POLICY BRIEFING

December 2020

scottish renewables

The Sixth Carbon Budget-The UK's path to Net Zero

This Policy Briefing provides summary information on the Climate Change Committee (CCC) reports, **The Sixth Carbon Budget: The UK Path to Net Zero** and **Policies for the Sixth Carbon Budget Net Zero[1],** which set out the actions that UK will need to take to achieve net zero emissions by 2050. This brief focuses on topics that are of interest for Scottish Renewables. This includes key policy messages for the renewable energy sector, a scenario analysis to achieve net zero, the electricity generation in those scenarios and the emissions pathways for Scotland.

POLICY MESSAGES

Electricity generation

- **Fully decarbonise electricity generation by 2035, while meeting a 50% increase in demand, through:**
  - Delivering 485 TWh of low -carbon generation by 2035 and deploying variable renewables at scale with:
    - Offshore wind expected to be 40 GW by 2030 and between 65 GW and 140 GW by 2050.
    - Onshore wind almost doubling in capacity to 25-30 GW by 2050.
  - Deploying at least 50 TWh of dispatchable and flexible generation (e.g. gas with CCS, hydrogen) by 2035 that can balance a system driven by renewables with low emissions.
  - An increasingly flexible system, including from demand-side response (with 20% of demand being flexible in 2035), storage, hydrogen production, and interconnection.

- **Develop and implement plans to overcome barriers to deployment, including through:**
  - Developing a holistic deployment strategy and planning and consenting regime for offshore wind.
  - Contracting models for nuclear, gas with CCS, and bioenergy with carbon capture and storage (BECCS) that provide predictable revenue streams.

- **Ensure networks are ready to accommodate new generation technologies and new demands, by:**
  - Delivering plans to ensure investment in networks can accommodate future demand levels in coordination with Ofgem.
  - Developing a strategy to coordinate interconnectors and offshore networks for wind farms and their connections to the onshore network, bringing forward legislation necessary to enable that.
  - An increasingly flexible system, including from demand-side response (with 20% of demand being flexible in 2035), storage, hydrogen production, and interconnection.
  - Investment in sufficient decarbonised dispatchable low-carbon capacity (including storage) to ensure security of supply.

- **By the end of 2021 the Government should commit to phasing-out unabated gas generation by 2035,** subject to ensuring security of supply. The Government should publish a comprehensive long-term strategy for unabated gas phase-out and ensure new gas plant are properly CCS, and/or hydrogen-ready, by 2025 at the latest.

- **In the 2020s the Government should ensure unabated gas generation faces a carbon price consistent with it being phased-out by 2035, and incentivise initial deployment of low-carbon alternatives**.

- **An evolutionary approach is appropriate in the short-to medium term**. 2040s: Running a fully decarbonised electricity system, with variability in renewable generation managed through flexible demand, medium- and long-term storage, and use of dispatchable low-carbon generation.

- **The Government should develop a coherent vision for a net zero electricity system by:** developing a clear long-term strategy as soon as possible on market design for a fully decarbonised electricity system; the government should continue using of long-term contracts as an appropriate investment mechanism; and focusing on developing the market for gas with CCS and hydrogen, strongly deploying low -carbon generation, and phasing-out unabated gas.

Hydrogen strategy

- The government should focus hydrogen demand on areas where that cannot feasibly decarbonise without it. Pursue proven solutions (e.g. electrification) in the 2020s, in parallel with developing hydrogen. Set out vision for contributions of hydrogen production from different routes to 2035.

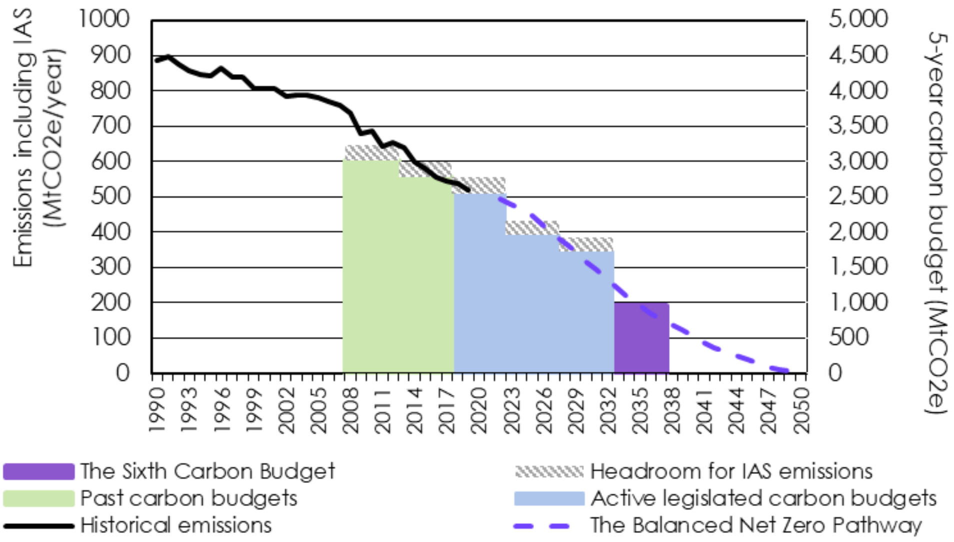
Heat and buildings strategy

- Produce a robust and ambitious heat strategy which sets the direction for the next decade, with clear signals on the phase out of fossil heating and commitments to funding. This must include a clear set of standards; plans to rebalance policy costs while making low-carbon more financially attractive; plans to introduce green building passports, and a role for area-based energy plans.

1 Introduction

The Sixth Carbon Budget sets out what actions the UK will need to take to achieve net zero emissions by 2050. The CCC's recommended pathway requires a 78% reduction in UK territorial emissions by 2035, and a 63% reduction from 2019. This early action is considered vital to support the required increase in global ambition, especially ahead of the UK hosting the COP26.

Figure 1: The recommended Sixth Carbon budget



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

Meeting the recommended budget will require a major nationwide investment. However, it was found that the net costs of the transition (including upfront investment, ongoing running costs and costs of financing) will be less than 1% of GDP over the entirety of 2020-2050.

Achieving the net zero will require building new infrastructure to support both the high levels of electrification needed and the large offshore wind capacity promised. The CCC report analyses 5 different scenarios to achieve net zero, each one with different levels of electricity demand by 2050. However, decarbonisation is similar across all scenarios over the 2020s, with variable renewables reaching 65-70% of electricity generation in 2030.

2 Scenario analysis to address the path for Net Zero

In the 2019 net zero emissions report to parliament the CCC developed a Further Ambition scenario that aimed to reduce the emission by 96% in 2050. In the report is stated that the 4% remaining could be achieved via other options such as additional engineering removals, further innovation and behaviour change, but for the purposes of costing the scenario the CCC assumed achieving the remaining 4% via emissions removals at £300/tCO_2, making them one of the most expensive emissions reduction options in all the scenarios.

The analysis has key differences between this and last year's Further Ambition scenario. This includes behavioural changes, lower residual emissions in several sectors, lower use of fossil fuels and higher levels of peatland restoration and tree-planting. For this, the CCC constructed 3 exploratory scenarios to reach net zero by 2050, one of which is similar to Further Ambition, the other two are more optimistic either regarding behavioural change or improvements in technology costs.

1. **Headwinds scenario**: Similar to the Further Ambition scenario of 2019. In this scenario people change their behaviour and new technologies develop, but we do not see widespread behavioural

shifts or innovations that significantly reduce the cost of green technologies ahead of the CCC current projections. This scenario is more reliant on the use of large hydrogen and carbon capture and storage (CCS) infrastructure to achieve net zero. This scenario considers 80% of renewable generation and capacity, 125 GW of wind and 85 GW of solar.

2. **Widespread Engagement scenario**: In this scenario the CCC assumes higher levels of societal and behavioural changes. People and businesses are willing to make more changes to their behaviour. This reduces demand for the most high-carbon activities and increases the uptake of some climate mitigation measures. Assumptions on cost reductions are similar to Headwinds. This scenario considers 85% of renewable generation and capacity, 130 GW of wind and 80 GW of solar.

3. **Widespread Innovation scenario:** The CCC assumes greater success in reducing costs of low-carbon technologies. This allows more widespread electrification, a more resource- and energy-efficient economy, and more cost-effective technologies to remove CO_2 from the atmosphere. Assumed societal/behavioural changes are similar to Headwinds. This scenario considers 90% of renewable generation and capacity, 175 GW of wind and 90 GW of solar.

The CCC also, constructed an exploratory scenario named Balanced Net Zero Pathway, as a further scenario that reaches net zero by 2050. It was designed to drive progress through the 2020s, while creating options in a way that seeks to keep the exploratory scenarios open.

4. **Balanced Net Zero Pathway scenario:** This scenario is informed by the range of solutions across the 'exploratory' scenarios, that would put the UK on track to net zero and would meet the recommended carbon budget. According to the CCC assessment this scenario is considered plausible and is the basis of the advice in this report. This scenario considers 80% renewable generation and capacity; 125 GW of wind and 85 GW of solar.

Finally, the CCC constructed another scenario named Tailwinds scenario that goes beyond the balanced pathway to achieve net zero before 2050:

5. **Tailwinds scenario:** This scenario assumes success of both innovation and societal/behavioural change and goes beyond the Balanced Pathway to achieve net zero before 2050. This scenario considers 90% renewable generation and capacity; 160 GW of wind and 75 GW of solar.

3 Electricity generation

3.1 The Balanced Net Zero Pathway for electricity generation

The Balanced Net Zero Pathway decarbonises electricity generation completely by 2035. The key features of the scenario are an increasing demand for electricity, decreasing carbon intensity of generation, and a more flexible system:

- **Increasing demand.** This will require increasing electrification of the economy. There is a doubling of demand, from around 300 TWh today to 360 TWh in 2030, 460 TWh in 2035, and 610 TWh in 2050. This excludes the production of hydrogen, which accounts for an additional 30 TWh.

- **Decreasing carbon intensity of electricity generation.** This will require:

  - **Phasing out unabated fossil fuel generation by 2035.** This means electricity generation will be completely low carbon by 2035.

- **Increasing variable renewables to 80% of generation by 2050.** This means that renewables reach 60% of generation by 2030, 70% by 2035, and 80% by 2050.
- Wind, particularly offshore, providing 265 TWh of generation in 2035 and 430 TWh in 2050. Which requires deploying 3 GW per year of new wind capacity, plus repowering of older sites as they reach the end of their (25-30 year) operating lives.
- Solar generation increases from 10 TWh in 2019 to 60 TWh in 2035 and 85 TWh in 2050. On average, 3 GW per year

- **Dispatchable low-carbon generation.** This includes **Gas with CCS,** which by 2030 is expected to produce 30 TWh of generation, meeting 6% of demand**. Bioenergy with carbon capture and storage (BECCS),** which by 2030 could provide 3% of generation. **Hydrogen**, which can provide a flexible form of dispatchable generation. By 2035, hydrogen gas plants could provide 20 TWh of generation, meeting 5% of demand.

- **Nuclear.** Despite retirements of existing nuclear plants in the 2020s, this scenario sees new nuclear projects restore generation to current levels by 2035.

- **A more flexible electricity system.** This will help to balance the variability of renewable generation. This should include:

  - **Storage** With an increasing share of variable renewables, storage can capture surplus energy when demand is low and provide backup generation when demand is particularly high.
    - The balanced pathway uses hydrogen as the primary source of storage.
    - Pumped hydro storage also offers dispatchable flexibility. This could provide an additional 7 GW to the current 3 GW installed [1]
    - Batteries which can provide within-day flexibility. The balanced pathway assumes 18 GW of battery storage by 2035.

  - **Flexible demand.** pre-heating and storage in buildings, and smart charging in transport can provide flexibility to the power system, by shifting electricity demand away from peak hours.

  - **Use of surplus electricity**. The Balanced Pathway has an important role for electrolysers to produce hydrogen at low cost from surplus generation. In the Balanced Pathway 25% of hydrogen supply comes from electrolysis in 2035, increasing to 45% by 2050

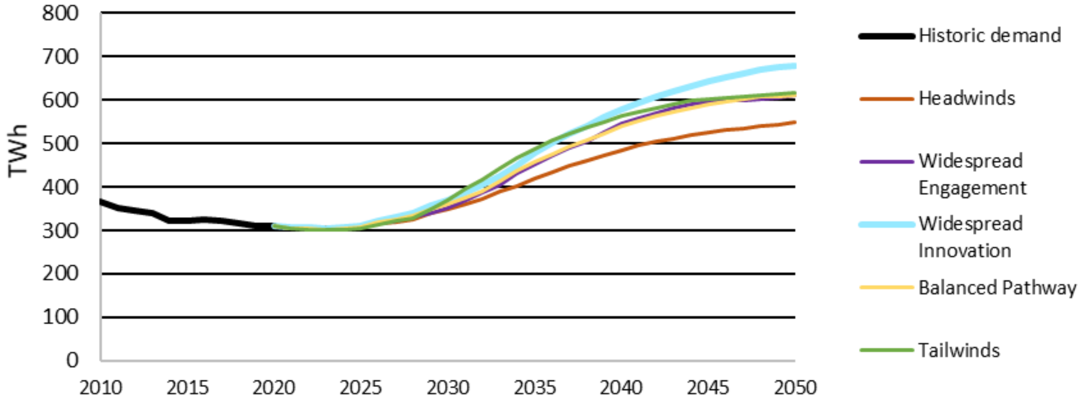
  - **Interconnectors**. Interconnections between the UK and neighbouring countries have a total current capacity of 6 GW. These allow the sale of surplus energy to neighbouring markets and provide access to resources in other countries. Under the Balanced Pathway interconnector capacity increases to 18 GW by 2050.

3.2 Alternative routes for delivering abatements in the mid-2030

In addition to the Balanced Pathway, the CCC report developed four exploratory scenarios for reaching net zero from electricity generation. Across the exploratory scenarios, electricity demand ranges from 350 to 370 TWh in 2030 and 550 to 680 TWh in 2050 compared to around 300 TWh today (see figure 2). The widespread innovation scenario is the one that will require more electricity by 2050. By contrast, the Headwinds scenario requires the lowest level of electricity compared to the rest of the scenarios by 2050.

[1] The deployment timeline of this 7 GW is not mentioned in the report. However, it could be assumed that it is expected to be by 2035 as the full electricity system is expected to be decarbonised by that time.

Figure 2: Electricity demand across the exploratory scenarios (2010-2050)



Source: BEIS (2020) Digest of UK Energy Strategy Statistics; CCC analysis

Onshore wind almost doubles capacity in all the scenarios modelled by 2050. This increases from 14 GW today to 25-30 GW by 2050.

Offshore wind is expected to be 40 GW by 2030 and at least 65 GW and up to 140 GW by 2050 in the Headwinds and Widespread Innovation scenario.

3.3. Challenges to deploying new renewable capacity

- **Offshore wind**
  Existing leasing is sufficient to meet the Government target of reaching 40 GW of offshore wind by 2030. This would require around 4,000 turbines of 10 MW, which would cover 5,700 to 8,000km^2 of the seabed, which represents less than 1%. Nonetheless, securing new seabed leases requires several years as projects need to do pre-development planning, consenting applications, and construction. Accordingly, the UK will need to hold new leasing rounds to provide clarity to developers.

  Supply chains will require long-term signals over capacity needs to provide a predictable environment to investors and developers. This includes certainty on offshore wind consenting and support mechanisms in order to avoid stop/start of supply chain investment. However, there could also be opportunities for UK supply chains to meet new demand for offshore wind capacity. A recent study suggests that 3,500 jobs could be created across the supply chain in the North East alone, if offshore wind were to be developed further.[2]

  Networks will need to be increasingly coordinated. To date, Offshore Transmission Owners (OFTOs), offshore wind developers and operators have taken responsibility for developing connections between offshore wind farms and the onshore network. The result has been a lack of coordination, as offshore wind farms planned connection routes independently. This represents a lost opportunity to optimise the existing network design, but it is also affecting coastal communities.

  Extensive activity in the seabed could lead to cumulative environmental impacts on birdlife and marine mammals. In addition to the environmental cost, this could lead to direct costs for developers, as compensation might be required.

[2] North East (2020) *Research study into the North East offshore wind supply chain*.

- **Onshore wind**
  With 14 GW, onshore wind currently takes up 2,700 km^2 of land. To deploy 30 GW of onshore wind could need an additional 3,300 km^2 of land[3]

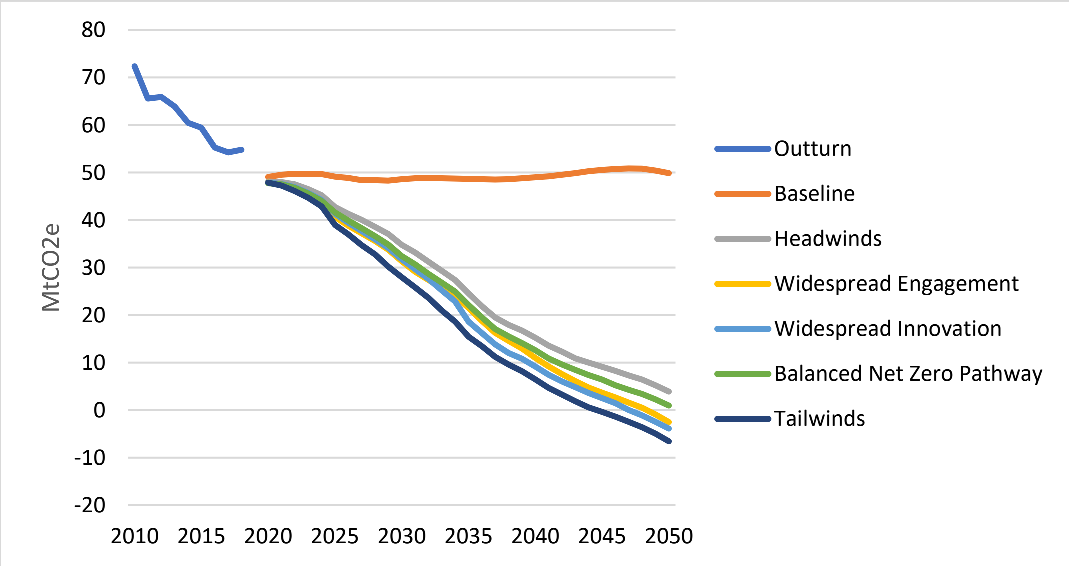
- **Solar**
  Large-scale solar currently has 13 GW installed capacity in the UK, which requires 290 km^2. Maximising the potential of solar generation might entail using an additional 1,500 km^2.[4]

4 Emissions pathway for Scotland

Today Scotland's emissions targets aim to reduce emission at least 75% by 2030, 90% by 2040 and 100% by 2045. However, according the scenario analysis introduced by the CCC, the 75% emissions reduction target will be difficult to meet. The CCC report analyses the emissions reduction in Scotland according the 5 scenarios mentioned previously. In none of these is Scotland able to achieve the 75% emissions reduction by 2030.

Despite of this, by 2050 Scotland meets the net zero target in most of the CCC scenarios (see figure 4), without considering greenhouse gas removals. The Balanced Pathway achieved 99% reduction by 2050 while the Tailwinds, Widespread Engagement and Widespread Innovation scenario achieves more than 100% reduction

Figure 3: Emissions pathways for Scotland without greenhouse removals



Source: CCC analysis

[1] https://www.theccc.org.uk/publication/sixth-carbon-budget/

[3] Assuming 5 MW/Km^2
[4] Assuming 45 MW/km^2.