Scottish & Southern Electricity Networks

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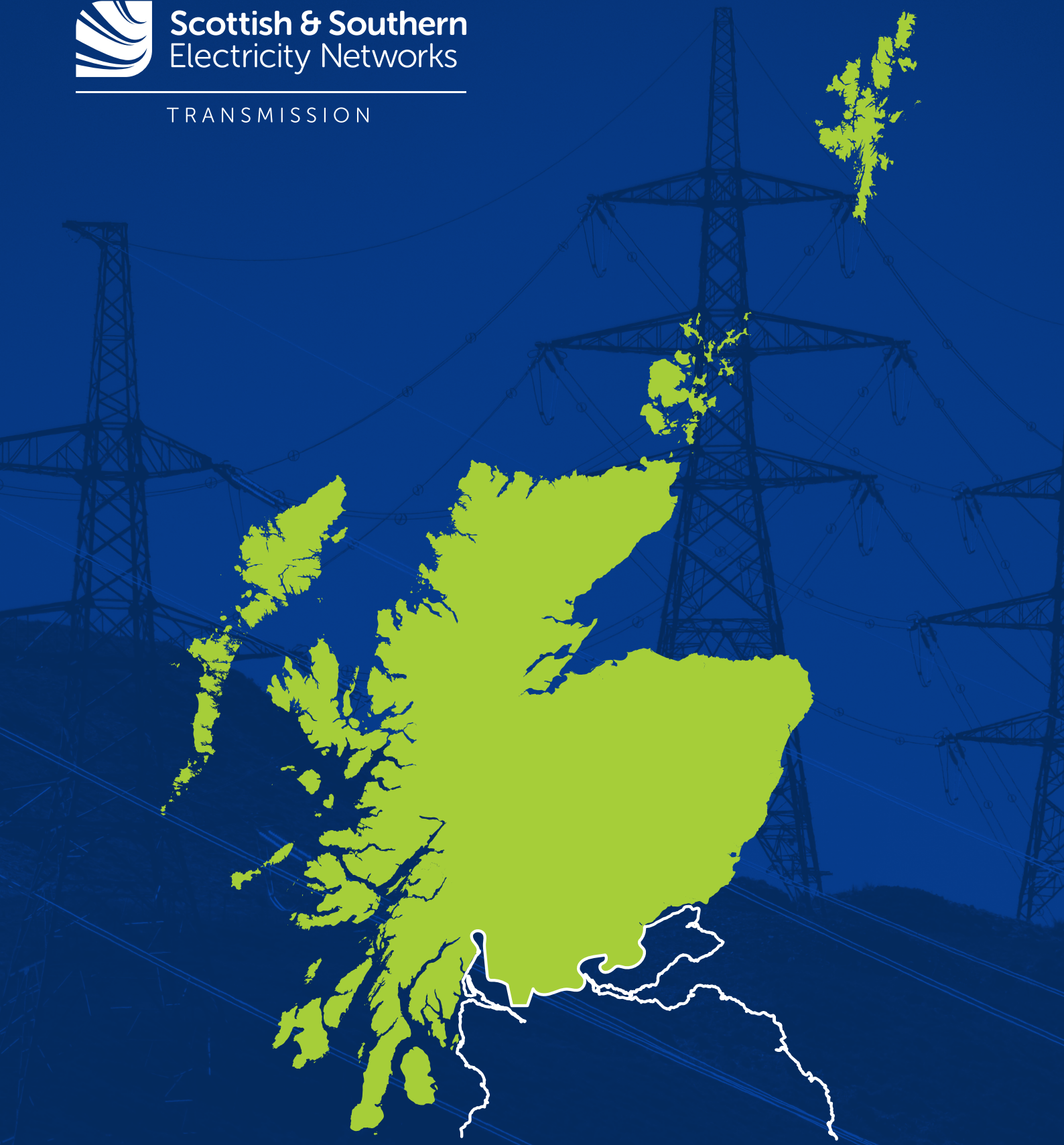


North of Scotland Future Energy Scenarios

February 2021

ssen-transmission.co.uk

This publication

The Great Britain (GB) energy landscape has undergone significant change in the past decade as decarbonisation and renewable energy targets have driven a rapid growth in renewable energy generation and overall reductions in electricity and gas demand have taken place.

To be able to meet customers' future needs over the next decade and beyond, we must understand which technologies are likely to impact generation and demand profiles. This publication sets out our view of a range of potential generation and demand scenarios in the north of Scotland out to 2050.

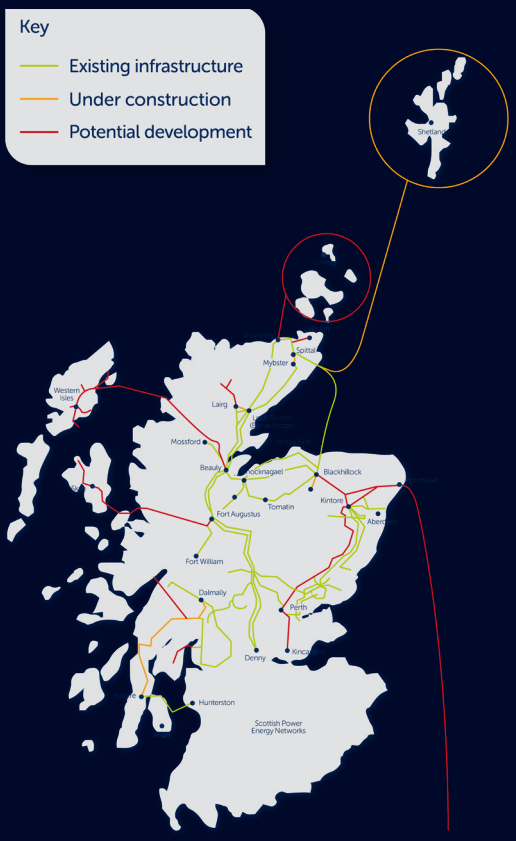
This analysis builds upon our previous North of Scotland Future Energy Scenarios document that was published in 2018 and will help shape our long-term investment strategy.

About us

We are Scottish Hydro Electric Transmission (SHE Transmission), part of the SSE Group, responsible for the electricity transmission network in the north of Scotland.
We operate under the name of Scottish and Southern Electricity Networks, together with our sister companies, Scottish Hydro Electric Power Distribution (SHEPD) and Southern Electric Power Distribution (SEPD), who operate the lower voltage distribution networks in the north of Scotland and central southern England.

As the Transmission Owner (TO) we maintain and invest in the high voltage 132kV, 220kV, 275kV and 400kV electricity transmission network in the north of Scotland. Our network consists of underground and subsea cables, overhead lines on wooden poles and steel towers, and electricity substations, extending over a quarter of the UK's land mass crossing some of its most challenging terrain.

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



A network for renewable generation

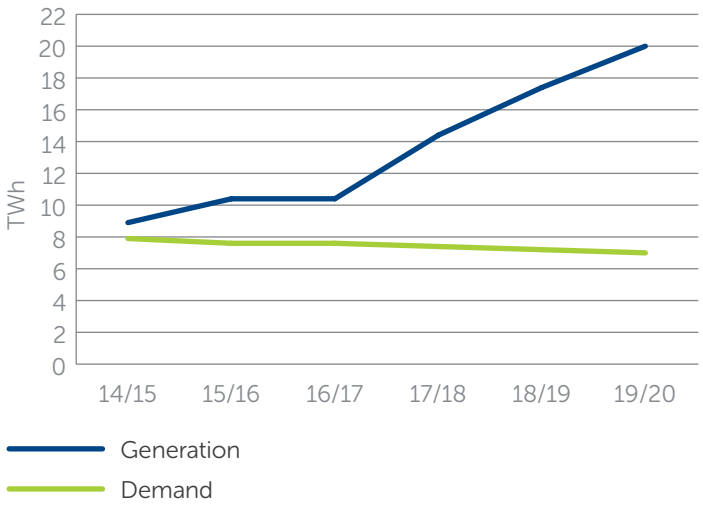
Introduction

As the electricity network owner in the north of Scotland, our main focus in the last decade has been on delivering the additional capacity and connections required for increased renewable energy generation in an economic and efficient way, while ensuring reliability of supplies for our network users and consumers.

Generation of largely renewable electricity in the north of Scotland significantly exceeds local demand consumption. Over recent years, the average electricity consumption in the north of Scotland has fallen slowly, in line with the GB trend. In 2019/20, the volume of electricity generated was around 3-times the amount consumed. The growing gulf between electricity generated and demand on our network drives the need for bulk power transfer from the north of Scotland to the south of the UK.

We need to be mindful of how the energy system could develop in the future which will influence what network developments are required in the north of Scotland.

Historic view of electricity generated and demand in the north of Scotland



The need for localised scenarios

Every year the GB Electricity System Operator, National Grid, produces their Future Energy Scenarios (FES) which identify a range of four credible energy scenarios for the next 30 years and beyond. These consider how much energy GB might need and where it could come from.

At a macro level, the FES are a powerful tool as they capture a range of potential national political, economic, social and technological possibilities.

However, the application of the FES assumptions on a regional level is limited. In the north of Scotland, our Energy Trends papers have identified developments that have not always matched the prevailing GB trends. Therefore, additional granularity provided through localised future energy scenarios for the north of Scotland would best meet energy users' needs.

As we consider whole system planning as a fundamental element in planning our network developments, thought must also be given to changes in other areas of the energy system such as electricity distribution, heat and transport.

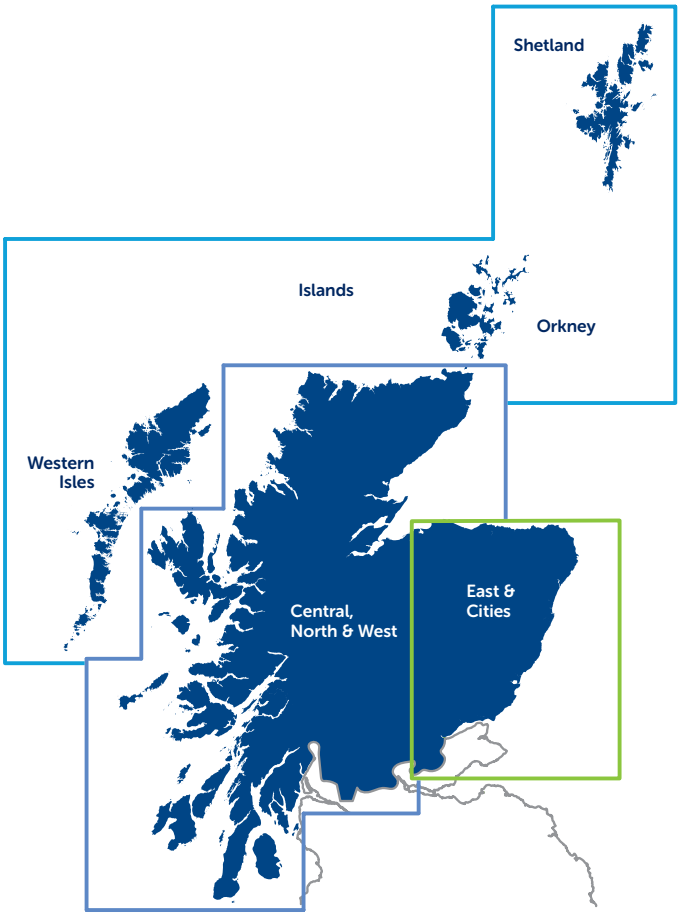
Why are scenarios important?

Our previous North of Scotland Future Energy Scenarios document looked at the time horizon out to 2030 which was dictated by the development of our RIIO-T2 business plan and the understanding that large scale strategic transmission infrastructure projects can spend 3-5 years in development and construction.

Since then, the UK Government legislated a net zero carbon emissions target for 2050. A 2045 net zero carbon emissions target has also been set by the Scottish Government. These are challenging targets that require us to begin the journey towards net zero carbon emissions now.

With this focus, we need to extend the time horizon of our scenarios from 2030 to 2050, allowing us to model how changes in the energy landscape will impact the transmission network in the longer term.

The map shows that within our north of Scotland network area there are three distinct regions that we use when planning the network. Scenarios outcomes will be modelled for each of these areas, ensuring that we build the required infrastructure to meet their respective needs.



New scenarios to put us on a pathway to achieving net zero carbon emissions

Our previous scenarios were designed when policy was in place to limit temperature increase to 1.5 degrees Celsius as set out in the Paris Agreement.

Achieving net zero carbon emissions requires transformational change in the energy system and required us to rethink the approach to our North of Scotland Future Energy Scenarios. Two of our scenarios are now designed to put us on a pathway to achieving net zero carbon emissions. Our third scenario falls short of achieving net zero carbon emissions.

The below table gives a brief overview of our new scenarios and the link to our previous scenarios;

Scenarios	Preceding scenarios	Key details in new scenarios
The Green Economy	Proactive Decarbonisation	• Puts us on a pathway to achieving net zero • Decarbonises heat through hydrogen and electrified heating
The Green Society	Local Optimisation	• Puts us on a pathway to achieving net zero • Decarbonises heat through electrified heating
The Decelerated Transition	Cost Limitation	• Does not achieve net zero • Low uptake in domestic and community-based generation

OUR SCENARIOS

THE GREEN ECONOMY

THE GREEN SOCIETY

THE DECELERATED TRANSITION

Our scenarios

Scenarios	Key details in new scenarios
The Green Economy	Scottish consumers and businesses are supportive of achieving net zero carbon emissions, increasing their use of renewables and engaging with the energy sector at local levels. The focus is on achieving net zero through two main routes; capital investment in renewable generation projects and decarbonising heat through the increasing use of hydrogen and electrified heating.
The Green Society	Scottish consumers and businesses engage directly with the energy industry by investing in micro-generation and renewable heating technologies, allowing them to contribute to achieving net zero carbon emissions. The focus is on achieving net zero through the electrification of heat and investment in both large-scale and community renewable projects.
The Decelerated Transition	Scottish consumers and businesses are less inclined to engage with the energy industry so fewer invest in micro-generation but local planning policy encourages uptake in renewable heating technologies. There is low uptake in domestic and community-based generation whilst increases are seen in large-scale renewables. Decarbonisation is a secondary consideration for Scottish consumers and businesses, with the 2050 net zero target not being achieved.

Government targets

Since COP21 in 2015, the focus on the environment has become more acute. The publication of the Committee on Climate Change's Net Zero document in 2019, has influenced the policy landscape in the UK, putting the UK on a pathway to achieving net zero carbon emissions.

UK and Scottish Government targets and ambitions have been used to set the policy framework and envelope of our scenarios. Our two net zero scenarios are designed to contribute towards achieving each government's respective targets. Examples of government targets and ambitions used are;

- The UK Government has confirmed that it aims to deliver 40GW of offshore wind, including 1GW of floating offshore wind by 2030.
- The Scottish Government's ambition to see the development of between 11 and 16GW of renewable capacity up to 2032, which includes between 8 and 11GW of offshore wind capacity by 2030.
- The Scottish Government's introduction of a standard requiring all new homes consented from 2024 to use zero emission heating.

The Green Economy

Scottish consumers and businesses understand the need to achieve net zero carbon emissions, engaging with the energy sector at local levels. Supportive policy increases the use of renewables, electric heating and hydrogen. Targets set by both the Scottish and UK governments provide a focused decarbonisation pathway in which the UK government seeks to achieve net zero emissions by 2050, as legislated in June 2019.

Intent on reaching the challenging decarbonisation and enabling the green recovery, government looks to support large-scale and community energy supply to maximise the use of renewable energy resources and balance local and national demand.

The economy is performing well, and investment in the energy sector remains high. Targeted support schemes lead to high capital investment in large scale projects across the north of Scotland.

Policy is in place to stimulate development of low carbon energy technologies. Significant policy support for offshore wind and carbon capture & storage (CCS) is in place which are seen as key technologies in achieving net zero carbon emissions. Gas CCS serves as a transition technology until biomass CCS enters the energy mix.

Established technologies, such as onshore wind and solar, benefit from the ability to compete for government subsidy, favourable Scottish planning policy, technology development and economies of scale, allowing projects to be developed with and without government subsidy.

Interconnection plays a role in the generation mix, which will allow for the export of large-scale renewable generation from the North and balancing through imports.

Scottish consumers invest in microgeneration and low carbon heating technologies to bring down cost of their energy bills through participation in demand side response.

Consumers use a mix of heating technologies; in rural areas where there is excess renewable generation, consumers utilise electric storage heaters, hybrid heat pumps and heat pumps; in more urban areas, natural gas boilers are used initially however as we progress towards 2050, more and more consumers invest in hydrogen boilers.

Many consumers and businesses switch from fossil fuel cars to electric cars as they look to mitigate their impact on the environment and make best use of their additional behind the meter generation.

In more urban areas, autonomous vehicles play a role and result in fewer cars on the roads.

Local authority led infrastructure development makes charging away from home easier with fast chargers in towns and cities and on key tourist routes in the north of Scotland.

The Green Society

Scottish consumers and businesses engage directly with the energy industry. Consumer led investment in micro-generation, electric vehicles and renewable heating technologies allow them to contribute to achieving net zero carbon emissions.

The economy is growing, with high investment taking place in large-scale and community renewable projects. Government policy provides opportunity for growth in community based renewable projects whilst support remains for large-scale renewable projects.

Renewable technologies have reduced in cost to such an extent that some large onshore and offshore wind projects are developed without the need for subsidy support.

Small scale energy resources such as local and community wind, solar and storage projects are supported through favourable Scottish planning policy, and beneficial connection and charging arrangements.

Gas CCS plays serves as a transition technology until favourable market conditions allow for biomass CCS to play a prominent role in the energy mix.

Interconnection provide flexibility for bulk flows, but with more decentralised generation on the distribution network, additional flexibility is provided at a local level by distributed energy resources.

Scottish consumers invest in microgeneration and low carbon heating technologies to bring down cost of their energy bills through participation in demand side response.

In communities where there are large amounts of excess local generation such as the Scottish Islands and more remote rural areas, consumers utilise electric heating in the form of storage heaters, heat pumps and hybrid heat pumps.

Where access to excess generation is limited, a range of combined heat and power (CHP) and district heat networks are used. In more urban areas, natural gas boilers are gradually replaced with hydrogen boilers.

Scottish consumers and businesses invest in electric cars. Less autonomous cars operate in urban areas resulting in higher numbers of electric vehicles being present on our roads.

Consumers prefer to charge their electric vehicles at home, benefitting from vehicle to grid services, with fast chargers being located in cities, on the motorways and on key tourist routes in the north of Scotland.

The Decelerated Transition

Scottish consumers and businesses are less inclined to engage with the energy industry so fewer invest in micro-generation but local planning policy encourages uptake in renewable heating technologies. There is low uptake in domestic and community-based generation whilst increases are seen in large-scale renewables. Decarbonisation is a secondary consideration for Scottish consumers and businesses, with the 2050 net zero target not being achieved.

Economic growth plateaus however investment in the sector continues.

Government policy focuses on less established technologies such as offshore wind, floating offshore wind and CCS. More established technologies such as onshore wind and solar are developed subsidy free.

Large scale onshore wind and solar projects are developed in the limited locations where subsidy free development is viable in the north of Scotland.

A reduction in the number of new renewable projects increases the need for interconnection in the north of Scotland in order to meet demand in other areas in the UK.

The removal of some subsidy costs lowers the cost of energy bills so fewer consumers and businesses see little need to engage with the energy industry and invest in microgeneration.

There is limited financial incentivisation from government to encourage consumers to move towards greener sources of energy, but planning policy encourages the deployment of low carbon heating solutions, such as heat pumps and hybrid heat pumps in off-gas areas.

In urban areas, efficient natural gas boilers continue to be used and remain the heating technology of choice.

Electric vehicle uptake takes place due to the government ban on petrol and diesel cars. There is little reduction in the number of electric vehicles on the road as autonomous vehicle uptake is negligible.

Charging electric vehicles at home remains the method of choice however charging away from the home is made easier through investment in transport hubs primarily located in towns and cities.

Electricity supply

The GB electricity system has continued to experience significant change as the energy mix becomes more renewable. 2020 was a record breaking year, which was categorised as the greenest year on record by the Electricity System Operator (ESO). Long periods of coal-free generation and increased output from zero carbon sources were major contributing factors to the reduced carbon intensity of the electricity system.

As we look forward to 2050, further growth in generation is required if we are to achieve net zero carbon emissions. Below is an overview of how generation develops in our scenarios;

The Green Economy

Within this scenario, policy support favours renewable energy generation allowing generation capacity to grow from 7,773MW in 2019 to 33,620MW in 2050. By 2050, Onshore wind has the largest share of generation capacity at 11,897MW. Offshore wind grows to 11,348MW by 2050 due to successful outcomes from ScotWind leasing rounds. Pumped hydro will reach 2,046MW with Hydro (river run) reaching 1,672MW by 2050. Solar and Interconnection capacity rises to 1,570MW and 1,400MW respectively by 2050. Carbon capture and storage (CCS) will play a key role in achieving net zero carbon emissions. Gas CCS will serve as a transition step until a Biomass CCS (BECCS) plant comes online with a capacity of 1,200MW connected to the network by 2050. 1,199MW of Other generation capacity, 1,041MW of Battery storage and 247MW of Tidal will be connected by 2050. 2041 represents the first year where all generation connected to the transmission network will come from renewable sources.

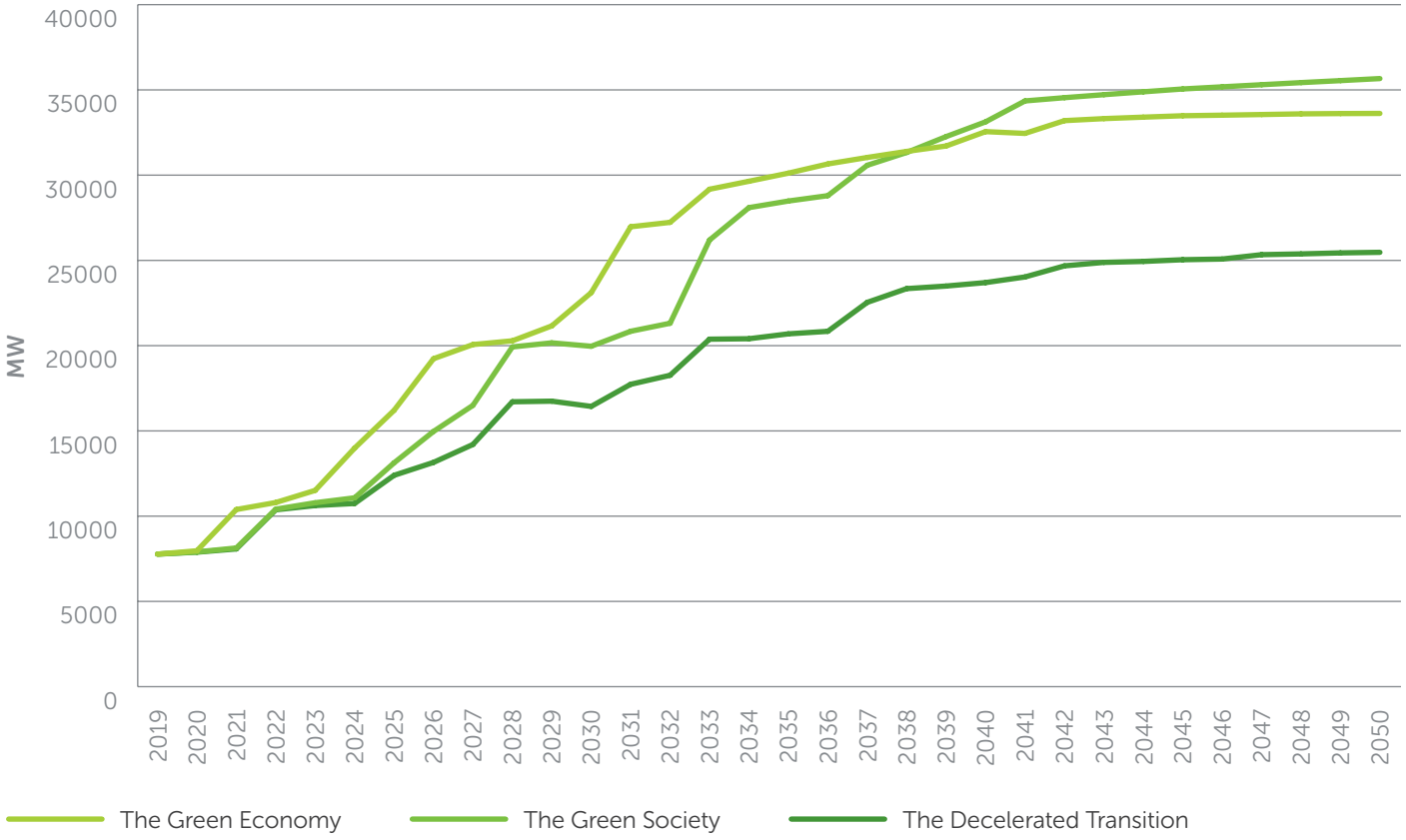
The Green Society

To meet increased electricity demand caused by the electrification of heat, this scenario sees the largest growth in generation capacity, reaching 35,665MW in 2050. Offshore wind represents the technology with the largest share of generation capacity at 13,148MW followed by Onshore wind at 12,062MW. Pumped hydro will reach 2,046MW followed by Hydro (river run) reaching 1,832MW by 2050. Solar capacity reaches 1,735MW by 2050 whilst Interconnection capacity grows to 1,400MW. By 2050, a 1,200MW BECCS plant is in operation following the decommissioning of a transitionary Gas CCS plant. 1,026MW of Other generation capacity, 969MW of Battery storage and 247MW of Tidal will be connected by 2050. All generation connected to the transmission network from 2041 onwards will come from renewable sources.

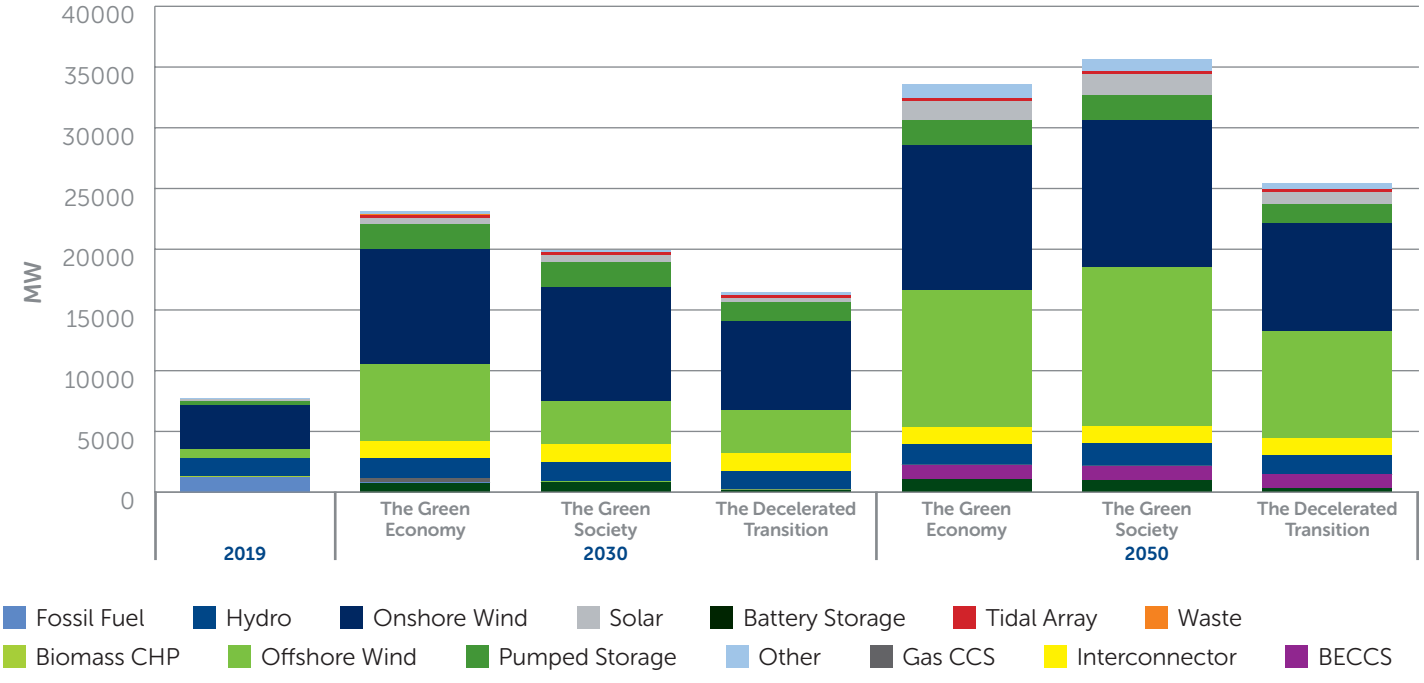
The Decelerated Transition

Within this scenario, fewer renewable energy generation projects come forward, resulting in generation capacity installed on the network reaching 25,474MW by 2050. Offshore wind has the largest share at 8,848MW. Onshore wind follows with 8,830MW of generation capacity on the network in 2050. By 2050, Pumped hydro will reach 1,596MW of generation capacity on the network with Hydro (river run) increasing to 1,546MW. Interconnection capacity reaches 1,400MW by 2050 whilst BECCS capacity grows to 1,200MW. Solar and Other generation capacity increases to 989MW and 535MW respectively by 2050. 282MW of Battery storage and 247MW of Tidal will be connected by 2050. From 2038 onwards, 100% of the generation connected to the transmission network will come from renewables.

Annual installed generation capacity by scenario



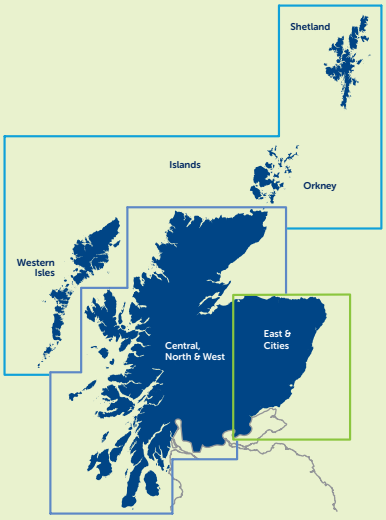
Annual installed generation capacity by scenario



Installed generation capacity by region in 2050

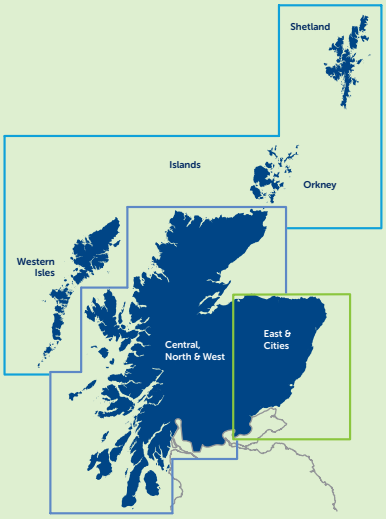
THE GREEN ECONOMY

Region	By 2050
Central, North & West	14,316MW
East & Cities	17,934MW
Islands	1,371MW



THE GREEN SOCIETY

Region	By 2050
Central, North & West	15,276MW
East & Cities	19,020MW
Islands	1,368MW



THE DECELERATED TRANSITION

Region	By 2050
Central, North & West	12,114MW
East & Cities	12,629MW
Islands	730MW

Summary of generation capacity in our scenarios

	THE GREEN ECONOMY	THE GREEN SOCIETY	THE DECELERATED TRANSITION
Connected capacity 2019	7,773MW	7,773MW	7,773MW
Connected capacity in 2021	10,389MW	8,133MW	8,077MW
Connected capacity in 2026	19,234MW	14,968MW	13,152MW
Connected capacity in 2030	23,107MW	19,965MW	16,437MW
Connected capacity in 2050	33,620MW	35,665MW	25,474MW
Connected capacity in 2050 connected at Transmission	24,240MW (72%)	26,041MW (73%)	19,719MW (77%)
Of which is renewable	24,240MW	26,041MW	19,719MW

Electricity Demand

As we strive to achieve net zero carbon emissions, the power sector is not the only sector that will need to decarbonise. Heat and Transport will also have to decarbonise. The use of hydrogen and the electrification of heat have been identified as means to enable further decarbonisation across the country.

Our analysis is particularly focused on the electrical impact of increased demand on the network in the north of Scotland. This section will provide an overview of how demand changes out to 2050 and what factors we have modelled that impact demand growth on our network.

Summary of electricity demand in our scenarios

	THE GREEN ECONOMY	THE GREEN SOCIETY	THE DECELERATED TRANSITION
Total electricity demand in 2019 at winter peak	1,412MW	1,412MW	1,412MW
Total electricity demand in 2050 at winter peak	1,660MW	2,414MW	1,738MW
Which is made up of;			
Residential demand in 2050 at winter peak	249MW	307MW	454MW
Industrial & commercial demand in 2050 at winter peak	909MW	944MW	786MW
Electric vehicle demand in 2050 at winter peak	197MW	246MW	282MW
Heat demand in 2050 at winter peak	304MW	916MW	217MW

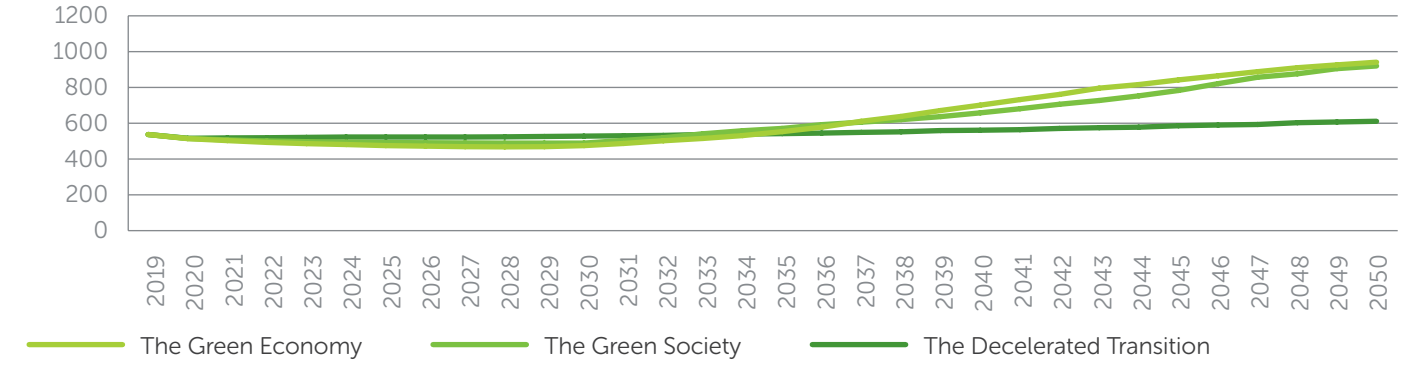
Factors affecting electricity demand in our scenarios

	THE GREEN ECONOMY	THE GREEN SOCIETY	THE DECELERATED TRANSITION
Electric vehicles on the roads in 2030	161,370	164,747	91,750
Electric vehicles on the roads in 2050	633,093	708,137	713,725
Heat pumps in homes by 2030	8,703	13,124	12,702
Heat pumps in homes by 2050	20,290	48,775	46,059
Hybrid heat pumps in homes by 2030	9,823	3,274	1,897
Hybrid heat pumps in homes by 2050	63,300	21,100	12,221
Electric storage heaters in homes by 2030	130,960	136,854	132,859
Electric storage heaters in homes by 2050	149,793	164,755	154,613

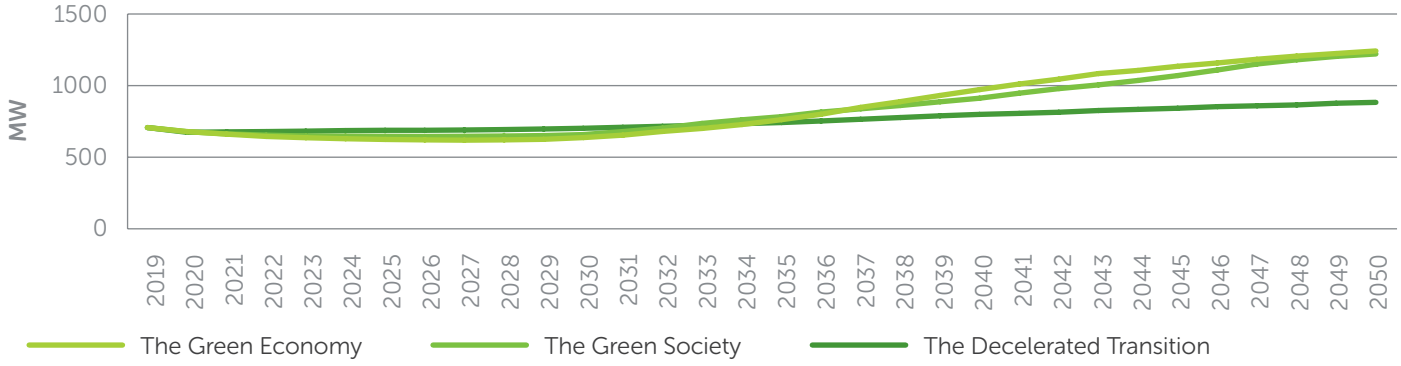
Total electricity demand in our scenarios

Total electricity demand at Winter Peak

Total electricity demand at Summer AM



Total electricity demand at Summer PM



How we will use our scenarios

Our scenarios played a role in the development of our RIIO-T2 business plan, determining the effects that the developments described in our scenarios would have on the electricity network. This included reviewing the network capacity and power flows within each region and whether additional capacity would be required to accommodate the changes in generation and demand.

We will update our scenarios as required, but no more than once a year. To ensure that the outputs of our scenarios are adding value to the business, we identified that we could utilise them in other internal processes where scenarios are used.

Before making any decision on expenditure, we must be certain that the investment is necessary, and the preferred option is the one that realises the most overall benefit for the GB energy consumer and local communities. Our cost benefit analysis (CBA) allows us to do just that. We will be using our scenarios in addition to National Grid's Future Energy Scenarios when carrying out cost benefit analysis to assess different investment options.

Further analysis and engagement

There are two areas where further analysis will be required to identify the potential impact on the electricity network in the north of Scotland; hydrogen and electrification of rail.

In 2020, there was a succession of announcements with regards to hydrogen. In the UK Government's Ten Point Plan announcement, it set out an aim to develop 5GW of low carbon hydrogen production capacity by 2030. The Scottish Government in their update to the Climate Change Plan, outlined that £180 million would be made available for an Emerging Energy Technologies Fund which would support the development of hydrogen. Additionally, the Scottish Government detailed that they would be publishing a Hydrogen Action Plan in 2021.

For the electrification of the rail network, Transport Scotland outlined that Scotland's rail services would be decarbonised by 2035. A large extent of the rail network in the central belt of Scotland has been electrified. The remaining parts of the network that require to be electrified are in the Borders and in our area in the north of Scotland.

We will be carrying out research during 2021 in order to give us the required inputs to model the impact of hydrogen production and the electrification of the rail on our network. We will also be carrying out engagement with stakeholders, giving you the opportunity to provide information and input into the development of our North of Scotland Future Energy Scenarios.

Scottish & Southern Electricity Networks

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We want to hear from you

We welcome any comments and feedback on this document.

This document and future North of Scotland Energy Scenario documents will be hosted on:
www.ssen-transmission.co.uk/information-centre/industry-and-regulation/future-energy-scenarios

If you would like to get in touch with the team to ask questions, provide feedback and comments or take part in our engagement activities then please use the following contact methods:

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