Scottish & Southern Electricity Networks

TRANSMISSION

Getting to Net Zero

The critical contribution from electricity generated in the north of Scotland

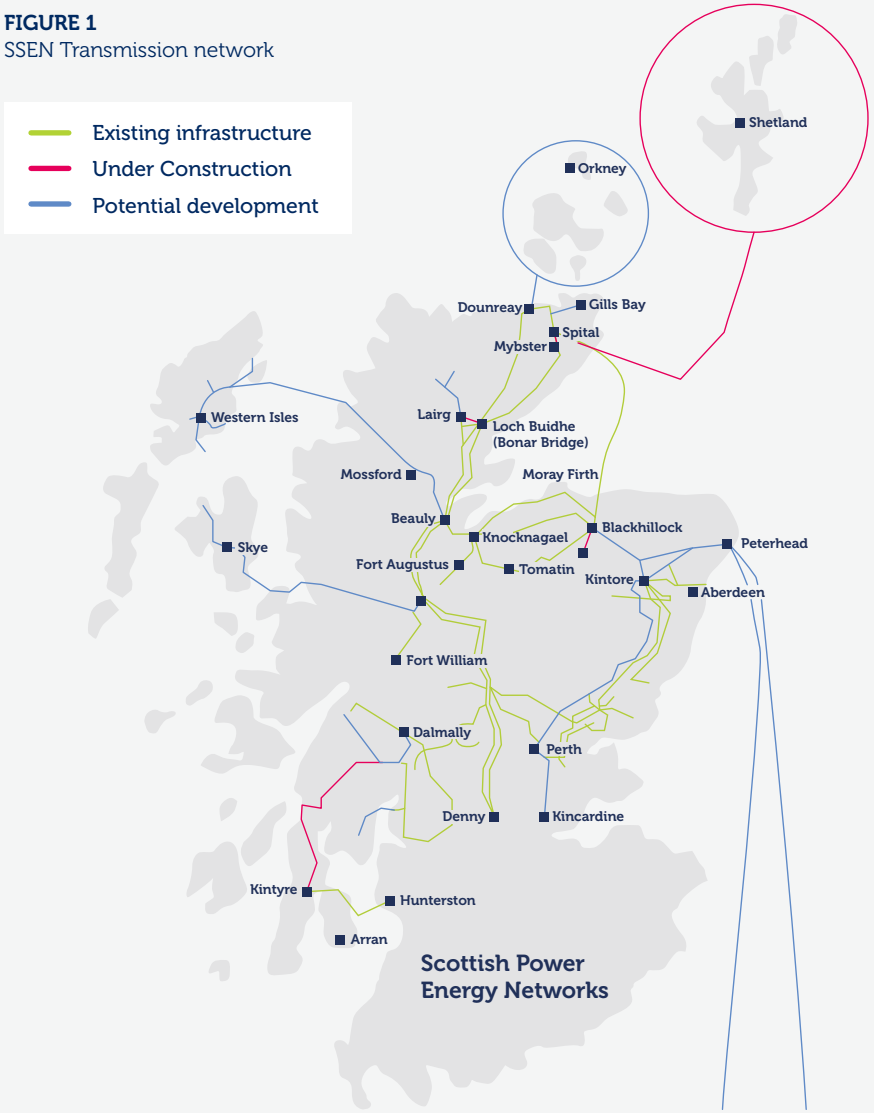
About us

Scottish Hydro Electric Transmission, operating under the name of Scottish and Southern Electricity Networks (SSEN), is responsible for the electricity transmission network in the north of Scotland (Figure 1).

As the Transmission Owner (TO), we maintain and invest in the high voltage 132kV, 220kV, 275kV and 400kV network of underground 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 take electricity from generators and transport it at high voltages over long distances through our transmission network for distribution to homes and businesses in villages and towns.

The north of Scotland is powered by wind and water. Over 80% of the connected generation capacity is renewable energy. This energy powers all of the homes and businesses in the north of Scotland, and around two-thirds is exported onwards to the rest of the UK. An important part of our role as the TO is to provide timely and cost-effective connections for renewable generators. Renewable power from the north of Scotland is critical to the national decarbonisation effort to achieve net zero greenhouse gas (GHG) emissions.

FIGURE 1
SSEN Transmission network



About this paper

Scotland is home to some of the UK's greatest resources of renewable energy. The north of Scotland is already a net exporter of clean, green energy and has huge potential to grow this export over the coming decades to contribute towards the UK Government's commitment to achieve a fully decarbonised electricity sector by 2035 and meet our national net zero targets.

This report assesses the potential contribution from the north of Scotland electricity sector in achieving net zero targets. The assessment primarily uses the Sixth Carbon Budget published by the UK Climate Change Committee (CCC) in December 2020 and SSEN Transmission's North of Scotland Future Energy Scenarios published in February 2021.

This pioneering analysis seeks to translate targets and pathways into a practical understanding of the role, contribution and significance of renewable electricity produced in the north of Scotland to our national net zero ambitions.

Foreword

Our job at SSEN Transmission is to transport large quantities of renewable electricity to where people need it. The abundance of wind and water mean the north of Scotland has a vital role in the UK achieving its net zero emissions targets.

To achieve our net zero ambitions, we must increase the generation of renewable energy to drive extensive electrification of heat and transport. This energy must be transported to homes and businesses and so our electricity networks have a critical role.

We have increased the renewable generation connected to our network in the north of Scotland by over 100%, from 3.4GW in 2013 to 7.8GW today, with a capital investment of £3.5 billion. Looking ahead, our analysis based on our North of Scotland Future Energy Scenarios 2020 figures shows that by 2050, the north of Scotland will need 33–35GW of clean, green renewable generation.

For the first time, this pioneering analysis quantifies that the north of Scotland electricity sector has the potential to contribute 10% of required emissions abatement for net zero. This clearly shows that the clean, green electricity produced in the north of Scotland is playing an outsized role in the effort to decarbonise our nation.

Rob McDonald
Managing Director, SSEN Transmission

A very large part of the reduction of the UK's greenhouse gas emissions to date has been achieved by changes in the way electricity is generated. In the coming years, the electricity sector needs to go much further in reducing the emissions intensity of production of energy at the same time as demand for electricity is expanded due to the electrification of much of our use of energy for heat and transport.

Nearly 20% of the wind generation capacity built and connected to the GB's transmission network by May 2021 lies in the north of Scotland with developers attracted by what are typically the UK's highest wind speeds. The region is currently also the site of more than 30% of the UK's hydro or pumped hydro capacity.

Massive investment in new low carbon generation capacity is going to be needed to meet the UK's future demand for low carbon energy. The geography of the north of Scotland means that investors in renewable generation will seek to build a significant part of it there. If the people filling jobs for construction, commissioning and operation live in the region and developments are sensitive to the natural environment, significant local benefits can be expected. However, utilisation of the available energy also depends on appropriate network capacity. As shown by the assessment reported in this paper, if that, too, can be delivered the region will be playing a huge part in meeting both the UK's and Scotland's net zero goals.

Professor Keith Bell
University of Strathclyde

The north of Scotland's role in powering net zero

The north of Scotland plays a vital and outsized role in the UK's net zero journey to address climate change.

What is net zero?

Net zero =
CO_2 produced — CO_2 removed from the atmosphere

Carbon emissions (CO_2) from fossil fuels are threatening our planet.

To resolve this, the UK has set a target to achieve net zero carbon emissions by 2050.

The UK needs to **replace fossil fuels** and reduce CO_2 by using renewable energy.

The north of Scotland is home to some of the UK's greatest resources of wind and water.

The region produces and exports low carbon electricity, and is home to **just 2% of the UK population.**

How does SSEN Transmission contribute to a net zero future?

We transport this low carbon electricity to meet the UK's demand sustainably.

This low carbon energy replaces existing fossil fuels and enables these sectors to decarbonise:

- Surface transport
- Residential buildings
- Fuel supply
- Manufacturing and construction
- Non-residential buildings

Low carbon electricity from the north of Scotland is creating a cleaner and greener future.

Our study shows that by 2031 and 2050, we will enable even more low carbon electricity and CO_2 removal.

Getting to net zero

Purpose of this analysis

Surveys show that there is increasing public awareness and concern about climate change and the importance of national net zero targets.

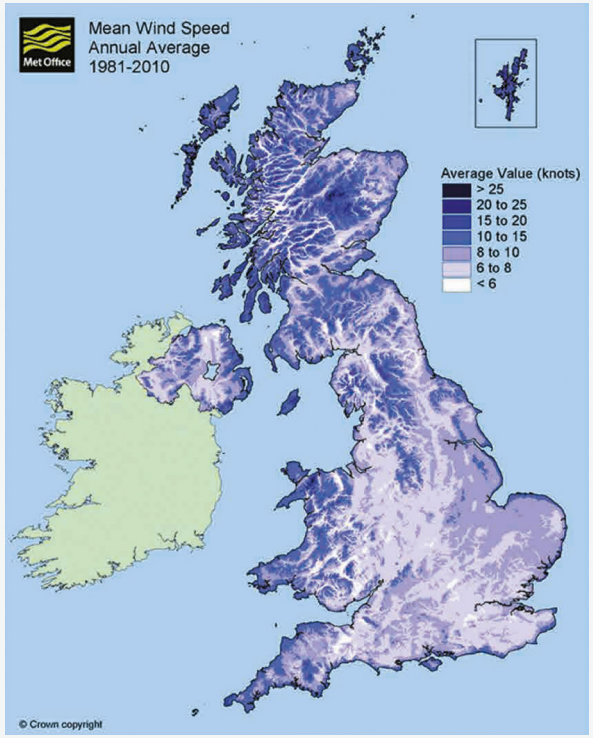
However, there is less understanding of how net zero can be achieved. Electrification will be critical to achieving net zero, as transport and buildings decarbonise.

This analysis explores the practical questions of how much electricity is needed and where that electricity will be produced. Specifically, we explore the role of the north of Scotland electricity sector.

Renewable resource in the north of Scotland

The north of Scotland is home to some of the UK's greatest resources of renewable power from wind and water (Figure 2). This is particularly evident in the case of onshore and offshore wind, where increased wind resource results in higher load factors thus increasing the level of electricity generated.

FIGURE 2
UK average wind speed



Source: Where are the windiest parts of the UK? – Met Office

Net zero pathways

In 2019, the UK Government was the first major economy to put a net zero commitment into law. The UK has set a target to bring all GHG emissions to net zero by 2050. The Scottish Government has also legislated for a net zero target by 2045.

The UK has made significant progress in reducing emissions since 1990, largely due to the power sector switching from fossil fuels to renewable energy. Looking towards 2050, the UK is expected to grow its demand for electricity as it becomes the dominant energy source.

In November 2020, the UK Government published its 'Ten Point Plan for a Green Industrial Revolution', which sets out its commitments to tackling GHG emissions. Following on from this publication, the UK Government published the 'Energy White paper: Powering our net zero future', which outlines its policy ambitions for the energy sector to deliver net zero by 2050. More recently, the UK Government published a comprehensive Net Zero Strategy which sets out the policies and proposals for decarbonising all sectors of the UK economy to meet the 2050 net zero target.

The UK CCC is the independent statutory body that advises the UK and devolved governments on emissions targets and reports on progress made in reducing GHG emissions. Its Sixth Carbon Budget sets out the important role of electrification in decarbonising sectors such as transport and buildings. The CCC estimates that around 57% of required emissions reduction by 2050 could be achieved through electrification. The remaining 43% relies on further action, such as utilising land for tree planting, producing low carbon fuels and developing carbon capture, utilisation and storage (CCUS) technologies.

Key data sources

Sixth Carbon Budget

The UK's pathway to net zero is mapped out in the CCC's Sixth Carbon Budget in the form of five ambitious scenarios.

These scenarios define the actions required in each sector every year to reduce UK emissions to net zero by 2050 at the latest. The detailed scenarios explore uncertainties around how far consumers will change their behaviours, how quickly technology will develop, and the balance between options where credible alternatives exist.

The Balanced Pathway is the basis for the recommended Sixth Carbon Budget and the UK's Nationally Determined Contribution (NDC) for 2030 as required under the Paris climate agreement. While it is not a prescriptive path, it provides a good indication of what should be done over the coming years.

Meeting the Sixth Carbon Budget will require action across four key areas:

Reducing demand for carbon-intensive activities through improved energy efficiency.

Adopting low carbon solutions such as electric vehicles (EVs).

Expanding low carbon energy supplies, including electricity and hydrogen.

Transforming the UK's land by increasing woodland cover.

Future Energy Scenarios

Scenarios are an important business planning tool that present alternative views of the future. For electricity networks, scenarios focus on the potential future use of the network.

National Grid, in its role as the UK Electricity System Operator, develops Future Energy Scenarios (ESO FES). SSEN Transmission's North of Scotland Future Energy Scenarios provide a regional view for the north of Scotland that builds upon the national, political, economic and technological possibilities explored by the ESO FES.

North of Scotland Future Energy Scenarios 2021

The North of Scotland Future Energy Scenarios 2021 set out the view of a range of potential generation and demand scenarios in the SSEN Transmission network area from now out until 2050 (Figure 3).

There are three scenarios, two of which would lead us on a pathway to net zero and so are used in this study:

The Green Economy: Consumers and businesses engage with the energy sector at local levels while supportive policy increases the use of renewables, electric heating and hydrogen, providing a focused decarbonisation pathway.

The Green Society: Consumers and businesses engage directly with the energy industry while investing in micro-generation, EVs and renewable heating technologies, all of which allow them to contribute to achieving net zero carbon emissions.

By 2050, the north of Scotland could provide 33–35GW of clean, green renewable capacity based on this assessment of net zero pathways. For context, 7.8GW of renewable generation is currently connected in the north of Scotland.

Relative to 2019 figures, electricity demand is expected to increase by up to 71% by 2050, as electrification of transport and heat grows to support net zero targets.

FIGURE 3
Annual installed capacity of low carbon generation connected to SSEN Transmission's network area[1]

[1]Based on NoS FES 2020 figures. ESO FES2021 figures are equivalent to 40-48.5 GW in 2050.

Methodology

This study used two publicly available data sources: the CCC Sixth Carbon Budget and SSEN Transmission's North of Scotland Future Energy Scenarios (NoS FES).

The Balanced Pathway scenario of GHG emissions abatement from the Sixth Carbon Budget was used. The CCC describe the Balanced Pathway as being "a good indication of what should be done over the coming years". The Balanced Pathway is based on insights from the other Carbon Budget scenarios and therefore acts as the guiding pathway to net zero. Generation and demand data were taken from the two net zero scenarios in the NoS FES.

The following three-step methodology was applied to assess the north of Scotland's electricity sector's contribution to achieving net zero targets:

Step 1:
Contribution to UK electricity demand

The NoS FES installed generation capacity (MW) was converted into electricity output (MWh) for each year to 2050. This conversion was technology specific (eg onshore wind) and used load factor data from the ESO.

The electricity output (MWh) was then compared with the total UK electricity demand in the Sixth Carbon Budget's Balanced Pathway – and so the north of Scotland's contribution to that total UK demand could be calculated.

Step 2:
Contribution to electrification of other sectors

GHG emissions reductions achieved through electrification of individual sectors were determined using data from the Sixth Carbon Budget.

Using the outcome of Step 1, the proportion of electricity output produced in the north of Scotland was applied to the GHG emissions reductions in each sector.

Step 3:
Overall contribution to net zero targets

The GHG emissions reduction from the electricity output in the north of Scotland from electricity supply [Step 2] was compared against the total GHG emissions reduction required to meet net zero in the Balanced Pathway.

This determined the overall contribution of the north of Scotland electricity generated to the UK net zero target.

All results have been calculated for each year out to 2050; however, in this paper the findings are presented for years 2031 and 2050 only.

Step 1: Contribution to UK electricity demand

Sixth Carbon Budget – UK electricity demand in the Balanced Pathway

The CCC's Balanced Pathway from the Sixth Carbon Budget estimates UK low carbon electricity demand to be around 612TWh in 2050, compared to around 200TWh of low carbon electricity produced today (Figure 4).

To understand the potential contribution that electricity produced in the north of Scotland could make towards meeting this demand, we used the projected electricity generated in the NoS FES (Figure 5).

FIGURE 4
Projected low carbon electricity demand in the UK (under the CCC's Balanced Pathway) and the north of Scotland alone

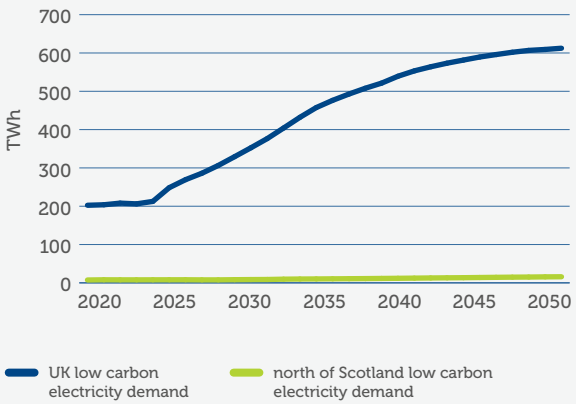
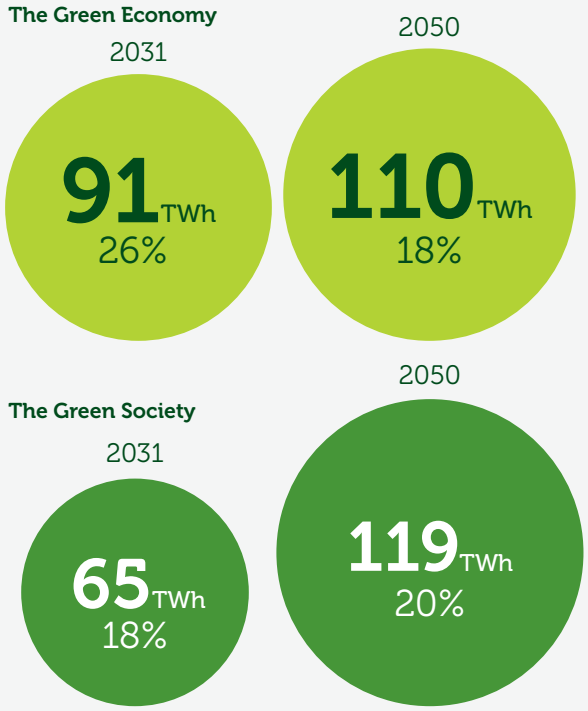


FIGURE 5
The contribution of electricity generated in the north of Scotland to the total UK electricity demand



Electricity generated in the north of Scotland contribution to UK electricity demand

Results from this analysis show that electricity generated in the north of Scotland has the potential to contribute:

- **65–91TWh by 2031**, equating to a contribution in the range of **18–26% of total UK electricity demand**.
- **110–119TWh by 2050**, equating to a contribution in the range of **18–20% of total UK electricity demand**.

The analysis shows that this growth in electricity output in the north of Scotland is predominantly due to the connection of new onshore and offshore wind farms, with smaller but significant contributions made by solar, hydro, and CCUS.

Step 2: Contribution to electrification of other sectors

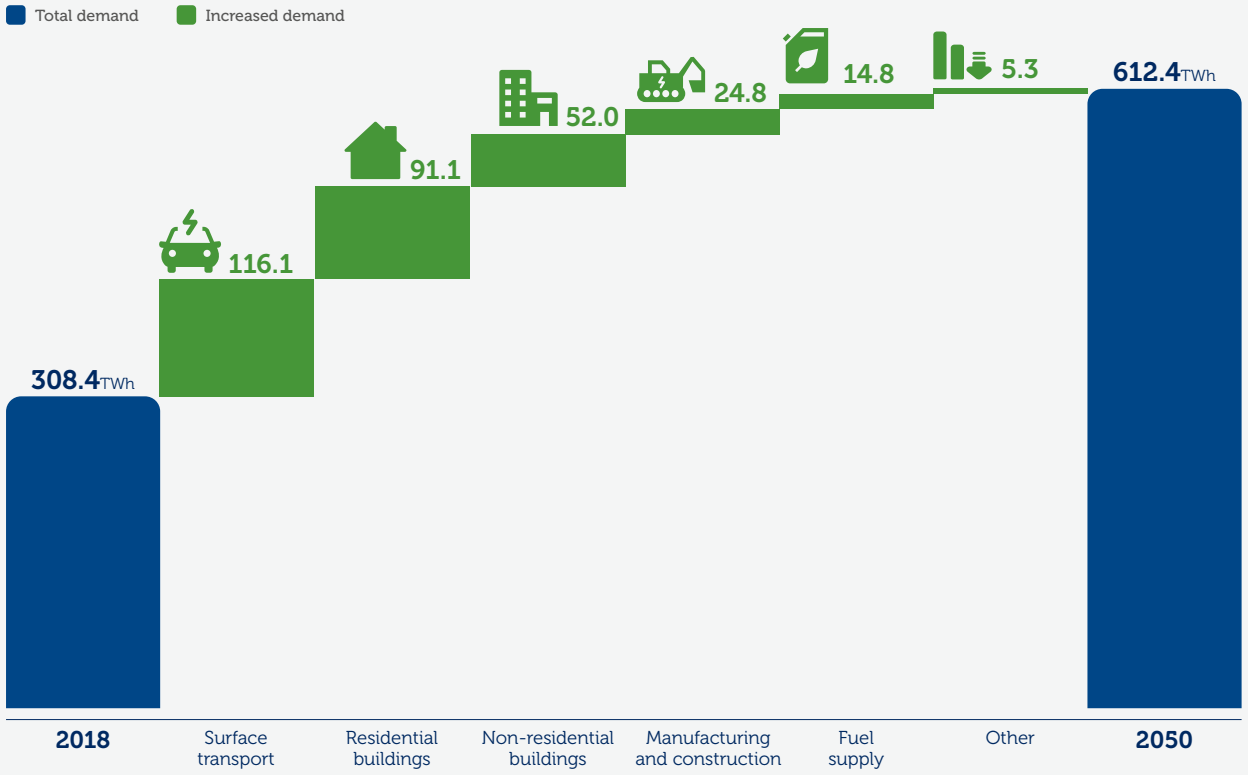
Sixth Carbon Budget – role of electrification in the Balanced Pathway

The CCC's Sixth Carbon Budget report shows how different sectors are expected to contribute to increased electricity demand in the Balanced Pathway (Figure 6).

The electrification of surface transport and heating in residential buildings are both expected to be the primary contributors to this increased demand.

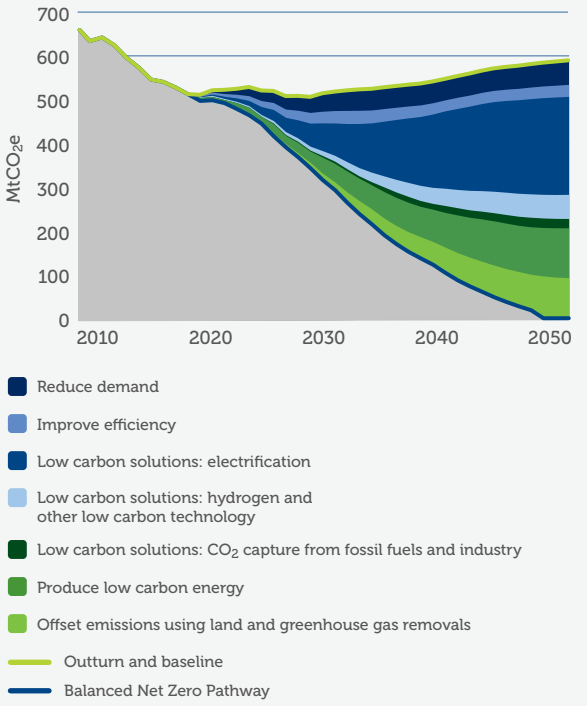
The uptake of electrification across these sectors is expected to drive a reduction in GHG emissions across the UK (Figure 7).

FIGURE 6
The increase in total electricity demand across all sectors by 2050 (from a 2018 base level) where each sector is represented by a segment of the waterfall diagram



Source: CCC analysis

FIGURE 7
The types of emissions reduction required to achieve net zero by 2050 with each coloured section corresponding to the respective areas below



Source: BEIS (2020) Provisional UK greenhouse gas emissions national statistics 2019, CCC analysis

The contribution of electricity generated in the north of Scotland to electrification of other sectors

Using the analysis of the north of Scotland's contribution to increased UK electricity demand from Step 1, we can calculate the reduction in GHG emissions (megatonnes of CO_2 equivalent, $MtCO_2e$) resulting from the electrification of other sectors using electricity produced in the north of Scotland (Figure 8).

Results from this analysis indicate that electricity generated in the north of Scotland has the potential to achieve the following carbon reductions:

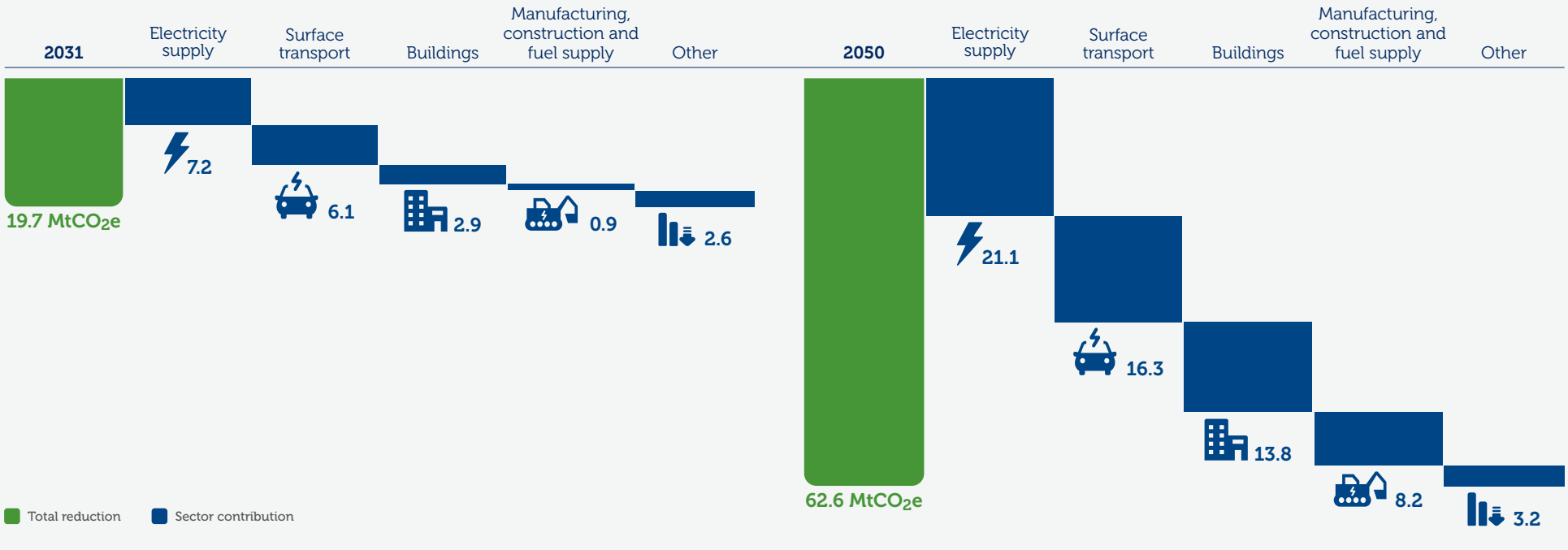
- **20–28 $MtCO_2e$ by 2031**
- **58–63 $MtCO_2e$ by 2050**

In 2050, the key components of the carbon reduction enabled by the electricity generated in the north of Scotland are summarised as follows:

- **Electricity supply: c.21 $MtCO_2e$**
- **Transport sector: c.16 $MtCO_2e$**
- **Buildings sector: c.14 $MtCO_2e$**

Further reductions are enabled, albeit on a smaller scale, in manufacturing and construction, fuel supply and carbon removals. Hydrogen production through electrolysis is also expected to play a role in increased electricity demand, and we are currently undertaking further analysis to incorporate this into our NoS FES – we will update this study once the analysis is complete.

FIGURE 8
The emissions reduction resulting from low carbon electricity connected in the north of Scotland. In addition to the decarbonisation of the electricity supply this also includes emissions reductions in other sectors which are powered through electrification.



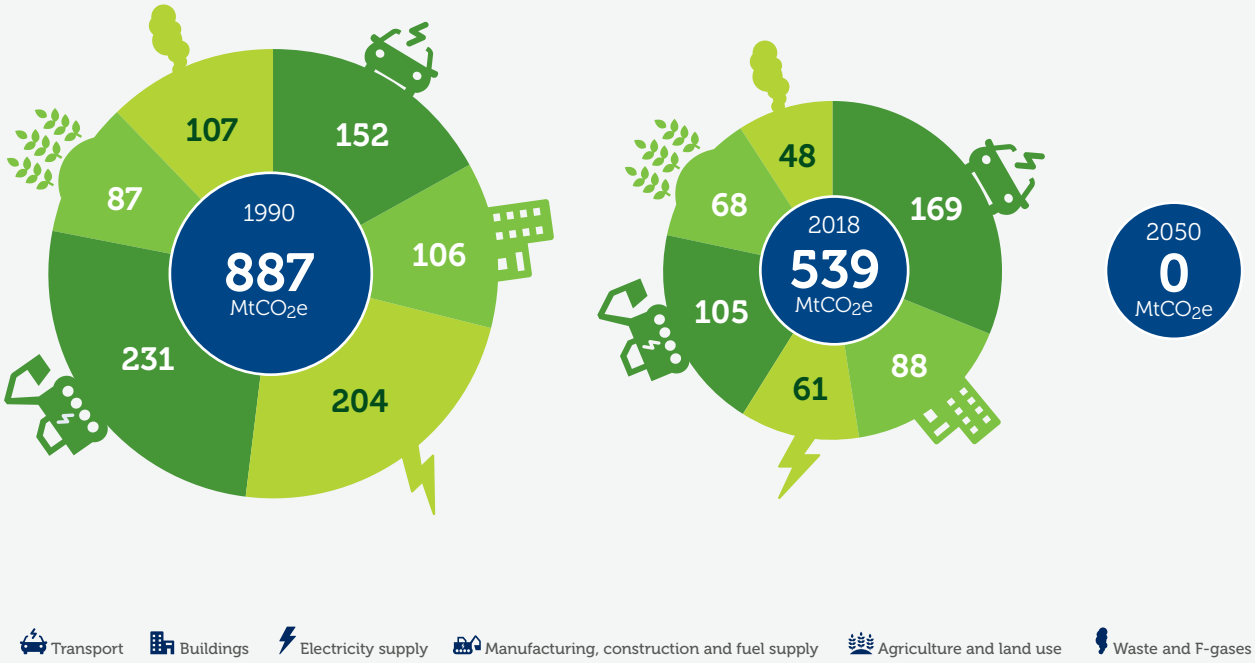
Step 3: Overall contribution to net zero targets

Sixth Carbon Budget – pathway to meet net zero

To reach the UK's net zero target by 2050, GHG emissions across all sectors need to fall to net zero from a 539 $MtCO_2e$ baseline in 2018 (Figure 9).

Significant emissions reductions have already been made in the electricity sector from 1990 to 2018, with further reductions required in other sectors to reach net zero.

FIGURE 9
Emissions reductions required across each sector to achieve net zero in 2050 from a 1990 and 2018 baseline



Source: BEIS (2020) Provisional UK greenhouse gas emissions national statistics 2019, CCC analysis

The contribution of electricity generated in the north of Scotland to net zero

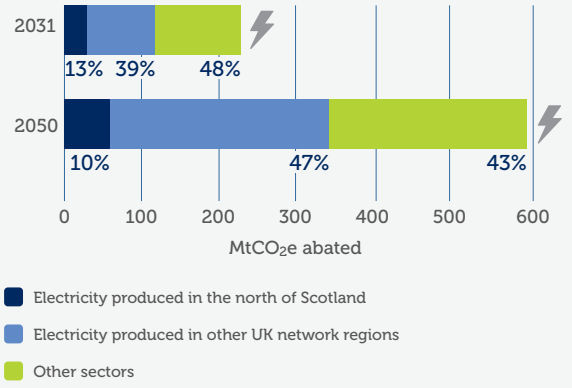
Through analysis of the north of Scotland's contribution to meeting UK electricity demand and the resulting emissions reduction this will enable across different sectors in Steps 2 and 3, we can then quantify the overall contribution electricity generated in the north of Scotland will make to achieving the UK's net zero target.

This is summarised as follows:

- **20–28 $MtCO_2e$ by 2031**, which equates to a **9–13% contribution towards the emissions reduction required for UK net zero targets**.
- **58–63 $MtCO_2e$ by 2050**, which equates to a **10–11% contribution towards UK net zero targets**.

Figure 10 shows how electricity generation connected in the north of Scotland compares to electricity generation connected in other UK network regions, as well as other sources of decarbonisation outside the electricity sector.

FIGURE 10
The contribution of low carbon electricity generation connected in the north of Scotland to the total emissions reduction required for net zero.



Implications of our analysis

"UK commits to decarbonise electricity system by 2035"

Department for Business, Energy & Industrial Strategy

The electricity sector has led the way in the national ambition to reduce GHG emissions and tackle climate change with emissions from electricity generation reduced by two-thirds over the past decade. Looking to the future, abatement of emissions from heat and transport relies, in large part, on a successful – and speedy – transition from fossil fuels to electricity.

Our analysis explores the practical question of the extent to which the north of Scotland, with its vast resources of wind and water, will contribute to increasing UK electricity demand under net zero pathways.

The findings are compelling:

- Up to 20% of UK electricity demand in 2050 could be met by power generated in the north of Scotland.
- Around 10% of the GHG emissions abatement by 2050 could be achieved through low carbon technologies powered by electricity generated in the north of Scotland.

Practically, these outcomes will require significant growth in renewable generation capacity in the north of Scotland over the coming 15 years. Our analysis indicates that the pace of growth would slow thereafter.

These findings incorporate changes in the energy system at a local level, including flexible, smart systems and increased deployment of small-scale generation and storage. The full deployment of such smart systems is essential to keeping down the cost of the energy transition to meet net zero.

As the owner and operator of the electricity transmission system in the north of Scotland, we highlight three key implications from this analysis:

1. There is high confidence in the net zero pathways and the ability of the electricity sector to deliver

- Given this, we strongly argue for a national strategic plan that sets out the necessary investment in the UK transmission system to achieve a fully decarbonised electricity sector by 2035

2. Timely investment in the electricity network infrastructure that connects renewable generation to homes and businesses is critical to success

- Investment decisions in the transmission system should demonstrably align with net zero pathways, with heavy weighting given to enabling full decarbonisation of the sector by 2035

3. As our reliance on electricity increases, the resilience of the electricity system must be strengthened

- Electricity infrastructure owners and operators should have a clear duty to ensure resilience, including timely adaption to the effects of climate change

The energy sector in north of Scotland has a disproportionate role in contributing to the national effort to tackle climate change. By working together, with focus, we can achieve net zero.


Scottish & Southern
Electricity Networks
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