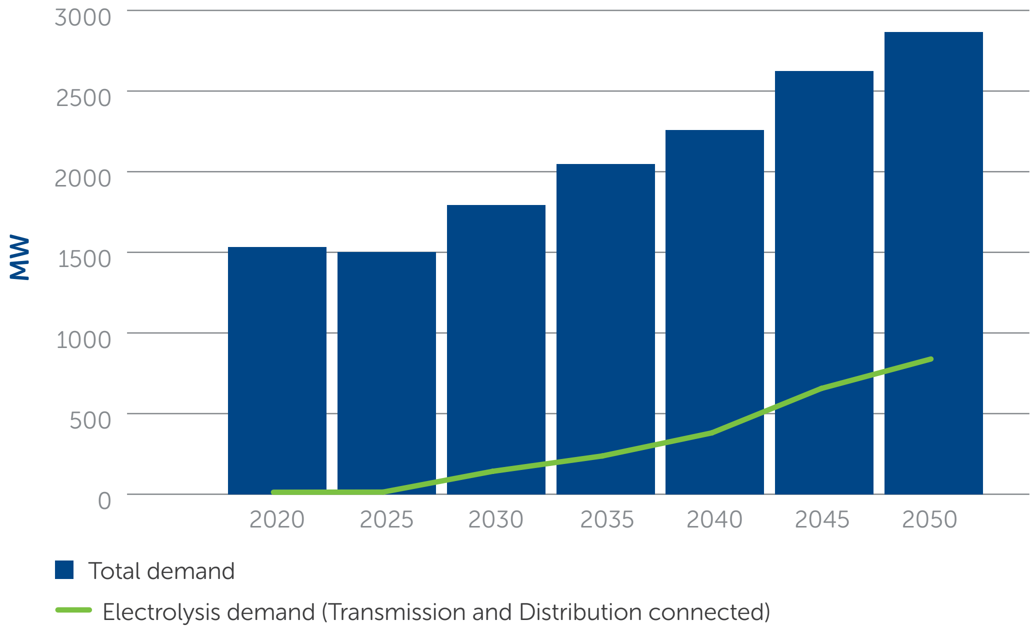


Figure 13 Electrolysis peak demand in north of Scotland

[10]https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy#hydrogen
[11]https://www.gov.scot/publications/draft-hydrogen-action-plan/pages/1/
[12]https://www.gov.scot/publications/draft-hydrogen-action-plan/pages/3/
[13]https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy#hydrogen

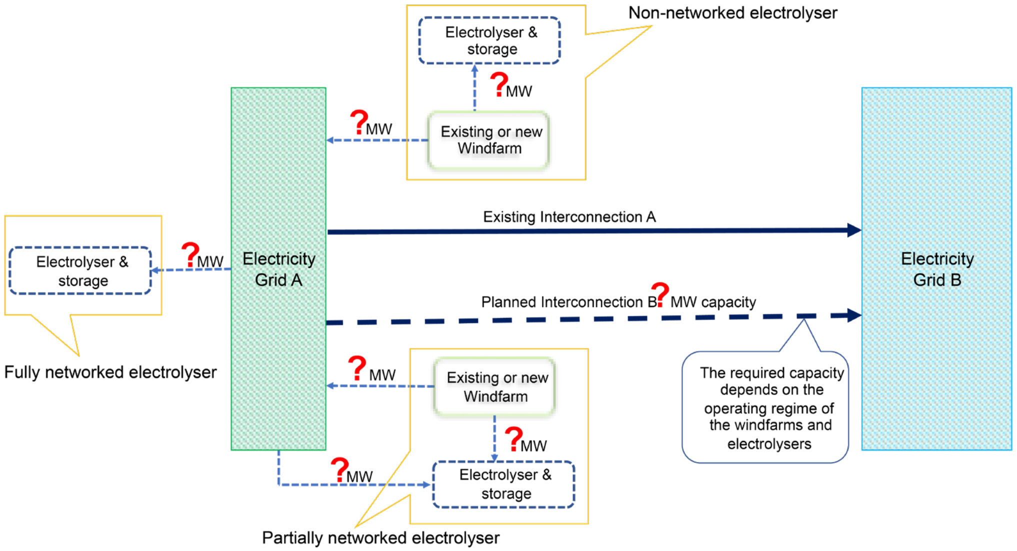


Figure 14 Electrolyser grid connection scenarios

| 3.9 Balancing and flexibility services

Balancing and flexibility services are used by the ESO to manage network constraints. This is achieved by either increasing or decreasing generation or demand, thus keeping the network supply at the right level and within the technical limits of the system. These services are not free and are only economical if the associated costs are lower than reinforcing the network. Constraint costs have soared over the years, and this is expected to increase from about £0.5 billion to close to £2.5 billion in the next 4 to 5 years[14] **(Figure 15)**. Even after the planned strategic network investment are implemented, constraints could still be more than double the current costs. This is partly because the rate of network development is lagging the rate of generation connections and the long standing connect and manage regime allows generation to connect ahead of completion of wider works in leu of the ESO managing the network limits via the balancing and service markets.

The economics of renewable generation is such that it should be in areas where there is abundant resource e.g., wind turbines are located in areas where wind blows most. Huge amounts of renewable generation resources are located in remote areas where there is limited network capacity. If the network is congested, the system operator resorts to constraining that remote generation and replacing it with quick response generation technology, typically carbon intensive generation like gas turbines, as they can respond quickly to instruction regardless of weather conditions and are located in less constrained parts of the network.

We agree with ESO who in their RIIO Draft Business Plan 2023-2025 state that flexible zero carbon technologies will be required to meet demand and to avoid significant curtailment of renewable energy[15]. The area where we operate is the home of an abundant resource of renewable generation, including large-scale, long-duration storage like pumped hydro that can provide the required flexibility, and yet the network capacity is limited. Curtailment of renewable generation and replacing it with carbon intensive alternatives is not aligned with meeting net zero and is very costly to consumers. We will therefore continue to engage and work collaboratively with all stakeholders including ESO to find long term efficient and economic solutions to these issues so as to maximise overall benefits to consumers.

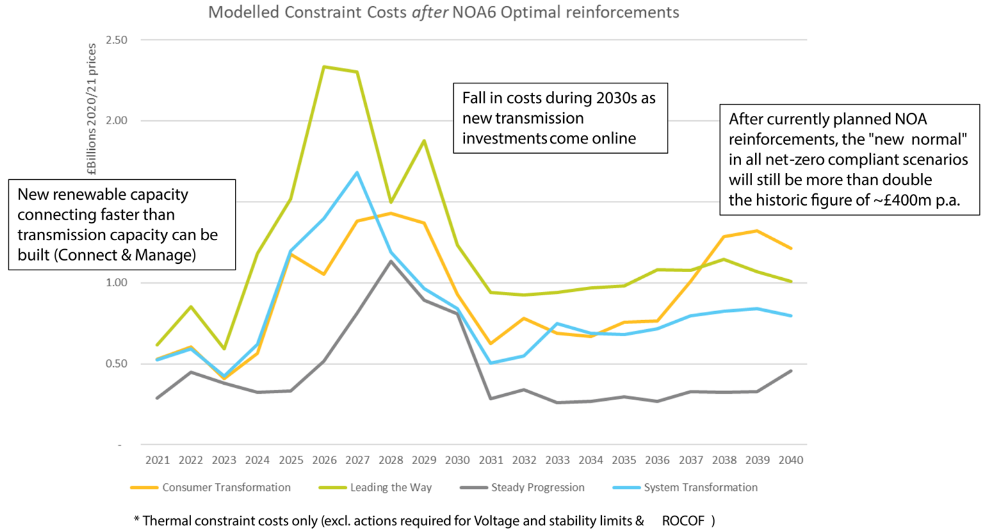


Figure 15 Constraint costs projections. Source: ESO

[14]https://www.nationalgrideso.com/document/198286/download
[15]https://www.nationalgrideso.com/document/249491/download

4 Our approach

In 2019 we published our first whole energy system strategy where we outlined three stages to the implementation of whole energy system working namely the framework stage, electricity stage and whole energy stage **(Figure 16)**.

We have delivered all the outcomes we targeted in the framework stage and are on track to deliver the outcomes in the electricity stage.

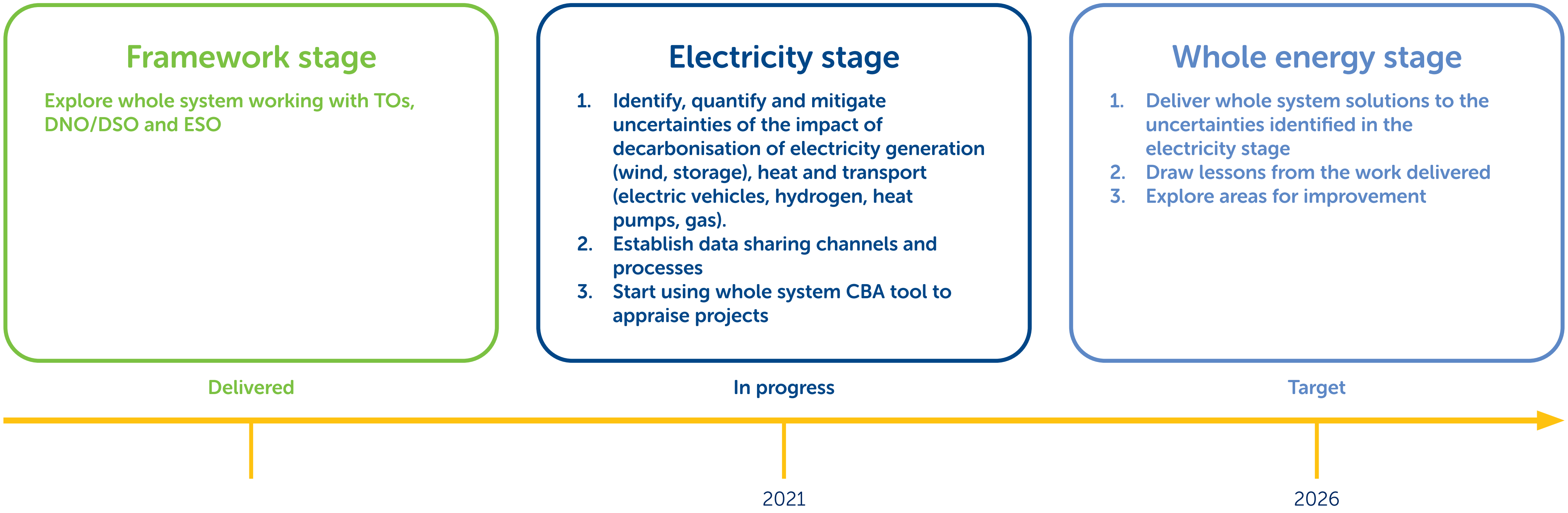


Figure 16 Whole energy system stages

| 4.1 Framework stage 2019-2021

We have now completed and delivered all our targeted outcomes in the framework stage **(Figure 17)**, where we reinforced our existing interfaces, working with stakeholders to understand where and how whole system could be best applied.

Within ENA workstreams, we worked collaboratively with other transmission owners (TOs), distribution network operators (DNOs)/distribution system operators (DSOs) and the electricity system operator (ESO) to develop a common understanding and definition of a whole energy system. Recognising that there are some differences in challenges that we face in our area as compared to the rest of GB, we have tailored our whole system definition to address specific issues in the north of Scotland as described in Section 1.

We realised early the need to have the right people, processes, and tools to enable whole system working. We therefore have established a dedicated team that seeks to address technical and commercial policy issues that pose barriers to whole system and implement innovative solutions that optimise whole system performance. We have developed processes and tools required to instil whole system thinking in our business. This involved creating new processes as well as making changes to the existing processes and procedures to enable whole system working. The Net Zero Investment Process is one of the processes that ensures whole system options are explored by different project teams. This includes collaboration and cooperation with other network licensees and network users for whole system solutions early in the project cycle. This has led to changes in our internal project governance process, meaning that a project cannot be progressed without demonstrating that the recommended solution meets whole system needs.

In exploring whole system working with other network licensees, we established a Whole System Development Forum and Whole System Strategy Group with the distribution network operator SHEPD. We are also involved in developing regional development programs (RDPs) with the ESO and SHEPD focusing on areas with high penetration of distributed energy resources (DER). The aim of these forums is to coordinate whole system working between transmission and distribution, making it easier to share data and information necessary to inform efficient and economic operation and development of the network.

Together with other parties we participated in the development and signing of a whole system charter committing ourselves to work collaboratively with others to achieve government's net zero targets.

Within the Energy Networks Association, we have been actively involved in the development of the methodology and tool for a whole system cost benefit analysis which will be used by network companies for project appraisal that includes social and environmental costs and benefits. We have also led the development of the Coordination Register template which is being used by network companies to record whole system activities as required by Transmission and Distribution standard licences.

As a stakeholder led organisation, we have listened to our stakeholders' concerns on the impact that Transmission Network Use of System charges have on investment in renewable energy in our area. We have therefore advocated for TNUoS reform and are pleased to see a positive change in direction by Ofgem publishing a call for evidence on TNUoS reform and it is expected that a wide-ranging review will take place.

During the Framework stage we targeted key projects as focus areas we could use to trial our whole system working. The outcome has been positive with clear benefits realised and we explain this in more detail in the case studies in Section 5.

Objective	**Explore TO, DNO/DSO, ESO whole system working**			
Outcome	Whole energy system definition	Data sharing	Whole system CBA methodology & tool	Modification to existing codes and regulations
Success	• We have actively participated in ENA work streams to explore a common understanding of a whole energy system. • We have defined what a whole system energy mean to us and in the area where we operate.	• We have established whole system development forum and whole system strategic group with SHEPD. • We participated in the development and signing off of the whole system charter.	• As part of the ENA workstream 4 P1 we have Contributed to development of a methodology & Tool to be used by networks for project appraisal.	• We have led the development of the Coordination Register template. • We have actively advocated for TNUoS reform.

Figure 17 Framework Stage success criteria

| 4.2 Electricity stage 2021-2026

The electricity stage looks to take the learnings from the framework stage and establish whole system working with TOs, DNOs/DSOs and the ESO. Building on those frameworks and new ways of working, we will look to expand whole system to other energy vectors where doing so will create sustainable value for our customers and communities.

We will focus on identifying, uncertainties and making them clearer while defining what low regret activities are. As a minimum we expect this to cover strategic network development requirements to support ScotWind, pumped storage (batteries and pumped hydro), hydrogen, electric vehicles, rail electrification and heat pumps.

Establishing data sharing channels and processes with our stakeholders is critical in the electricity stage as it will enable us to make robust investment decisions that are evidence based. This data will also enable us to operationalise the whole system cost benefit analysis tool which is critical in justifying investments that will realise maximum benefits to consumers.

We will continue to engage all stakeholders and work collaboratively with other parties in the industry on matters that benefit whole system. We commit to publishing our annual Whole System Report to keep our stakeholders abreast with our whole system activities and how we have used these to benefit customers and consumers. **Figure 18** summarises areas we will be focusing on during this period, the outcomes and how we will measure success.

Objective	**Establish TO, DNO/DSO and ESO working whilst exploring other energy vectors for whole system opportunities**			
Outcome	Identifying key uncertainties and making them clearer whilst defining what the low regret activities are	Establish data sharing channels and processes	Start using the whole system CBA tool to appraise projects	Identify and consistently publicise what whole system means for the North of Scotland
Success	• All essential projects identified by HND to support Scotwind achieve milestones on time to meet the required delivery dates. • A clear view of what needs to be done on the network to support EVs, hydrogen heat pumps and storage.	• Data sharing established and process approved before end of 2022-23 FY.	• Whole system CBA used on at least 1 major project before end of 2022-23 FY. • Cost savings not less than £10 million.	• Whole system annual report published annually. • Whole system strategy reviewed and published at least every two years.

Figure 18 Whole Energy Stage success criteria

Measuring success

We have a clear method of measuring success of the outcomes from the electricity stage. We will measure success through the following ways:

We will continue to work with the ESO and other parties to progress strategic network development projects required to transport renewable energy to the rest of GB. In the recently published Holistic Network Design (HND), the ESO has identified essential network requirements to facilitate the connection of 23 GW of in scope offshore wind projects to the grid by 2030.

In the electricity stage we will be focusing on ensuring that there are appropriate mechanisms to deliver these projects in the required timescales. This includes strictly tracking progression of projects through the internal governance process and we will measure success by ensuring that all projects achieve milestones on time to meet the required delivery dates.

As stated in Section 3, hydrogen production presents uncertainty on how our network will be impacted. In this financial year we will be doing analytical work to better understand the impact of hydrogen on our network through closer engagement and collaboration with the government, developers, ESO and other stakeholders. By the end of the electricity stage we will have a clearer picture of what we need to do on the network to support hydrogen development in our area.

In 2021 we did some work on electric vehicles and found out that there is potential for our local networks and grid supply points to be impacted by the increase in demand from electric vehicles. Recognising the fast-evolving developments in this sector, we will be reviewing this work including the impact of heat pumps which like electric vehicles will put significant pressure on certain parts of our local networks. The work on the impact of electric vehicles and heat pumps on our local networks is critical for us to make the right long term investment decisions as we plan to replace ageing and poor performing assets in these areas.

One of the enablers of whole system working is to have clear and agreed data sharing channels. We will start by establishing a data sharing process with SHEPD by the end of this financial year and extend it to other network licensees and ESO in RIIO 2. The whole system cost benefit analysis tool developed by ENA has not been put to full use by network licensees due to issues around inputs like cost of embedded carbon among other things. We will seek to operationalise the tool and use it on at least one major project targeting cost savings of not less than £10 million per project.

We will ensure that our stakeholders are kept informed and consulted on our progress on whole system by publishing a whole system annual report as well as reviewing this strategy at least every two years.

4.3 Whole energy stage - 2026 onwards

By 2026, taking a whole energy system approach to network planning and investment will be well established in our BaU activities (Figure 19) and some of the projects with whole system solutions will be in the delivery stage. We will continuously monitor progress on these projects to ensure that the delivered solution remains relevant to whole system.

This stage will also involve drawing lessons from the work delivered and exploring areas for improvement. Further work will focus on identifying further vectors that could deliver whole system benefits and developing the frameworks to encompass them if necessary.

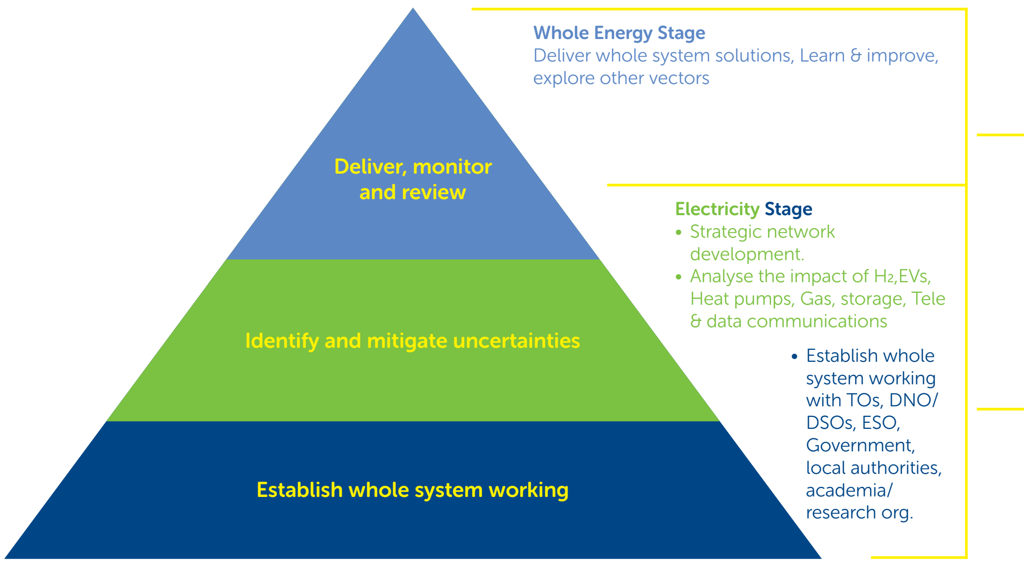


Figure 19 Whole energy system delivery plan

| 4.4 Building blocks

There are three building blocks we are using in implementing whole system working **(Figure 20)** and these are:

- Engaging stakeholders to gain a common understanding of the desired outcomes.
- Working collaboratively to identify and assess possible solutions; and
- Supporting innovation to improve outcomes for GB society.

We have used these three building blocks in the Framework stage, and we will continue to use them in the Electricity stage going forward. We show how we have used these building blocks in the case studies in Section 5.

Engage stakeholders

Stakeholder engagement is critical for us to establish whole system working and deliver solutions that meet current and future customer needs. We have a wide range of stakeholders who have different interests, and it is important that we understand their needs and how we can address them in a manner that benefits whole system.

Apart from being a source of valuable data and information, stakeholders provide us with feedback that help us to stay the course. In developing this strategy, we have engaged stakeholders from government agencies, local authorities, energy associations (e.g., ENA), academia, electricity, and gas licensees etc who have provided feedback that we have used to shape this strategy. We list some of the stakeholders we have consulted in the Appendix.

The success we have achieved in the framework stage (explained in Section 4.2) has been possible because of the positive interactions we have had with our stakeholders, and we are confident that this will continue as we progress into the electricity and whole energy stages.

Work collaboratively

There are interdependencies in the energy sector and hence the need for organisations in this sector to work collaboratively. We believe that it is essential for network licensees to coordinate their operational and development activities to avoid negative cross network impacts with consequent additional costs that are not in the interest of consumers.

In developing whole system solutions, we have worked collaboratively with other network licensees to maximise benefits for customers and consumers.

Figure 20 Whole system building blocks

We have been transparent with our plans and strategy, sharing information, our whole system thinking, and lessons learned for the benefit of the industry.

Whole energy system goes beyond the electricity industry and that is why in our strategy we extend our engagement and collaboration with other energy sectors such as gas, transport, and the emerging hydrogen sector. Decarbonisation of heat and transport will result in significant changes in these sectors which will eventually impact on the electricity industry, and it is essential for us to understand and respond to these dynamics in a way that creates overall benefits to consumers.

Innovate to Improve

We see innovation as an important element in delivering sustainable whole system solutions and in our innovation policy[16] we define innovation as a way of:

"Identifying and proving new ways of working for the long-term benefit of our stakeholders and ourselves."

[16] https://www.ssen-transmission.co.uk/riio-t2-plan/innovation-strategy/

Advancement in technology has provided us with the opportunity to be the first UK transmission owner to install sulphur hexafluoride gas (SF6) free switchgear at our substation in Dunbeath[17]. SF6 is a manmade greenhouse gas and is 23,500 times more harmful to the environment than carbon dioxide. Using SF6 free switchgear is a step forward to reducing our own emissions as we operate and develop a network for net zero.

The increase in penetration of distributed energy resources (DER) is putting pressure on our local networks and often needing network reinforcements based on the current deterministic planning approach. We are currently trialling probabilistic planning concepts to better understand the interactions of energy resources like battery storage and the resultant network risks. Understanding this risk has enabled us to progress with non-network solutions in certain areas and allow customers to connect ahead of network reinforcements. We explain this work in the case study in Section 5.3. We have secured Network Innovation Allowance (NIA) funding to develop a tool that will enable us to fully utilise the concept of probabilistic planning across our network where doing so will create value to our customers and consumers[18].

We are also actively engaged in forums and associations e.g., ENA as well as with other research organisations to share our experiences and learn from others how we can apply innovation in advancing whole system for the benefit of customers and consumers.

[17]https://www.sse.com/news-and-views/2019/10/ssen-transmission-another-step-closer-to-net-zero/c
[18]Probabilistic Modelling for Connection Studies | ENA Innovation Portal (energynetworks.org)

5 Case studies

In this section we give a summary of how we have created value by taking a whole system approach in our network investment decision making. By employing the three building blocks of engage stakeholders, work collaboratively, and innovate to improve (explained in Section 4), we clearly show the difference that a whole system approach has made as opposed to the traditional approach of working in silos. We detail this in more detail in the annual report we published in April[19].

[19]https://www.ssen-transmission.co.uk/media/6524/2022-whole-system-annual-report-final-report.pdf

| 5.1 Argyll-Kintyre Whole System

We have submitted to Ofgem a robust proposal to reinforce the Argyll transmission network from 132kV to 275 kV. The project is required to support the connection of several renewable generation schemes across Argyll and transport the power across Scotland and beyond. We have taken a whole system approach to determine the most efficient and economic pathway to connect this renewable generation to the grid and we summarise this in **Figure 21** below.

Purpose

To support renewable generation growth

Approach
Three building blocks

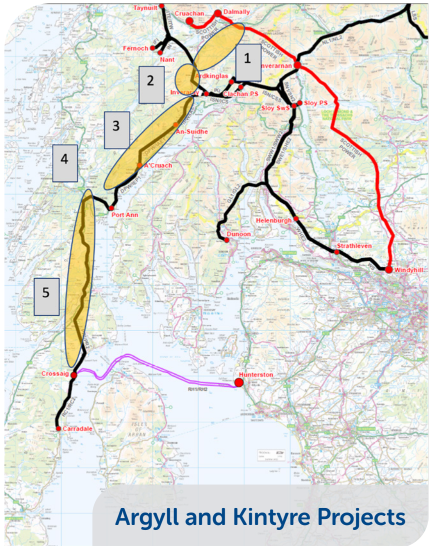
Engagement
We have extensively engaged and consulted local authorities, communities and developers.

Collaboration
We have worked collaboratively with SHEPD, Scottish Power and the ESO to develop a whole system solution that will create maximum overall benefits to consumers.

Innovate to improve
We have demonstrated commitment to reducing our own environmental impact by being the first UK transmission owner to deploy SF6 free technology. It is our intention to use this technology in this project after a full risk assessment has been done.

Scope

- Upgrade the existing 132kV transmission network to 275kV.
- Supply Port Ann grid supply point at a distribution voltage of 33kV from Craig Murrail.



Number	Project name
1	North Argyll Reinforcement
2	North Argyll - Inveraray Reinforcement
3	North Argyll - Craig Murrail Reinforcement
4	Craig Murrail Substation
5	Craig Murrail -Crossaig 275kV

Benefits of a whole system approach
We have recommended a combined transmission and distribution option and, by supplying Port Ann GSP at a distribution voltage rather than transmission we will realise cost savings of about £35 million. This would not have been possible if we did not take a whole system approach.

↓ £35m

Figure 21 Argyll and Kintyre whole system solution

| 5.2 Skye network reinforcement and Edinbane/Dunvegan projects

Skye Reinforcement and Edinbane/Dunvegan are two separate projects in the same area. The cross-network impacts of the two projects require a whole system solution to minimise costs and maximise overall benefits to consumers. We summarise this in **Figure 22** below.

Purpose

- To support renewable generation growth.
- Replace assets that are in poor condition and;
- Maintain security of supply to homes and businesses in Skye.

Approach
Three building blocks

Engagement
We have extensively engaged and consulted local authorities, communities and developers to develop a project that will meet long term needs.

Collaboration
We have worked collaboratively with SHEPD and the ESO to develop a whole system solution that mitigates cross network impacts and maximises overall benefits to consumers.

Innovate to improve
We have demonstrated commitment to reduce our own environmental impact by being the first UK transmission owner to deploy SF6 free technology. It is our intention to use this technology in this project as well.

Scope

- Build a new 132kV double circuit line from Fort Augustus to Edinbane and a single line from Edinbane to Ardmore.
- Build a new grid supply point at Edinbane.

A map showing planned corridor for Skye and Edinbane/Dunvegan projects

Benefits of a whole system approach
By working with SHEPD we have recommended moving new customer connections from Dunvegan to Edinbaneto avoid distribution lines encroaching into the planned corridor for the Skye Reinforcement project. This will result in shorter distribution lines to connect customers realising cost savings of about £2 million plus avoided costs from additional works to mitigate cross network impacts e.g. rerouting or maintaining safety clearances between transmission and distribution lines.

↓ £2m+

Figure 22 Skye reinforcement and Edinbane/Dunvegan projects

| 5.3 Errochty - Charleston regional development plan

We have seen significant interest from customers requiring connection for embedded battery storage particularly in the Errochty-Charleston area. In addition to this, the condition of assets on this network is deteriorating and will need replacement in the near future. Reinforcing the network to enable connection of these small-scale battery storage schemes is uneconomical and hence the need for a solution that will enable connection of the battery storage ahead of asset replacement and reinforcement.

We are working collaboratively with SHEPD and the ESO in exploring a non-network solution that will enable connection of the renewable generation ahead of reinforcement without putting the network at risk. We summarise this in Figure 23 below.

Purpose

To support the connection of embedded battery storage to the grid ahead of network reinforcement and asset replacement.

Approach
Three building blocks

Engagement
We have engaged and consulted developers and planning more engagement with local authorities and communities on the asset replacement program

Collaboration
We have worked collaboratively with the ESO and SHEPD to develop a whole system solution that will enable customers to connect to the grid ahead of network reinforcement.

Innovate to improve
We have employed a probabilistic planning approach as opposed to the traditional deterministic planning to better understand and manage risk of connecting customers ahead of network reinforcement.

Scope

Exploring use of non-network solutions to connect customers to the grid including active network management and flexibility.

Tower corrosion – asset condition deterioration on the Errochty-Charleston line

Benefits of a whole system approach
By Working with the ESO and SHEPD in the regional development program, we have managed to employ new ways of facilitating connection of distributed energy resources like battery storage enabling us to better understand and manage the risks of doing this ahead of network reinforcement. The solution allows immediate connection of renewable generation required to meet net zero as well as cost savings realised from delivering timely network investment.

Figure 23 Errochty-Charleston regional development plan

6 Challenges, opportunities, and lessons learned

In this section we will outline the challenges we have faced, and lessons learned in the course of exploring whole system solutions which have shaped our whole system strategy. These challenges present us with the opportunity to lead and be part of the energy transformation that will benefit our customers and stakeholders. Below we give examples of key challenges we have encountered, the opportunities that these challenges have presented to us and what we are doing in collaboration with our stakeholders to support our commitment to maximise benefits for consumers as we operate and develop the network for net zero.

| 6.1 Electricity consumption and generation trends

There has been progress within network companies to enable whole system working. Scotland energy networks have signed up to the whole system charter committing themselves to work collaboratively to achieve government's net zero targets. Within the ENA there is workstream 4 (whole energy systems) where network companies work together to build a common understanding of whole energy system and how this can benefit consumers. However, the understanding of whole energy system outside network companies is limited. In our stakeholder engagement sessions, we found out that about 80% of respondents do not fully understand whole energy system - reinforcing the need for the industry to do more **(Figure 24)**.

In order to extend whole system thinking to the wider society, we have launched a whole system hub on our website where we explain and demonstrate the benefits of whole energy system through publication of our whole system strategy, whole system annual report and coordination register[20]. The whole system hub also provides opportunity for stakeholders to contact our dedicated whole system team which is ready to receive and act on the feedback as well as respond to queries around whole energy system.

When the licence standard condition on whole system came into effect last year, we volunteered to lead the development of the Whole System Coordination Register template to provide consistency and clarity to stakeholders on how network companies report whole system activities.

How well do you understand whole system?

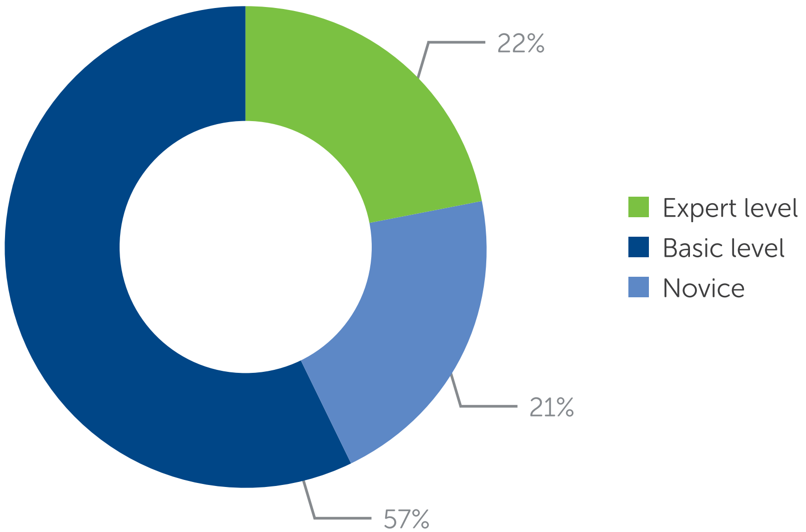


Figure 24 Stakeholder feedback on whole energy system

[20]https://www.ssen-transmission.co.uk/information-centre/whole-system-hub/

| 6.2 Regulatory challenges

Misalignment between transmission and distribution price control periods

Price control periods for transmission and distribution (RIIO-T and RIIO-ED) start and end at different times. This may result in misalignment in the network investment plans for transmission and distribution thereby creating challenges in whole electricity system planning, or funding of them, leading to hesitance when it comes to developing new whole system schemes, as whole system takes significant time and resource at the early stages of project development. There are currently no plans by the regulator Ofgem to align the two price control periods. This could result in whole system opportunities that require increased early development being missed, meaning loss of value to GB consumers. As such, networks will need to be proactive and collaborate more with each other as they develop and undertake their business plans to avoid negative cross-network impacts that could erode the intended benefits.

Coordinated Adjustment Mechanism (CAM) re-opener

The CAM re-opener is triggered by the licensee, where an opportunity that delivers greater overall consumer value has been identified, to reallocate responsibility of delivering a regulatory output is transferred to another[21] licensee. A key requirement of the mechanism is that the identified piece of whole system work, which will deliver the output, needs to be covered by an existing approved allowance. Where one does not exist, then an allowance must be approved for the original way of delivering the output, then the CAM needs to be applied. This adds further uncertainty and time to an already lengthy regulatory timeframe and thus drives delays to whatever connections or network developments are driving the need.

The whole system solution in the Argyll Reinforcement Project (explained in Section 5.1) could have used the CAM. However, to do so would have required us getting the Initial Needs Case developed, submitted, and approved by Ofgem, followed by the Final Needs Case being developed and approved by Ofgem, all based on the non-whole system solution. Only then could the CAM be submitted based on the whole system design. All because the CAM only works for transfer of existing approved allowances. We are working collaboratively with Ofgem and SHEPD to use the lessons learnt from this project to improve the process and share our experiences with others.

| 6.3 Data and information sharing challenges.

Data and information sharing between network companies is critical in understanding cross-network impacts in order to achieve optimal efficiencies across the whole system as evidenced in the Skye Reinforcement and Edinbane/Dunvegan projects in Section 5.2. Although networks are obligated to share certain information, we believe that more needs to be done to simplify the process. The whole system approach presents us with the opportunity to reinforce and close the gaps in the data and information sharing channels with network licensees and other stakeholders. At SSEN Transmission we are working with other network licensees to develop business to business processes that will make it easier to share data and information that can be used in making coordinated, efficient and economic whole system investment decisions without violating competition laws. Time is of great essence and the earlier we share information the better chances we have to avoid unnecessary costs which ultimately are passed on to consumers.

[21] https://www.ofgem.gov.uk/sites/default/files/docs/2021/02/reopener_guidance_and_application_requirements_document.pdf

| 6.4 Codes and planning standards

Misalignment of 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 other. 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, Engineering 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 the 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.

Charging codes

We also find some charging codes like Transmission Network Use of System (TNUoS) charges unfair and a barrier to whole system and net zero particularly for renewable generation in Scotland. They were established at a time when the power system was setup for large fossil fuel central generation stations. They fail to recognise the locational value renewable energy, i.e., it is windy and sunnier in some parts than others, and instead seek to penalise renewable generators for not locating near demand centres, where there is typically less renewable resource and increased planning challenges. We have advocated for reform of these codes to create a level cost playing field for Scottish projects to make our ambition for net zero a reality. Our work in this area has led us to becoming a trusted source of information that stakeholders rely on. We have seen a positive change in direction by Ofgem publishing a call for evidence on TNUoS reform and it is expected that a wide-ranging review will take place[22].

Deterministic planning standards not suitable for new generation technologies

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. In section 5.3 we give an example of a project where we have employed a probabilistic planning concept to better understand network risks and allow customers to connect ahead of network reinforcement. Using Ofgem's Network Innovation Allowance (NIA), we have developed a tool that will enable us to fully utilise the concept of probabilistic planning across our network where doing so will benefit our customers and consumers.

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[22]https://www.ofgem.gov.uk/publications/tnuos-call-evidence-next-steps

7 Appendix 1: Stakeholder Engagement

We have consulted and listened to our stakeholders whose feedback and proposals have shaped this strategy. In tables 1, 2 and 3 we list key activities in the development of the strategy, some of the stakeholders we have engaged with and, key feedback we have received and used to arrive at the outcomes we are targeting in this strategy.

Strategy review proposals: June - October 2021			
Review progress on whole system working	Review whole energy system definition	Review outcomes of electricity and whole energy stages	Case study selection

Stakeholder input: November 2021 - February 2022			
ENA workshop (Nov 2021)	External webinar (Dec 2021)	A session with Stakeholder Advisory Panel (Feb 2022)	Internal workshop (Feb 2022)

Amend proposals: March - April 2022		
Reviewed whole system definition and focus areas	Clarified outcomes and success criteria for each stage	Clarified benefits realised in each case study

Stakeholder feedback: May 2022		
External webinar (April 2022)	ENA workshop (May 2022)	A session with Scottish Government (May 2022)

Strategy paper: May - June 2022			
Identify key uncertainties	Define low regret activities	Quantify benefits	Success criteria

Table 1 Whole system strategy development and stakeholder engagement

Energy Networks Association	Renewable UK	Western Power Distribution
BEIS	Oxford University	Siemens Energy
Scottish Government	Community Energy Scotland	Highlands and Islands Enterprise
NG ESO	Balfour Beatty	Scottish Enterprise
Ofgem	Net Zero Technology Centre	Scottish Power
SHEPD	SSE Renewables	Community Energy Scotland
Strathclyde University	Dundee City Council	Orkney Islands Council Planning
SGN	National Grid Transmission	Perth & Kinross Council Planning
Baringa	Shetlands and Islands Council	Argyll & Bute Council Planning
Citizen Advice	Stirling Council Planning	Aberdeen City Council

Table 2 List of stakeholders

Comment	How we accounted for it
"The whole energy definition should focus on meeting consumer needs, responding to behaviour change and environment."	We have revised our whole energy system definition by including environment. We will also be looking at understanding how change in consumer behaviour will affect and influence what we need to do on the network in the future.
"The outcomes and success criteria of the electricity and whole energy stages should be clearer."	We have made changes to the outcomes, clearly stating that the focus area is to identify key uncertainties and mitigation measures. We have also clarified how we will measure success for each outcome.
"Study cases should clearly state the difference that a whole system approach has made."	We have selected three study cases where we clearly articulate and quantify the value that a whole system approach has created. We have published these case studies in our annual whole system report.
"What progress have you made on the whole system cost benefit analysis tool."	Whole system CBA requires more inputs/data than a traditional CBA. We are in the process of working on these extra inputs such as embedded carbon costs. One of the outcomes in the Electricity stage is to make this tool work and use it to appraise at least one major project before the end of this financial year.
"Is it a whole system approach if we have different network companies having their own whole energy system strategies/definitions? Does it not stack up credibly by having an all-networks approach e.g., via the ENA?"	At the high level, the definition should be the same. However, there could be some variations in specific areas to address location specific issues. In our strategy we have tried to include everything that has potential to influence how our network will evolve in the future.
"Good to see progress with data sharing between organisations. Has any triage been done to understand whether SSEN-D and SSEN-T data sharing could benefit others through wider whole system sharing?"	In this strategy we explain the progress we have made in the Framework stage on exploring whole system working with stakeholders. We formed the whole system development forum with SHEPD (the distribution network operator in north of Scotland) which facilitates whole system working between transmission and distribution including data sharing. One of the outcomes in the electricity stage is to formalise data sharing process. Our plan is to trial and improve the process before extending it to other network operators.
"I think a WS approach is essential. I think another increasingly important element is how to deal with uncertainty and different potential futures across the system. Uncertainty about the role of H2, for example, could stick around for a while. So will be interesting to consider how you will respond to that uncertainty, as well as considering the whole system now."	In the strategy we have included "identifying key uncertainties and defining low regret activities" as the main outcome in the electricity stage. This includes understanding the impact of hydrogen on the network. For us to achieve this, we need to establish relationships/networks with stakeholders (Govt, LAs, Academia/research orgs, other network companies etc), get the data we need to carry out scenario analyses and use the whole system CBA to better quantify overall benefits to consumers.

Table 3 Key stakeholder feedback

Scottish & Southern Electricity Networks

TRANSMISSION

We want to hear from you

In this report we have outlined our commitment to delivering value to our stakeholders and communities where we operate through the work we are doing where whole system approach is central to our investment decision making process. We want to thank all our stakeholders for continuing to support us in our effort to operate and develop a network for net zero.

Now you know what we are doing as regards whole system, we would like to hear from you. In particular, we would like to know where you think we have missed it and areas where we should improve. We would also like to hear your suggestions on activities we should do that would benefit whole system. You can contact us through the following ways.

- **Email:** WholeSystemTransmission@sse.com
- **Telephone:** 07584 011 998
- **Twitter:** @SSETransmission
- **LinkedIn:** www.linkedin.com/company/ssen-transmission

SSEN TRANSMISSION AA1000 STAKEHOLDER ENGAGEMENT PERFORMANCE ACCOMPLISHED 2021

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