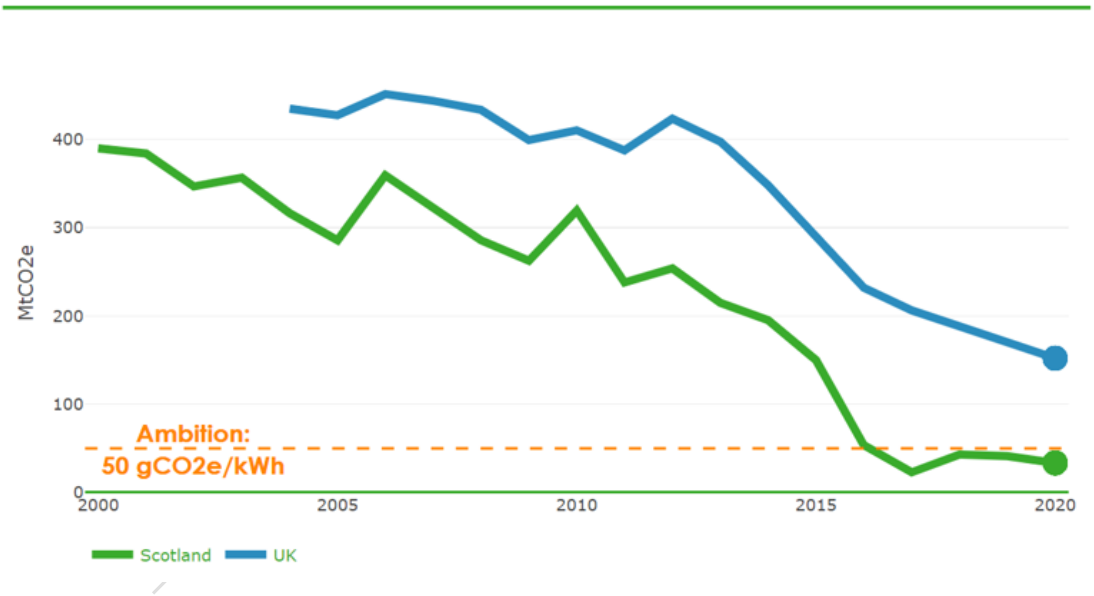
Energy supply, decarbonisation and potential costs

This paper sets out the progress to date and strategy for continued decarbonisation of Scotland's energy supply, the ability of supply to meet demand, and gives some projected costs of refuelling HGVs with electricity, hydrogen and diesel.

Introduction

Scotland has made world leading progress in decarbonising its energy supply with greenhouse gas emissions from this sector reducing by 75.2% from 1990 to 2020.[1] This is due to the closure of carbon intensive coal fired power stations and the increased use of renewable power.

Figure 1: Average greenhouse gas emissions per kilowatt hours of electricity, Scotland 2000-2020.[2]



The Updated Climate Change Plan (2020) set out over 100 new policies and proposals to achieve 75% reduction in greenhouse gas emissions across Scotland's economy by 2030, a 90% reduction in greenhouse gas emissions by 2040 and Net Zero by 2045.

Scotland's climate change targets mean that Scotland needs to continue its progress, and move from a low to a zero carbon electricity system. There is also a need to address the substantial challenges of maintaining security of supply and a resilient electricity system. Operating a zero carbon electricity system will mean finding new ways to provide a range of technical services and qualities currently

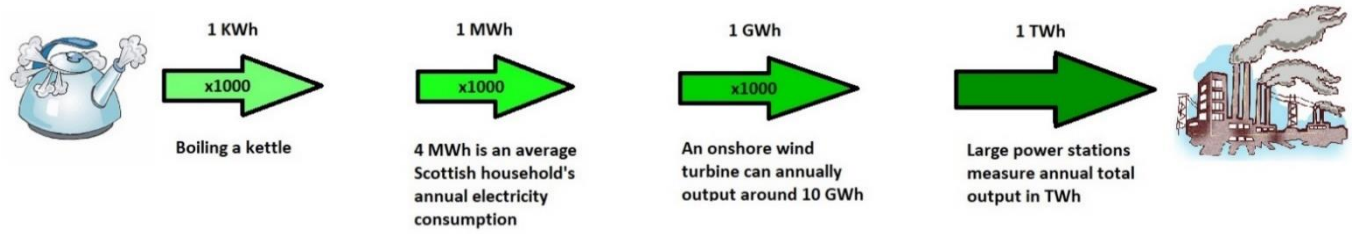
[1] scottish-greenhouse-gas-statistics-2020.pdf page 3.
[2] Scottish Energy Statistics Hub (shinyapps.io)

provided by fossil fuel and nuclear generation.

Electricity

In 2021, 27.2 TWh of renewable electricity was generated in Scotland, the equivalent of powering all households in Scotland for almost three years.[3] There is currently around 12 GigaWatts (GW) of renewable generation capacity installed across Scotland[4] and offshore wind capacity could grow that capacity by between 8-11 GW by 2030.[5]

Figure 2: A brief explanation of power terminology



Scotland is a net electricity exporter with electricity transmission cables linking Scotland with England, Wales and Northern Ireland. These cables allow electricity to flow bi-directionally but in the main they operate to export power from Scotland.
In 2021, Scotland's net export of electricity was 16.0 TWh. The value of Scotland's electricity exports had an estimated wholesale market value of £2.4 billion, which is more than three times the estimated wholesale market value of electricity exports in 2020. This is due to large increases in the average price of electricity in 2021, particularly in the latter half of the year.[6]

Hydrogen

There are three main methods of hydrogen production:

- **Grey Hydrogen:** is produced from the reforming of natural gas (steam methane reforming). This produces both hydrogen and carbon emissions.
- **Blue Hydrogen:** made the same as grey hydrogen but aligned with Carbon Capture and Storage to capture most of the emissions and store them (in depleted oil fields for example).
- **Green Hydrogen:** produced from electrolysis of water (splitting water into its parts – hydrogen and oxygen). When renewable electricity is used to do this the process is zero emission.[7]

Producing hydrogen, particularly green hydrogen, and using it to meet energy demand, will play an important part of the next stage of the energy transition.

[3] Scotland+Energy+Stats+Q4+2021.pdf (www.gov.scot)
[4] update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero (8).pdf
[5] Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update - gov.scot (www.gov.scot)
[6] Scotland+Energy+Stats+Q4+2021.pdf (www.gov.scot)
[7] Scottish Government Hydrogen Policy Statement - gov.scot (www.gov.scot)

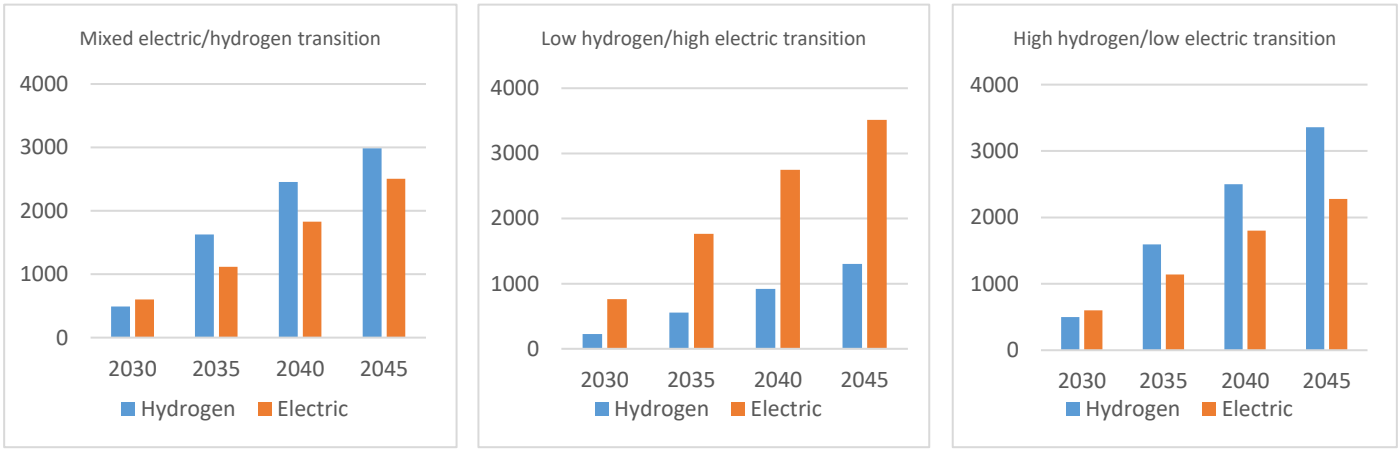
With an estimated 25% of Europe's offshore wind capacity (in addition to resources for Grey and Blue hydrogen) Scotland has many of the key natural resources to grow a strong hydrogen economy and is committed to positioning itself as a global leader in hydrogen technology. Further detail on Scotland's commitments can be found in the accompanying Hydrogen in Scotland Paper.

Estimated Energy Usage of a Future Decarbonised Truck Fleet

The zero emission truck market is at an early stage of development and there remains some uncertainty around the technology mix for the decarbonisation of HGVs. The Zero Emission Energy for Transport study[8] produced a forecast range of potential electricity and hydrogen demand from trucks, using information on costs, efficiencies and expected roll-out trajectories for zero-emission trucks in Scotland.

Depending on the relative level of investment in electric vs hydrogen trucks in the earlier years (over the next decade), the forecast energy demand from the Scottish zero-emission truck fleet varies according to the charts presented in Figure 3 below.

Figure 3: Forecast energy demand (GWh) from electric and hydrogen trucks, 2030-2045.[9]



Refuelling costs

UK Government forecasts (May 2022) suggest a fall in electricity prices of around 9% and an increase in diesel fuel costs of 24% between 2022 and 2035.[10] However, given the ongoing energy crisis and significant volatility in fuel prices, it is extremely challenging to predict future fuel prices, and the long-term outlook may change once the impacts of current events affecting energy supply and prices are better understood. Costs for hydrogen are also very challenging to project and have a much wider range of uncertainty.

Analysis prepared for the Committee on Climate Change in 2020 estimated that, for Large Rigid trucks, refuelling with hydrogen is likely to become cheaper than with diesel by 2035. Fuel costs for pure battery electric trucks are estimated to be consistently lower than for diesel equivalents.

[8] Zero Emission Energy for Transport Forecasts: National | Transport Scotland
[9] Zero Emission Energy for Transport Report
[10] TAG Data Book (May 2022) – Fuel and electricity price forecasts

Figure 4 shows the expected trajectory of refuelling costs for diesel and zero emission trucks between 2020 and 2050. However, this analysis was undertaken prior to recent fluctuations in fuel and electricity prices, and so it could be expected that the trajectories for refuelling costs will have changed to some extent.

Figure 4: Comparison of lifetime fuel costs for ZE and diesel Large Rigids by year of purchase (6-year 1st owner lifetime and 53,000km/y assumed)