Climate Change Committee

The UK's independent adviser on tackling climate change

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Dear Edwin,

I am writing in response to your request in February 2020 for advice relating to Northern Ireland's fair contribution to the UK Net Zero target and reductions by 2030, as well as additional correspondence with your officials. I am pleased to attach a copy of our latest report 'The UK's path to Net Zero'.

A fair contribution to the UK Net Zero target

In 2019, the Committee recommended that the UK set a target to reach Net Zero greenhouse gas emissions by 2050. Our advice at the time was that deep emissions in Northern Ireland are required as part of the fair contribution to that target, but that the fair contribution would, relative to 1990 levels, be around an 80% reduction in all greenhouse gases by 2050.

Now that we have conducted a comprehensive analysis of different pathways to reach Net Zero to underpin our advice on the UK Sixth Carbon Budget, we are in a position to provide further advice on the appropriate trajectory for emissions in Northern Ireland between now and 2050.

Achieving net-zero emissions for the whole UK by 2050 does not necessitate that every part of the UK (both geographical and sectoral) gets to zero emissions. Some parts of the UK will be 'net sources' of greenhouse gases by 2050 with emissions offset in other parts of the UK that are 'net sinks'.

As you will know, Northern Ireland is a significant net exporter of agri-food products with nearly 50% of all agri-food products produced in Northern Ireland consumed in the rest of the UK. It is therefore fair that, as well as taking the right actions to reduce emissions from agriculture, some of these emissions are offset by 'sinks' that are located elsewhere in the UK.

We have now completed a comprehensive analysis of pathways to reach Net Zero for the whole of the UK in the attached report. Our analysis suggests that Northern Ireland achieving Net Zero greenhouse gas emissions is not necessary for the UK to meet its climate targets.

Deep emissions reductions in Northern Ireland are still crucial if the UK is to reach Net Zero overall. On the basis of our analysis, we find that:

- In every scenario for achieving UK Net Zero that we have constructed, Northern Ireland would not get to Net Zero greenhouse gas emissions by 2050.
- In our Balanced Net Zero Pathway, which meets Net Zero by 2050 at UK level and on which our recommended Sixth Carbon Budget is based, Northern Ireland would reach at least an 82% reduction in greenhouse gases by 2050 compared to 1990 levels.
- Northern Ireland would achieve Net Zero CO_2 emissions by 2050 as part of the Balanced Pathway to UK Net Zero.

An 82% reduction in all greenhouse gases in Northern Ireland represents equivalent effort and a fair contribution to the UK Net Zero target.

There is no purely technical reason why Net Zero is not possible in Northern Ireland. However, when compared to the scenarios set out in our new advice on the Sixth Carbon Budget, getting to Net Zero in Northern Ireland would mean one (or both) of the following:

- A substantial reduction in output from Northern Ireland's livestock farming sector that goes beyond even the more stretching scenarios we have analysed.
- A much greater than equitable share of all UK greenhouse gas removal technologies being located in Northern Ireland compared to the size of Northern Ireland's current emissions, population, land area or economy.

Greenhouse gas targets for Northern Ireland

My Committee welcomes the cross-party commitments made to set new climate change targets for Northern Ireland in law.

All greenhouse gases (GHGs) contribute to warming temperatures, and all greenhouse gases must be reduced in Northern Ireland as part of the fair contribution to UK Net Zero.

We recommend that **any climate legislation for Northern Ireland must include a target to reduce all GHGs by at least 82% by 2050** in line with the UK Net Zero goal to ensure that these emissions.

However, the circumstances in Northern Ireland mean that supplementary targets may also be appropriate:

- **Supplementary targets for CO_2 only.** Peak temperature change is determined by when emissions of long-lived GHGs reach net-zero (assuming that short-lived GHG emissions are not rising). Of the long-lived GHGs, CO_2 contributes most to warming and therefore the date of net-zero CO_2 is closely linked with when the contribution to rising temperatures ends. Northern Ireland would reach Net Zero CO_2 emissions by 2050 under our Balanced Net Zero Pathway.
- **Supplementary targets for all greenhouse gases excluding biogenic methane.** You will have seen that the Republic of Ireland's Climate Change Advisory Council 'Annual Review 2020' specifically recommends seeking EU agreement to creating a split national target for 2050: net-zero emissions of long-lived greenhouse gases and anthropogenic methane, with a separate, longer target for biogenic methane. As requested by your officials, we therefore present possible targets on this basis in Table 1.

These targets must be backed up by a target to reduce all greenhouse gases, to ensure that all of Northern Ireland's emissions are covered as part of a contribution to Net Zero for the UK.

Table 1
Possible targets in Northern Ireland Climate Change legislation

	All greenhouse gases	CO_2 only	All GHGs excluding agricultural methane emissions	All GHGs excluding agricultural, land use and waste methane emissions
2030	**48% reduction**	56% reduction	53% reduction	52% reduction
UK Sixth Carbon Budget period (2033-2037)	**60% reduction**	70% reduction	67% reduction	67% reduction
2040	**69% reduction**	83% reduction	78% reduction	79% reduction
2050	**82% reduction**	Net Zero	93% reduction	96% reduction

Our annex provides details of the pathways we have developed for Northern Ireland, which are also set out in Chapter 4 of our advice on the UK Sixth Carbon Budget and in more detail in the supporting databook.

We stand ready to support the Northern Ireland Executive as you develop and pursue emissions reduction targets, and would welcome the opportunity to provide further advice on other elements of a legislative framework, including specific details on the design and appropriate level of targets.

Yours

Lord Deben
Chairman

Annex

Why the Sixth Carbon Budget is right for Northern Ireland

Scotland, Wales and Northern Ireland together cover a fifth of UK emissions. They have an integral role to play in delivering the UK's Sixth Carbon Budget on the path to Net Zero. For Scotland and Wales, this will be achieved under long-term targets passed in Holyrood and the Senedd Cymru. Northern Ireland is considering introducing its own climate legislation.

The challenges and solutions to tackling greenhouse gas emissions are broadly similar across the UK. The respective contributions made by each part of the UK will depend, at least in part, on the relative importance within their economies of particular types of emitting activity (e.g. agriculture, industry) and opportunities for removing CO_2 from the atmosphere through natural or engineered solutions.

Meeting the Sixth Carbon Budget will help Scotland, Wales and Northern Ireland meet their own ambitions.

UK climate targets cannot be met without strong policy action across Scotland, Wales and Northern Ireland, tailored for national, regional and local needs:

- While some important policy levers are held in Westminster, powers are fully or partially devolved in most key areas, including encouraging shifts to walking, cycling and public transport; providing electric vehicle charging points; improvements to the efficiency and comfort of the building stock and heating in homes off the gas grid; agriculture and land use; waste; carbon trading; and public provision of education and training. Northern Ireland also has wider devolved powers over energy networks.
- The frameworks in Wales and Scotland are ahead of the rest of the UK in emphasising the importance of the potential health and environment benefits, and the need for a just transition. Wales' Wellbeing of Future Generations Act and Scotland's Just Transition Commission will be important in ensuring this.
- Even where the main policy levers are held by the UK Government, Scotland, Wales and Northern Ireland can take action through complementary measures at the devolved level (e.g. provision of additional incentives, public engagement, and supporting policies such as planning and consenting).

Using scenarios to identify a balanced path to Net Zero

We have developed scenarios for the Sixth Carbon Budget advice[1] to explore a range of ways to achieve Net Zero by 2050 at the latest, and used those exploratory scenarios to identify a 'Balanced Pathway' towards Net Zero that keeps in play a range of ways of getting there based on central assumptions.

Our scenarios explore different ways of getting to Net Zero.

Our scenarios demonstrate that there are multiple ways to meet the Net Zero 2050 target and many routes to our recommended Sixth Carbon Budget. While our Balanced Pathway is the basis for our recommended budget it is not intended to be *prescriptive*. Rather it is *illustrative* of what a broadly sensible path based on moderate assumptions would look like. A little more or a little less may be achieved in any area, or alternative low-carbon options could be used, but the overall level of ambition and delivery must match.

This section sets out that approach in three parts:

a) The value of using scenarios to set a path to Net Zero

b) Our 'exploratory' scenarios to reach Net Zero

c) A Balanced Net Zero Pathway

a) The value of using scenarios to set a path to Net Zero

A key design feature of the Climate Change Act is that legislation of the budget level leaves free a choice about how this is to be delivered. It is the responsibility of Government then to determine how the budget will be met.

We go beyond our 2019 Further Ambition scenario, which underpinned the Net Zero advice.

In our 2019 advice on setting the Net Zero target, we presented a single ('Further Ambition') scenario for 2050 (Box 1.2) – this acted as a 'proof of concept', providing confidence that Net Zero can be achieved at reasonable cost without relying on major breakthroughs in technologies and behaviours.

In this year's advice, we have developed three exploratory scenarios that reach Net Zero emissions by 2050 in quite different ways, illustrating the range of pathways that are currently available. We also present a further, highly optimistic, scenario that enables Net Zero to be achieved prior to 2050. This allows exploration of a range of approaches over the next three decades.

We use these scenarios to guide judgements on the achievable and sensible pace of decarbonisation in the face of uncertainty, and to understand how less success in one area can be compensated for elsewhere. The scenarios are also useful for monitoring progress subsequently (see section 5 of Chapter 10).

Box 1.2
The Committee's 2019 Further Ambition scenario

In determining our 2019 advice on whether the UK could reach Net Zero emissions by 2050, we developed a Further Ambition scenario as a snapshot of sources and sinks of emissions in the UK by 2050 (Figure B1.2). This scenario was specific about how 96% of the emissions reductions could be achieved, compared to emissions in 1990, but noted that multiple options were available for achieving the last 4% of emissions reductions, including additional engineered removals, further innovation and further behaviour change.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

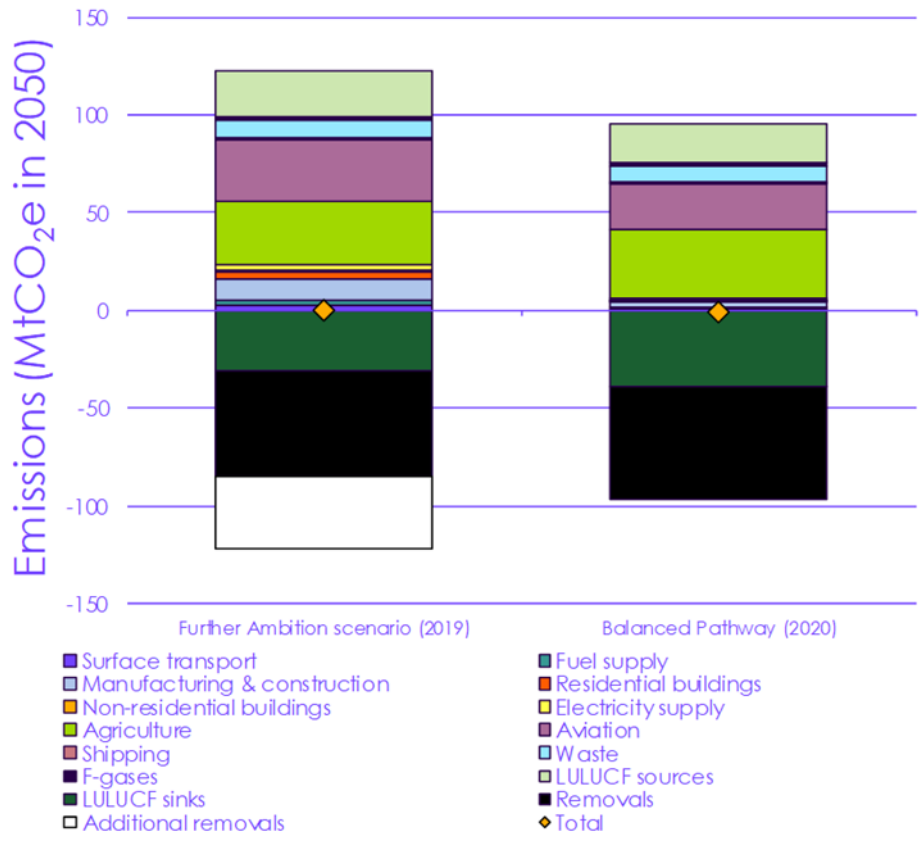
For the purposes of costing the scenario we assumed the remaining 4% of emissions reductions were delivered via emissions removals at £300/tCO_2, making them one of the most expensive emissions reduction options in our scenarios.

This year's analysis includes our recommended pathway to meet the Sixth Carbon Budget, the 'Balanced Pathway'. Key differences between this and last year's Further Ambition scenario include:

- **Behaviour change plays a larger role our new scenarios.** For example, the Balanced Pathway includes a 35% reduction from today's levels of meat consumption, up from 20% in the Further Ambition scenario.
- **Lower residual emissions in several sectors,** such as aviation, manufacturing and construction, buildings and electricity and hydrogen production, due to more ambitious assumptions on technology costs and innovation.
- **Lower use of fossil fuels,** particularly for power and hydrogen production. This sees gas demand fall by around 75% (compared to just 30% in last year's analysis). This is largely replaced by increased offshore wind which is used to produce electricity and electrolytic hydrogen.
- **Higher levels of peatland restoration and tree-planting** increase land use sinks.

Overall, this means that less engineered removals are required, reducing the overall cost of the scenarios (see Chapter 5).

Figure B1.2 Emissions in 2050 in the Further Ambition scenario and Balanced Pathway



Source: CCC analysis based on CCC (2019) *Net Zero*, and the *Sixth Carbon Budget*.

b) Our exploratory scenarios to reach Net Zero

When setting the Net Zero target, we erred on the side of caution.

Our 2019 Further Ambition scenario made relatively conservative assumptions on the extent of cost reductions as a result of innovation, and on societal and behavioural change. Making conservative assumptions was appropriate in the context of *setting* the target, as it was important to ensure a legally binding target could be met. But in the context of *achieving* Net Zero, and setting a pathway to match, we must consider how success can be maximised on these fronts.

Exploring how to meet Net Zero means looking at bolder assumptions on behaviour and innovation.

Greater contributions from societal/behavioural change and from innovation would reduce the challenges in achieving Net Zero emissions by 2050, by reducing emitting activities (e.g. flying, livestock farming) and making emissions reduction cheaper and/or easier. The Government should therefore ensure that policy frameworks are designed in a way that encourages both behavioural change and innovation to contribute strongly to decarbonisation.

However, even with well-designed policies, it remains uncertain how large a contribution each will make. Our scenarios therefore reflect potential ranges for their contributions, together with the sets of choices (e.g. on HGVs and low-carbon heat) that are necessary in this decade.

- **Societal and behavioural change** across all scenarios illustrates how choices by people and businesses can affect emissions. In many cases these align with the findings of the recent Climate Assembly (Table 1.2).
- **Innovation.** The costs and efficiencies of low-carbon technologies varies in our scenarios, according to the latest available evidence and projections for these technologies.

Our scenarios also explore choices around how to reach Net Zero.

- **Choices are also prevalent in our scenarios,** where the clearest low-carbon option is not currently evident. For example, in some scenarios hydrogen takes the place of electrification in HGVs and in some home heating. Similarly, our scenarios also try to reflect preferences, such as a preference for nature-based removals over engineered removals in the Widespread Engagement scenario, or the use of synthetic fuels in aviation instead of only offsetting aviation emissions via emission removals.

Our pathways use known solutions where they exist and minimise use of greenhouse gas removals.

As a general principle, consistent with the preferences expressed in the Climate Assembly,[2] our pathways prioritise emissions reductions where known solutions exist and thereby minimise the use of greenhouse gas removals. This will tend to lead to lower overall cumulative UK emissions and limit risks of over-reliance on being able to deploy removals sustainably at scale.

We initially constructed three 'exploratory' scenarios that reach Net Zero by 2050, one of which is similar to Further Ambition while the other two are more optimistic either on developments regarding behavioural change or improvements in technology costs and performance (Figure 1.2). Although to some extent these reflect choices on the way to Net Zero, they primarily reflect greater or lesser degrees of success on key policy priorities on the path to Net Zero – engagement of the public and businesses, and innovation:

- In the **Headwinds** scenario, we have assumed that policies only manage to bring forward societal/behavioural change and innovation at the lesser end of the scale, similar to levels assumed in our 2019 Further Ambition 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 our current projections. This scenario is more reliant on the use of large hydrogen and carbon capture and storage (CCS) infrastructure to achieve Net Zero

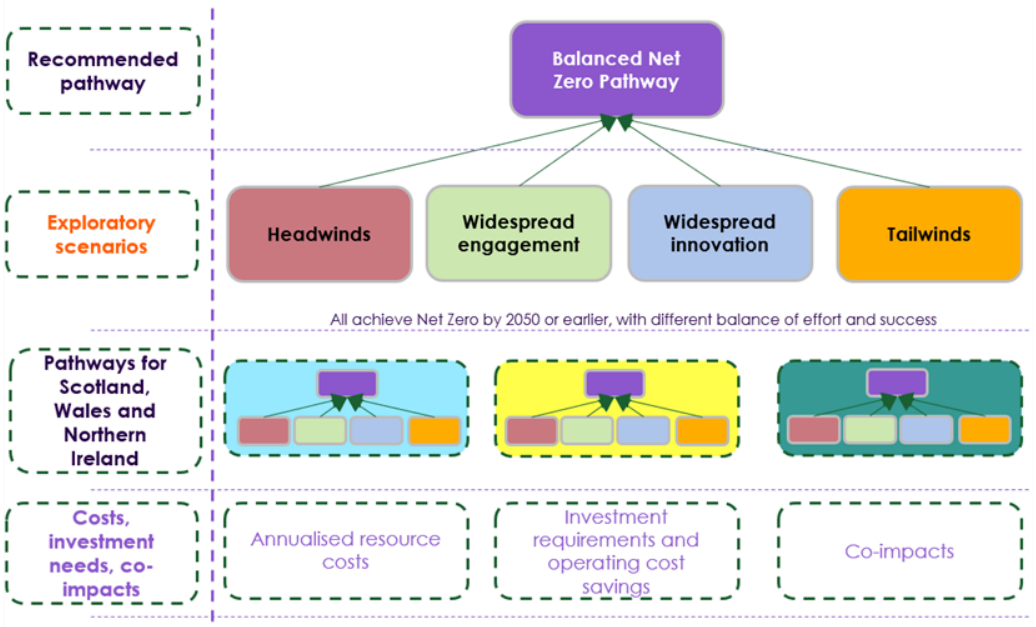
Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

- In the **Widespread Engagement** scenario, we assume 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.
- In the **Widespread Innovation** scenario, we assume 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.

Our Balanced Pathway navigates through the range of possibilities we have identified.

We then constructed the '**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 (see subsection (c) below). We also constructed a further exploratory scenario ('**Tailwinds**') that assumes considerable success on both innovation and societal / behavioural change and goes beyond the Balanced Pathway to achieve Net Zero before 2050.

Figure 1.2 Scenario framework for the Sixth Carbon Budget analysis



While these scenarios are designed to have self-consistent narratives, there is some potential to 'mix and match' strategies or compensate for under-delivery in one area with greater delivery elsewhere based on another scenario. Our sectoral analysis takes a 'bottom-up' approach which allows a detailed assessment of the options that are most relevant to each source of emissions within each sector.

The methodology used for each sectoral analysis is described in the accompanying Methodology Report.[3]

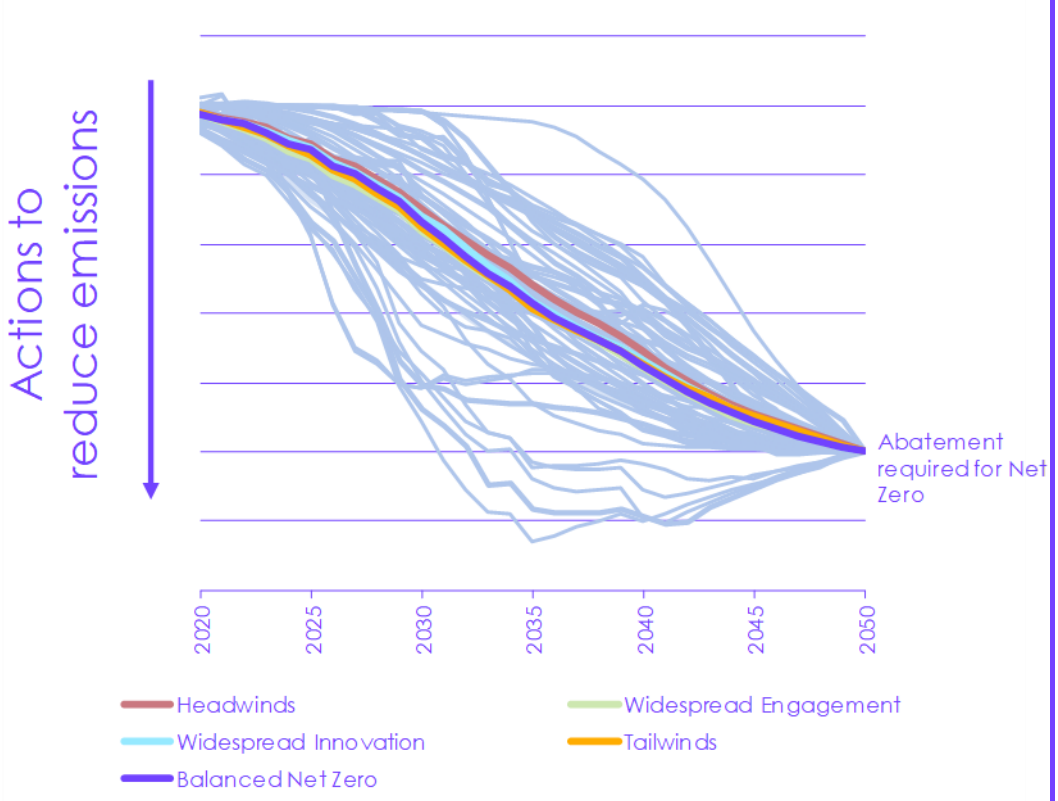
Our analysis contains many paths, with various different shapes.

Our scenarios allow for both the impacts of climate change (e.g. rising global temperatures reduce UK heating demand) and the need to adapt to those impacts (e.g. we include shading and ventilation measures alongside insulation). This is particularly important for the buildings and land use sectors.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

In the process of developing five scenarios to reach Net Zero at UK level, we have produced a total of 70 sectoral pathways* for the UK (Figure 1.3). We have taken steps to ensure that each of the sectoral scenarios represents a coherent picture at the economy-wide level (Box 1.3), including what happens to infrastructure and operation of the electricity system (Table 1.1).

Figure 1.3 The five economy-wide scenarios are constructed from 70 individual scenarios for action across every sector of the economy



Source: CCC analysis.
Notes: Each individual line represents the path for new abatement in a sector between 2020 (effectively zero) and by 2050 where all sectors reach a level of abatement that is consistent with the UK getting to Net Zero. Not all sectors will get to zero emissions. Abatement in the fuel supply sector is greater in the 2030s than by 2050.

We have tried to ensure that each of the scenarios represents a coherent view of a possible future.

Box 1.3
Developing self-consistent scenarios for each sector of the economy

In developing the scenarios, we have made efforts to ensure they are self-consistent:

- The residual emissions in each sector have been aggregated to obtain the level of total UK emissions, ensuring that the decarbonisation of energy carriers that are used in multiple sectors (e.g. electricity, hydrogen, bioenergy) is accounted for once and once only.
- Aggregated energy demand across all sectors is a key input to our analysis of the production, transportation and consumption of low-carbon electricity, hydrogen, fossil fuels, waste and bioenergy.
- We have considered the overall use of biomass so that it does not exceed limits that we judge could be sustainably sourced and available to the UK in the next 30 years.

* These sectoral pathways are disaggregated further into 280 pathways for Scotland, Wales, Northern Ireland and the rest of the UK.

- We have considered the shared use of infrastructure across sectors, including specific areas of the gas grid and the co-location of industrial carbon capture and storage with hydrogen production and bioenergy with carbon capture and storage (BECCS).
- CO_2 capture requirements are aggregated across all sectors to investigate the scale of storage required for the UK.
- We have drawn on findings from our extensive use of energy system models to date and incorporated them into this analysis.
- Each sectoral scenario uses a shared set of assumptions about the future, including economic and demographic factors such as the growth rate of the economy, population growth and energy prices.

Table 1.1
Summary of key differences in the economy-wide scenarios

	Balanced Net Zero Pathway	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
Diet change	**35% reduction in all meat and dairy by 2050**	20% reduction in all meat and dairy by 2050	50% reduction in all meat and dairy by 2050	50% reduction in all meat and dairy by 2050	50% reduction in all meat and dairy by 2050
Airport terminal passengers	**365m in 2050**	365m in 2050	245m in 2050	438m in 2050	245m in 2050
Tree-planting rates	**50,000 ha/year from 2035**	30,000 ha/year from 2025	70,000 ha/year from 2035	50,000 ha/year from 2030	70,000 ha/year from 2035
Wholesale electricity cost*	**2035: £60/MWh 2050: £50/MWh**	2035: £65/MWh 2050: £60/MWh	2035: 65/MWh 2050: £55/MWh	2035: £55/MWh 2050: £40/MWh	2035: 60/MWh 2050: £35/MWh
Natural gas grid	**Hydrogen grid conversion trials in 2020s.** **Patchwork larg e-scale conversions start from 2030 near industrial clusters.** **Some buildings in those areas switch to hydrogen.** **Conversion continues to 2050.**	Hydrogen grid conversion trials In 2020s. Large-scale conversions start from 2030 around industrial clusters and radiate out at 10 km/yr. 20% of homes on gas grid with hydrogen by 2035.	Gas grid not converted to hydrogen. Full electrification in buildings. Industry hydrogen sourced via private pipelines.	Hydrogen grid conversion trials in 2020s. Large-scale conversions start from 2030 around industrial clusters and radiate out at 10 km/yr. Most buildings within radius convert to hydrogen. After 2035 no further buildings convert – further radial expansion beyond 2035 only applies to parts of grid to supply some industrial users.	

* Shown for residential users. Larger users are assumed to receive a discount on the wholesale electricity price.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

c) A Balanced Net Zero Pathway

In our assessment, the Balanced Pathway is right for the climate and for the UK.

The multiple scenarios we present in this advice provide an illustration of the various ways that we can pursue emissions reductions on a path to Net Zero. However, the implied flexibility on how to deliver it does not mean the near-term path is unclear. Many steps can be taken with confidence in the next decade and should begin immediately. Our 'Balanced Net Zero Pathway' 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. This pathway:

- Represents a sensible strategy to underpin policy on over the coming years, based on known technologies and behaviours, with potential to be adapted as we learn more about the most effective ways to cut emissions (see the *Policy Report*).
- Takes a whole-system approach to decarbonisation, reflecting the range of opportunities across behaviour, efficiency, land, low-carbon energy supply and end-use technologies, and how these potentially interact.
- Develops key options for decarbonisation in the 2030s and 2040s, with action in the 2020s, accepting that some things will not work but that it is necessary to try things out to find the best options and develop effective policies.
- Includes some measures that are not cost-effective when considering only emissions reductions, where they support other objectives (e.g. some higher-cost improvements to energy efficiency of homes, due to benefits to fuel poverty, health and employment).
- Is designed to be delivered in a way that works for *people* – reflects their priorities and choices, and aligns very well to the preferences expressed by the Climate Assembly, which was called by six Select Committees of the House of Commons to understand public views on how the UK should tackle climate change (Table 1.2).
- Works in the real world and at the local level, providing good quality jobs, and benefits to health and wellbeing.
- Allows time for societal choices to contribute and the necessary scale-up of supply chains, skills, business models and infrastructure during the 2020s.
- Puts the UK on track to Net Zero, and supports the required global path for decarbonisation (see Chapter 7) by reflecting the highest possible ambition on emissions reduction as a necessary contribution the Paris Agreement.

The Balanced Pathway is challenging but feasible.

The Balanced Net Zero Pathway is plausible based on our assessment. An alternative strategy that delivers the same emissions reductions in different ways, with less in one area compensated by more elsewhere, would also meet the recommended budget. Our wider set of scenarios illustrate different pathways that could help to achieve the budget and get on track to meeting Net Zero (see subsection b) above). However, there is a series of actions that need to be taken now, irrespective of the choices that we make later, and a continuing programme to be fulfilled if those later choices are to remain open. More generally, the need to act on climate change and to reach Net Zero emissions is now widely recognised in businesses.

Business will be key in delivering the Sixth Carbon Budget.

Many UK businesses have set their own Net Zero goals and stand ready to transition to the new technologies, behaviours and business models required.
In that context, the most positive economic strategy is to proceed with 'highest possible ambition', as required by the Paris Agreement.

This is the best strategy we have now – as we do more, we will learn more about what works.

A bold strategy to get the UK on the path to Net Zero is required, with immediate action based on available solutions and active development of new ones, while accepting that we can't know how every aspect of the transition will play out. But that need not imply locking in every aspect of the transition – there is clear benefit to an adaptable strategy that can be adjusted as we learn more about the most effective ways to cut emissions.

Table 1.2
How the CCC's scenarios compare to the recommendations of the Climate Assembly

Sector	Climate Assembly recommendations	Range in CCC scenarios
Transport	• A ban on the sale of new petrol, diesel and hybrid cars by 2030–2035. • A reduction in the amount we use cars by an average of 2–5% per decade.	• 2030-2035 switchover date for EVs. • Up to 5-11% of car-km switch to alternative modes of transport.
Buildings	• At least 80% of assembly members 'strongly agreed' or 'agreed' that each of hydrogen (83%), heat pumps (80%), and heat networks (80%) should be part of how the UK gets to net zero. • Supportive of energy efficiency: slight preference for upgrading each home all in one go (56%), compared to upgrading each home gradually (44%).	• Scenarios are led by electrification via heat pumps or hybrid heat pumps. Hydrogen features in Headwinds scenario. • All scenarios include district heating. • Energy efficiency in over half of homes by 2035.
Electricity supply	• Members were highly supportive of wind and solar (80-90% in favour). • Only 40% of assembly members agreed that bioenergy should be used to produce electricity (even if producing negative emissions). • Support was lower for nuclear (34%) and fossil fuels with carbon capture and storage (22%).	• Wind and solar provide 75-90% of electricity. • Some bioenergy is used to produce electricity, transitioning to BECCS. • Nuclear and power generation with CCS provide 10-25% of electricity.
Aviation	• Assembly members would like to see a solution to air travel emissions that allows people to continue to fly. • But not without limits, promoting an acceptable balance between achieving the net zero target, impacts on lifestyles, reliance on new technologies, and investment in alternatives.	• Flying ranges between a 15% fall and 50% increase on pre-COVID-19 levels, matching popular Climate Assembly scenarios. • Low-carbon fuels in all scenarios, providing 20-95% of fuel by 2050.
Agriculture & Land Use	• A change in diet to reduce meat and dairy consumption by between 20% and 40%. • Highly supportive of nature-based removals, seen as 'natural' and having significant co-benefits (99% in favour of afforestation, 80-85% peatland restoration and wood in construction, but lower (60%) for enhancing soil carbon).	• 20-50% reduction in all meat and dairy consumption by 2050. • High ambition on tree-planting (30-70 kha per year) and peatland restoration. Enhanced soil not included. • Some focus on more biodiversity in the people scenario.
Emissions removals	• Members were less supportive of DACCS and BECCS (40%) with significant concern over the permanence of CO_2 storage and that they are treated as a 'magic solution' which doesn't get to the crux of the problem (reducing emissions).	• BECCS included at scale (45-95 $MtCO_2$/year by 2050) in all scenarios. DACCS included at 0-15 $MtCO_2$/year.

Source: CCC analysis based on Climate Assembly UK (2020) *The path to net zero.*
Notes: The Climate Assembly did not consider emissions reductions associated with manufacturing and construction, fossil fuel supply, shipping or F-gases.

Our approach to advice on the Sixth Carbon Budget

Our advice on the Sixth Carbon Budget is based on an extensive programme of analysis, consultation and consideration by the Committee and its staff, building on the evidence published last year for our Net Zero advice. That programme has addressed the requirements set out for the Committee in the Climate Change Act.

The Sixth Carbon Budget can be the platform for a step-change in climate action.

It aims to set a platform to support the UK Government in taking confident decisions on the budget and the actions required to deliver it. Doing so can fulfil the UK's commitments on climate change, support investment and job creation by businesses in the UK, deliver on priorities of UK citizens and support the UK's positive place in the world.

The outputs of the work, including our public Call for Evidence, several new research projects, three expert advisory groups, detailed datasets and deep dives into the roles of local authorities and businesses, are published on our website (www.theccc.org.uk) and explained in the four parts of this report and its accompanying Methodology and Policy Reports.

a) The requirements of the Climate Change Act

The Climate Change Act requires the Committee to provide advice on the Sixth Carbon Budget by the end of 2020. The Government is then required to legislate the carbon budget by the end of June 2021, and to produce proposals and policies to meet it 'as soon as is reasonably practicable' thereafter.

The carbon budget must be set with a view to meeting the 2050 target, which is now set in legislation as an emissions reduction of 'at least 100%' (i.e. Net Zero).

We have considered all of the aspects required by the Climate Change Act.

In recommending carbon budgets, the Committee is required by the Act to take into account a range of considerations. These are designed to ensure that action to tackle climate change contributes fully to the global effort, while supporting other Government objectives. Below we outline these considerations, and where within the Sixth Carbon Budget advice report they are addressed:

- **Scientific knowledge about climate change.** We set out in Chapter 8 the updated state of knowledge on the science of climate change, which remains similar to that when providing the advice on Net Zero. Considerations relating to cumulative emissions inform our assessment for the appropriate shape of the emissions path on the way to Net Zero (Chapter 9).
- **Technology relevant to climate change.** Our scenarios, set out in Part 1 of the report (i.e. Chapters 2 and 3), take into account the potential roles, costs and interactions between the various technologies that can help to reduce emissions. One of these, the Balanced Net Zero Pathway provides the basis for our recommended level for the carbon budget.
- **Economic circumstances, and in particular the likely impact of the decision on the economy and the competitiveness of particular sectors of the economy.** Quantitative and qualitative assessments of the economic transition through the Sixth Carbon Budget on the path to Net Zero are set out in Part 2 of the report (i.e. Chapters 5 and 6). Competitiveness is addressed both within our scenario design and specifically in Chapter 6.

- **Fiscal circumstances, and in particular the likely impact of the decision on taxation, public spending and public borrowing.** Part 2 addresses the costs and investment requirements of the transition, and what choices over how to fund decarbonisation might mean for the Government's fiscal position.
- **Social circumstances, and in particular the likely impact of the decision on fuel poverty.** We consider a range of social circumstances in Part 2 of the advice, including fuel poverty, impact on employment and health co-benefits. Our scenarios (Part 1) include some measures that are not cost-effective when only considering emissions reductions, where they support these wider objectives.
- **Energy policy, and in particular the likely impact of the decision on energy supplies and the carbon and energy intensity of the economy.** By design, our scenarios set out in Part 1 of the report maintain security of electricity supply at similar levels to those required today. Chapter 2 sets out the impact of the recommended budget for emissions and energy consumption, including the reduced dependence on imported oil and gas.
- **Differences in circumstances between England, Wales, Scotland and Northern Ireland** under our scenarios are set out in Chapter 4, as well as what our UK-wide pathways mean for emissions in each part of the UK.
- **Circumstances at European and international level.** We consider the role of the UK in the global effort to tackle climate change in Chapter 7, including the UK's commitments under the Paris Agreement and the benefits of UK leadership in the run up to COP26 in Glasgow in November 2021.
- **The estimated amount of reportable emissions from international aviation and international shipping for the budgetary period or periods in question.** Emissions from these sectors under our scenarios are set out in Chapter 3, while considerations on how these affect the recommendation on the Sixth Carbon Budget are set out in Chapter 10.

As well as the recommended level of the Sixth Carbon Budget, the Act also requires this advice to cover:

- Whether and how emissions from international aviation and international shipping can be formally included in the carbon budgets;
- The role of international emissions credits (known as 'carbon units' under the Act);
- The opportunities for emissions reduction in particular sectors; and
- The balance of emissions in the sectors that have been covered to-date by the EU ETS as against those outside.

All of these matters are addressed in our recommendations in Chapter 10 of the advice on the Sixth Carbon Budget.

Supporting evidence and publications

Other outputs more fully present the rich analysis that has gone into this advice.

In support of the advice in this report, we have also produced

- A Methodology Report, setting out the evidence and methodology behind the scenarios presented in Part 1 of this report.[4]
- A Policy Report, setting out the changes to policy that could drive the changes necessary particularly over the 2020s.[5]
- A dataset for the Sixth Carbon Budget scenarios, which sets out more details and data on the pathways than can be included in this report.

We are also publishing a set of other documents alongside these reports (Box 1.3).

Our advice has drawn on extensive consultation and stakeholder input.

In December 2019, we published a call for evidence on the Sixth Carbon Budget, which ran until February 2020. We received 177 responses, and published each of these, together with a summary document, in July 2020. We have also undertaken a wide range of engagement as an input to our advice (Figure 1.4 and Box 1.4).[6]

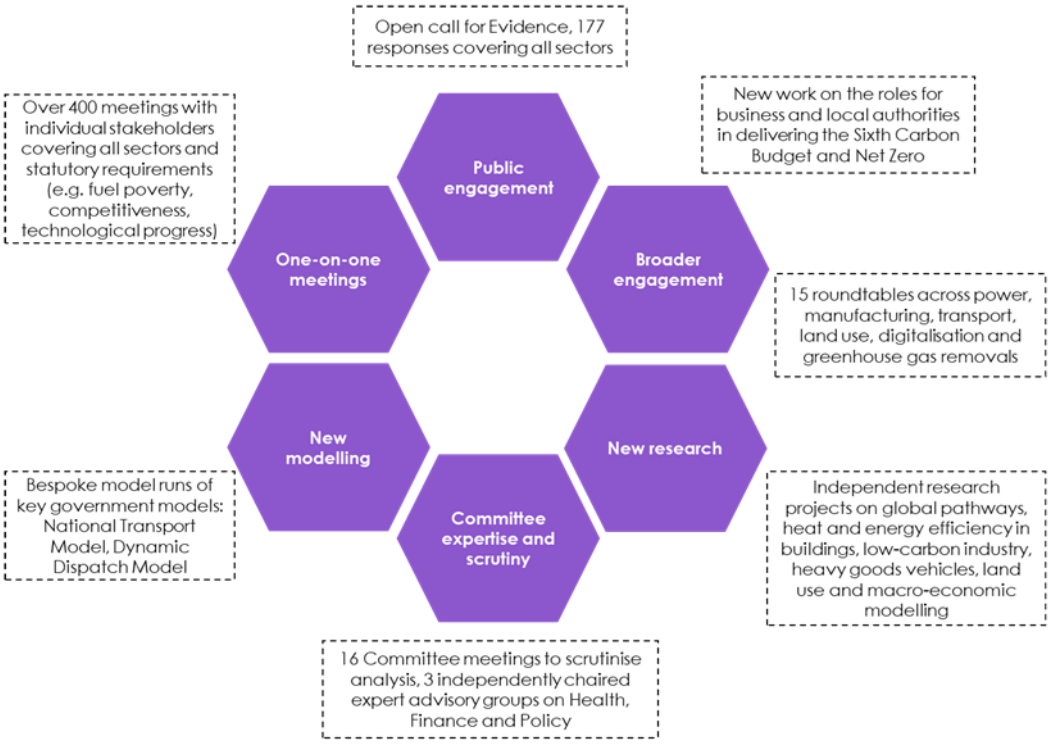
Box 1.3
New evidence and new CCC research

In our work for the Sixth Carbon Budget we engaged with a range of experts to ensure that our analysis reflects up-to-date evidence wherever possible, building on the evidence we produced alongside our *Net Zero* report in 2019. In addition to the Call for Evidence (Box 1.4) new evidence and research collected for this report includes:

- **Three Expert Advisory Group reports on:** the health co-benefits of the actions in our Sixth Carbon Budget scenarios, financing the investment required in our scenarios and how cross-cutting policy interventions can accelerate a transition to Net Zero.
- **Research and engagement with the UK's business community,** culminating in a series of briefing notes on enabling business to take a full role in Net Zero.
- **An in-depth report on how local and regional Government** can deliver the UK's Net Zero ambition.
- **Consultancy reports** on the UK's international climate influence, heat in buildings, energy efficiency in buildings, deep decarbonisation in industry, industry policy, heavy goods vehicles, agricultural abatement, land use modelling, low-carbon hydrogen and macroeconomic modelling.
- **Expert roundtable discussions** on electricity market design, phase-out of unabated gas-fired generation, industrial decarbonisation policy, digitalisation, emissions removals, arable yield improvements and policy for buildings decarbonisation, including a published summary of the removals discussion.

New evidence is summarised in Boxes in this report and the accompanying Policy and Methodology reports, with significant further detail available in the published materials on the Committee's Sixth Carbon Budget webpage.

Figure 1.4 Engagement, evidence and scrutiny for the Sixth Carbon Budget advice



Box 1.4
Call for evidence and wider engagement

The Committee launched a Call for Evidence to inform its advice on the Sixth Carbon Budget and Welsh interim targets which ran between 5 December 2019 and 5 February 2020. The Call for Evidence included 37 questions on five topics:

A. Climate science and international circumstances

B. The path to the 2050 target

C. Delivering carbon budgets

D. Wales, Scotland and Northern Ireland

E. Sector-specific questions

The Call for Evidence received 177 responses from across business and industry, NGOs, academia and from individuals (Figure B1.4). The Committee published a summary of responses to the Call for Evidence in July 2020. The summary, including a list of respondents and links to responses in full, is available on the Committee's website.

Several common themes emerged from the Call for evidence. In particular:

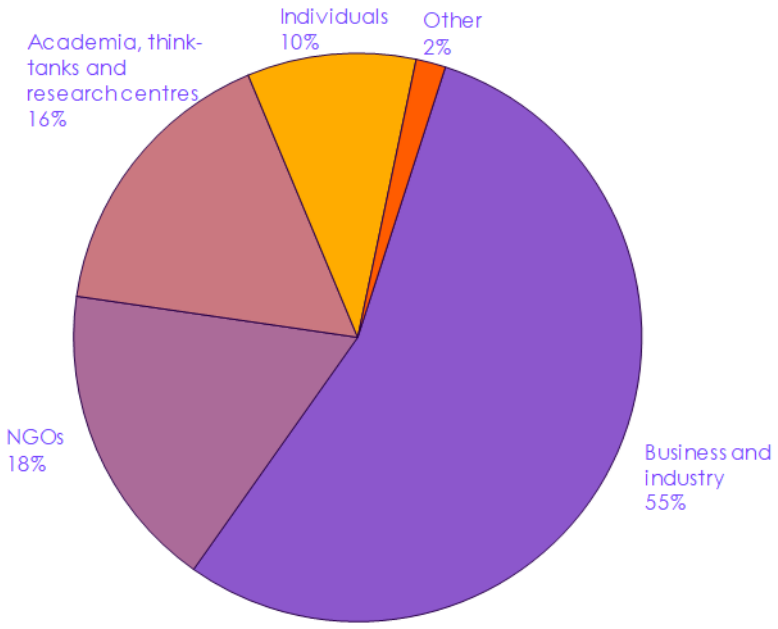
- The importance of **equity-based approaches in determining the UK's share of remaining global carbon budgets**, though some respondents did not feel that remaining cumulative global budgets were relevant, but that the UK's long-term Net Zero target and cost-effectiveness should instead be the main factors taken into account in determining UK carbon budgets.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

- **Strengthened international commitments should be reflected** in a more stringent Sixth Carbon Budget and nationally defined contribution (NDC) for the period out to 2030. This could include revisiting the level of the Fourth and Fifth Carbon Budgets, for which there was strong support.
- **The role of individual behaviour change is important,** but Government has a role in guiding people to make the right choices.
- Many respondents highlighted the need to develop **a robust approach to addressing consumption emissions** (e.g. by adopting explicit consumption emissions targets, technology-adjusted consumption-based accounting, border carbon adjustments) to avoid emissions offshoring and better reflect the UK's impact on global emissions.
- Many respondents noted **a range of cross-cutting delivery challenges**, such as public engagement, the need for local action and a need for a Just Transition, including suggestions on how these can be overcome.
- This Call for Evidence included for the first time **a large number of sector-specific questions** (20 in total). The evidence submitted in response to questions in this section was considered by the CCC's sector teams and reflected in our Sixth Carbon Budget scenarios, as well as our advice on policy and progress in each sector.

The Call for Evidence was an important part of the Committee's engagement programme, but not the only one. We also held a large number of roundtable discussions and bilateral meetings, including with groups that did not respond to the Call for Evidence.

Figure B1.4 Responses to the Call for Evidence by type of respondent



Source: CCC analysis.
Notes: 'Business and industry' includes consultancies and industry / trade bodies. 'Other' includes public and parliamentary bodies.

Source: CCC (2020) *Sixth Carbon Budget and Welsh emissions targets – Call for Evidence Summary*

Northern Ireland's contribution to UK-wide Net Zero

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

Key messages

Scotland, Wales and Northern Ireland have an integral role to play in delivering the UK's emissions targets.

Scotland, Wales and Northern Ireland have an integral role to play in delivering the UK's Sixth Carbon Budget on the path to Net Zero. Combined, they produced 23% of UK emissions in 2018, while accounting for 16% of the UK's population, 13% of economic activity and nearly half of the UK's land area (46%) (Table 4.1).

They have fully or partially devolved powers (Table 4.5) in a number of areas relevant to emissions reduction. Key areas of devolved responsibilities include demand-side transport measures, energy efficiency and heat in off-gas properties, agriculture, land use and waste, and most energy policy in Northern Ireland.

While some important policy levers are held in Westminster, powers are fully or partially devolved in most key areas.

The devolved administrations can also ensure that UK policy in reserved areas (e.g. a regulatory phase-out of petrol and diesel car sales) is delivered effectively through the provision of additional incentives, public engagement, and supporting policies such as planning. The UK cannot achieve its climate targets without strong policy action across Scotland, Wales and Northern Ireland.

This chapter sets out what the different pathways for UK Net Zero mean for emissions in Scotland, Wales and Northern Ireland, the costs of action, and high-level policy recommendations for the devolved administrations. A full discussion of costs and their distribution can be found in Chapter 5 and 6, and a detailed set of policy recommendations is laid out in the Policy Report that accompanies this report.

Scotland, Wales and Northern Ireland are at different stages of developing their own climate legislation, targets and policy:

- Scotland has already legislated a Net Zero target for 2045 and a set of legally binding targets between 2020 and 2045. The Scottish Government is now preparing an update to the Climate Change Plan containing policies and proposals to meet those targets that will be published shortly after this report.
- The Welsh Government already has a climate legislation framework and currently has a legal target to reduce emissions by 80% in 2050 compared to 1990 levels. The Welsh Government is in the process of defining and legislating new targets that are consistent with UK Net Zero by 2050. In 2019, Wales committed to setting a 95% reduction target in 2050, with an ambition to set a Net Zero target if possible.[7]
- The Northern Ireland Executive is planning to introduce new climate change legislation as part of the New Decade, New Approach power-sharing agreement.[8]

Our key messages in this chapter are:

- **The credibility of the Sixth Carbon Budget rests on action in all parts of the UK.** 23% of the abatement in our Balanced Net Zero Pathway during the Sixth Carbon Budget period is delivered in Scotland, Wales and Northern Ireland.
- **The technical and behavioural challenges and solutions to tackling greenhouse gas emissions are broadly similar across the UK.** This does not mean that each country will follow the exact same emissions reduction pathway, nor does it lessen the need for policies that are tailored for national, regional and local needs (see *Local authorities and the Sixth Carbon Budget* in the Policy Report).

Our pathways for each part of the UK entail consistent amounts of effort, but lead to different overall reductions in emissions.

- **Equal effort towards UK Net Zero will lead to different emissions pathways.** The balance of activity across different sectors - particularly aviation, agriculture and land use, manufacturing and construction, fuel supply and greenhouse gas removals - means different levels of emissions reduction are possible in different parts of the UK through the Sixth Carbon Budget period and by 2050.
- **The scale of action required in Scotland, Wales and Northern Ireland is broadly comparable to the current share of UK emissions.** The costs of decarbonisation in Scotland, Wales and Northern Ireland will likely be shared across the whole of the UK to some degree.
- **Devolved policies have a crucial role to play.** 11% of all the abatement in the UK Balanced Net Zero Pathway is in areas where some or all key powers are reserved to the Scottish Government, Welsh Government and Northern Ireland Executive.
- **Nearly 60% all the abatement in Scotland, Wales and Northern Ireland is in sectors where key powers are partially or mostly devolved.** Priority sectors for devolved policy include agriculture and land use, buildings efficiency and heat, demand-side transport measures and waste.

1. Opportunities to reduce emissions

Chapter 2 of the Sixth Carbon Budget advice sets out the actions that are required for the UK to meet our recommended Sixth Carbon Budget on the pathway to reach UK Net Zero by 2050.

All our scenarios reflect strong contributions from a set of key technologies and behaviours. The technical and behavioural challenges and solutions to tackling greenhouse gas emissions in the 2020s and beyond are broadly similar across the UK:

- **Consumer and business choices.** Significant changes in behaviour can be made alongside improvements to people's lives. In some cases that means adopting new technologies that provide the same service (e.g. electric cars), in others it means larger changes (e.g. shifting to home-working or walking/cycling). Particularly important in our scenarios are a continued shift in diets away from meat products, a slow-down in growth of flying and reductions in travel demand.
- **Efficiency.** Much of our use of energy, and wider resources, is currently inefficient. By better insulating buildings, improving vehicle efficiency and improving efficiency in industry the UK can use the energy we produce and the resources we consume most productively.
- **Electrification.** Low-carbon electricity can now be produced more cheaply than high-carbon electricity and has potential to be rolled out at a scale many times larger than the UK's current entire electricity demand.
- **Hydrogen & CCS.** Low-carbon hydrogen can be produced from electricity or from natural gas with carbon capture and storage. Carbon capture and storage (CCS) is used to avoid further emissions from industry, alongside a role in permanent removal of CO_2 from the atmosphere and potentially in electricity and hydrogen production.
- **Land and removals.** A transformation is needed in the UK's land. Our scenarios involve planting of 300,000 hectares of mixed woodland by 2035 across Scotland, Wales and Northern Ireland, accelerating to 850,000 hectares by 2050. Peatlands must be restored widely and managed sustainably. Food waste will need to be reduced and diets will need to shift away from the most carbon-intensive products. Low-carbon farming practices must be adopted widely, and farm productivity raised. Alongside these nature-based removals, by 2035 the UK should be using bioenergy with CCS to deliver engineered removals of CO_2 at scale – some of which could be located in the devolved administrations.

Each part of the UK has a different starting point and set of opportunities to contribute to UK Net Zero.

The key factors determining the rate at which the devolved administrations can reduce their emissions before, during and beyond the Sixth Carbon Budget period are: different levels of activity and emissions in each sector today; existing land usage and opportunities for land-based removals; existing infrastructure; opportunities to remove CO_2 from the atmosphere; and existing policy.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

Table 4.1
Greenhouse gas emissions relative to population, economic activity, and land area

		UK	Scotland	Wales	Northern Ireland
GHG emissions in 2018 ($MtCO_2e$)		539	55	42	25
Population	Population in 2018 (million)	67	5	3	2
	GHG emissions per person (tCO_2e/person)	8	10	13	13
Economic activity	GDP in 2018 (£ billion)	2,140	160	70	50
	GHG emission per GDP (tCO_2e/£)	252	340	562	505
Land area	Land area (km^2)	250,000	80,000	21,000	14,000
	GHG emissions per area (tCO_2e/km^2)	2,200	700	2,000	1700

Source: ONS (2020) Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2019; ONS (2020) Regional economic activity by gross domestic product, UK: 1998 to 2018; ONS (2020) The Countries of the UK; NAEI (2020) Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2018.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

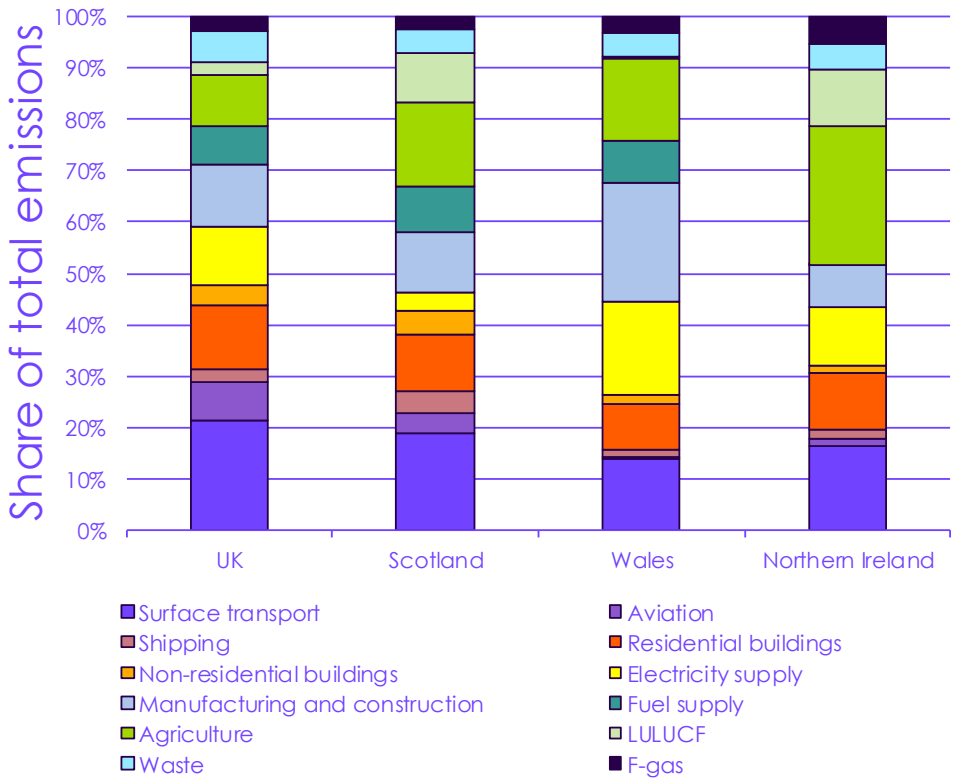
a) Existing levels of emissions and activity in each sector

The current sectoral shares of total emissions are different in each devolved administration (Figure 4.1), due to different levels of activity and output in these areas.

Higher or lower shares of current emissions and activity in each sector mean that the pace and scale of mitigation actions - or failures to act - will have a proportionally higher or lower impact on the economy-wide emissions pathways for Scotland, Wales and Northern Ireland. Higher shares of emissions in sectors that can decarbonise rapidly in the next decade will mean that economy-wide emissions will fall more quickly.

Northern Ireland has relatively high agricultural emissions but relatively low emissions from aviation, manufacturing and fuel supply.

Figure 4.1 Sectoral emissions in 2018 for Scotland, Wales and Northern Ireland compared to the UK



Source: BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019;* NAEI (2020) *Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2019;* CCC analysis.
Notes: Values shown use AR5 Global Warming Potentials with carbon-cycle feedbacks and include an estimate of emissions from peatlands.

The following sectors differ from the UK share by more than five percentage points in one or more of Scotland, Wales and Northern Ireland:

Agriculture is bigger in each of Scotland, Wales and Northern Ireland than in England.

- **Agriculture.** All three of the devolved administrations have a significantly higher proportion of their total emissions from agriculture compared to England. Around 10% of all UK emissions are from agriculture, compared to 16% in both Scotland and Wales and 27% in Northern Ireland.
- **Aviation** comprises a much smaller share of emissions, particularly in Wales (<1%) and Northern Ireland (2%), compared to the UK as a whole (7%).

- **Surface transport** emissions make up a smaller proportion of total emissions in Wales (14%) and Northern Ireland (16%) than in the UK (21%), but this is not due to a more carbon-efficient surface transport sector. Other sources of emissions increase the total national emissions that surface transport emissions are compared to (i.e. agriculture in Northern Ireland and manufacturing in Wales) making the share of transport emissions of the total smaller. Per person, surface transport emissions are actually higher in Northern Ireland than the UK average.
- **Fuel supply** emissions are very low in Northern Ireland compared to the rest of the UK, with virtually zero emissions from oil and gas production or refining.
- **Offshore oil and gas emissions.** Around 15 $MtCO_2e$ of GHGs from offshore oil and gas exploration and production are classified within the UK Greenhouse Gas Inventory as 'unallocated' emissions and are not attributed to any of the devolved administrations totals. Decarbonising these sources of UK emissions will not directly affect the pathways for Scotland, Wales or Northern Ireland – though there will be knock-on impacts for onshore emissions from oil and gas production.

b) Existing land use and opportunities to remove CO_2 from the atmosphere

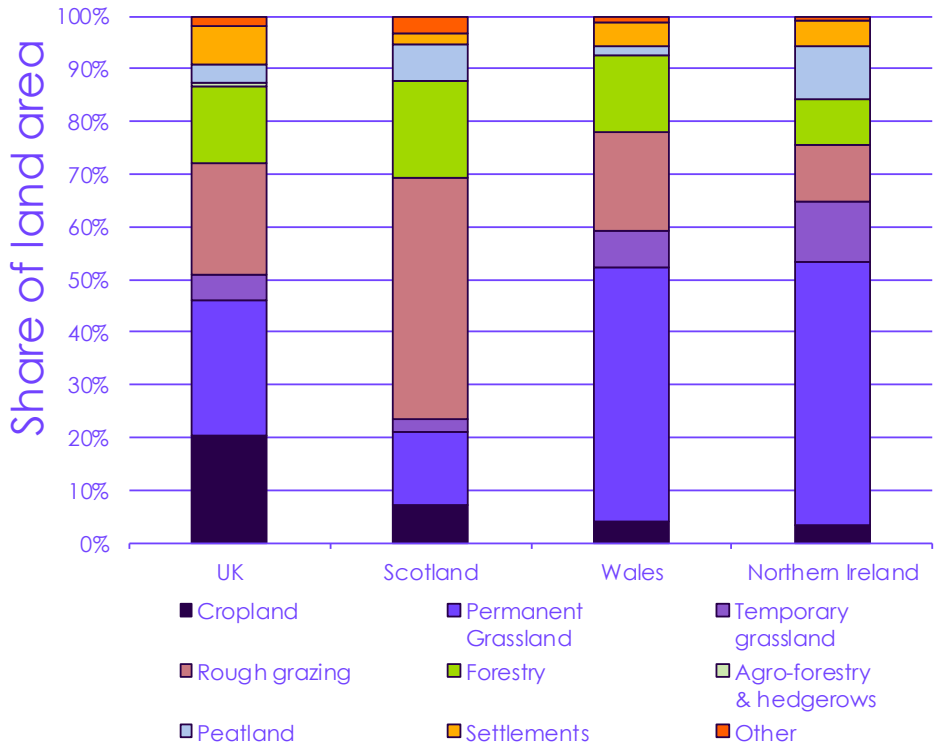
Emissions from land use, land-use change and forestry (LULUCF) are inherently location-specific. Across the UK, there are differences in the types of existing land use, as well as in the types of land-use change needed to deliver the UK Net Zero target and the costs associated with those changes.

As a result, the costs and benefits for England, Scotland, Wales and Northern Ireland differ to the results for the UK as a whole. The two main differences across the UK that have been incorporated in our analysis are:

- Different combinations of measures that can be deployed across England, Scotland, Wales and Northern Ireland based on differences in geographies and existing land use (Figure 4.2). The livestock sector dominates agriculture in Northern Ireland (over 90% of agricultural GVA in 2017), particularly beef and dairy. This is reflected in the high proportion of grassland in Northern Ireland and low proportion of cropland. Forest coverage is also lower than the rest of the UK at around 8% (including small woodland area).
- Differences in land acquisition costs in England, Scotland, Wales and Northern Ireland. Other costs are also likely to vary (e.g. based on remoteness of land) but it has not been possible to take this into account.

Our 2019 Land Use Policy Report found that the set of measures to reduce emissions from agriculture and land use in our scenarios deliver a higher ratio of benefits to costs in each of Scotland, Wales and Northern Ireland than in England.

Figure 4.2 Existing land use in Scotland, Wales and Northern Ireland compared to the UK



Source: Centre for Ecology and Hydrology (2020) and CCC analysis.
Notes: Does not include land used for agro-forestry and hedgerows (<1% at UK level) for Scotland, Wales or Northern Ireland. 'Forestry' includes small woodlands.

c) Existing infrastructure

Some differences in infrastructure will continue as far as 2050. This is particularly important for the gas and electricity networks, existing housing stock, and clusters of heavy industry:

Properties off the gas grid in Northern Ireland are likely to go straight to low-carbon heating rather than connect to the gas grid.

- **The gas network** is much less developed in Northern Ireland, with only 24% of households connected to the gas grid in 2017 (although this is increasing), compared to 87% for the UK as a whole.[9] Scotland and Wales also have a higher proportion of homes off the gas grid than the UK average. Heat decarbonisation options that rely on the gas network will not be possible in these particular properties, and will require a greater use of other options such as heat pumps and smart storage heating.
- **The existing building stock**, including current levels of energy efficiency, ownership or tenancy type, heating technology, suitability for low-carbon district heating, and the proportion of buildings that are 'hard-to-treat' or heritage properties.

  Our analysis takes into account the different characteristics of buildings in Scotland, Wales and Northern Ireland using a detailed model of the housing stock. Differences in population density also affects the number of miles driven by people in different parts of the UK.

The timing with which industrial clusters in Scotland and Wales decarbonise will have a big impact on total emissions.

- **Large point sources of emissions.** Existing fossil-fuelled power stations and industrial clusters (e.g. the South Wales industrial cluster and Grangemouth in Scotland) are large point-sources of emissions that will continue to pollute until effective measures to decarbonise them are put in place (see Chapter 3 and the Methodology Report). Reducing emissions from any large point-source of emissions will have a larger proportional impact on Scottish, Welsh and Northern Irish emissions than it will on the UK total. The timing and pace of the transition to low-carbon technologies at individual locations will have larger impact on the total emissions pathway for each nation.
- The UK's **airport infrastructure** is concentrated in England, particularly around London. This means that successful abatement of – or failures to act on – aviation emissions will have a smaller impact on the total emissions pathways for Scotland, Wales and Northern Ireland.
- **The Integrated Single Electricity Market** is the all-island electricity network shared between Northern Ireland and the Republic of Ireland. As interconnection increases, energy policy in Northern Ireland must support an efficient, low-carbon electricity market to operate on both sides of the border.

d) Potential to store CO_2

Unlike emissions reductions, deployment of greenhouse gas removals is not tied to specific location.

Carbon capture and storage (CCS) is crucial for the transition to Net Zero. In addition to playing a central role in reducing emissions from industrial processes and combustion, as well in electricity generation and potentially hydrogen production, CO_2 will also need to be removed from the atmosphere through greenhouse gas removals technologies, such as bioenergy with CCS (BECCS) and direct air CO_2 capture with storage (DACCS).

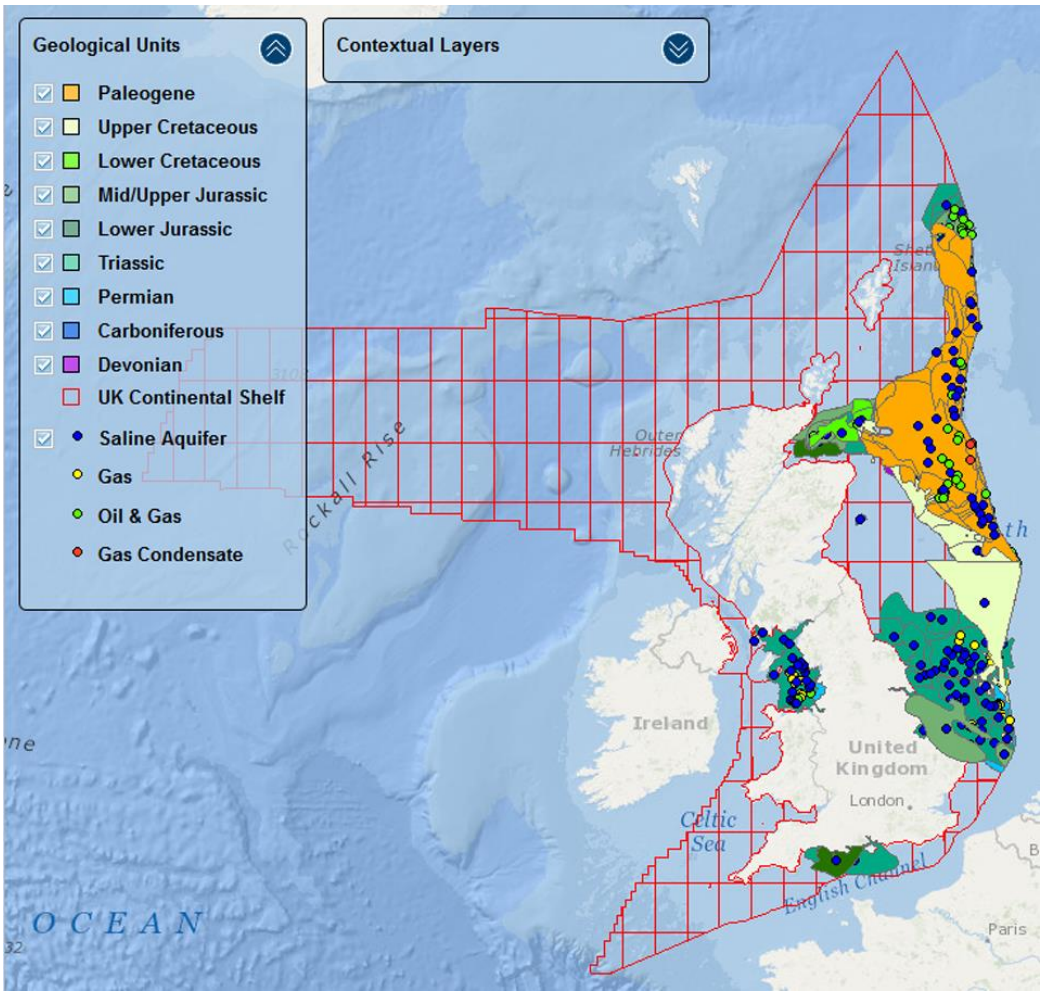
Under IPCC accounting rules the emissions credit for BECCS removals is allocated where the CO_2 capture occurs (i.e. where the biomass is combusted), rather than where the biomass is grown. Greenhouse gas removal technologies could – in theory – be located anywhere in the UK and would count towards UK emissions reductions.

It would be sensible for engineered removals to be located close to CO_2 stores.

However, there are strategic reasons why BECCS and DACCS might be best located in certain areas of the country – such as co-location with industrial CCS clusters, in close proximity to CO_2 storage sites (Figure 4.3), or in close proximity to sources of biomass.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

Figure 4.3 Map of potential CO_2 storage locations around offshore UK



Source: Energy Technologies Institute LLP, NERC and The Crown Estate (2020) *CO_2 Stored Database.*

The emissions pathways for Scotland, Wales and Northern Ireland are therefore highly dependent on carbon storage capabilities:

- If CCS is used in places that are not located near to CO_2 storage sites, the CO_2 that is captured must be used or transported to a storage site. This will incur higher costs (e.g. the additional costs of shipping CO_2 at around £10-20/tCO_2)[10] and may make other solutions that do not require CCS such as electrification more cost competitive.

Wales and Northern Ireland are less well-placed for CO_2 storage than England and Scotland.

- Large parts of Northern Ireland have more limited access to CO_2 storage sites and therefore do not appear to be the most ideal places to locate BECCS power plants.

Particularly in the 2020s and early 2030s, the location of existing biomass power generation capacity in the UK will be important as these sites could be the first to be retrofitted with carbon capture and storage.

e) Existing policies

Existing and planned policies will have lasting effects for emissions pathways for Scotland, Wales and Northern Ireland. To the extent possible, we include these impacts in our analysis. These include:

- **Long-term contracts for electricity production** that will drive new offshore wind capacity in the 2020s and recent UK Government decisions on other low-carbon electricity generation projects, including nuclear and tidal energy.
- **Tree planting.** The trees that are planted today will continue to sequester carbon over time – particularly in Scotland where planting rates have more than doubled in the last five years, a supply chain is in place and funding is already secured for the next decade.
- **Waste management policy** is mostly devolved and differs across devolved administrations. This has been reflected in our analysis, with Wales and Scotland achieving higher recycling rates than England in our scenarios before 2030. Waste sent to landfill today can continue to emit greenhouse gases for decades, so existing policy will have an impact on long-term emissions pathways in the waste management sector.

2. Pathways for Northern Irish emissions

Chapter 1 of the Sixth Carbon Budget sets out how the Committee has developed new scenarios to explore a range of ways to achieve Net Zero by 2050 at the latest, and used those exploratory scenarios to identify a balanced pathway towards Net Zero for the UK.

Here we present the results of our Balanced Pathway and exploratory scenarios for Wales, Scotland and Northern Ireland.

In this section, we present an analysis of what the Balanced Net Zero Pathway and exploratory scenarios and the for the UK mean for emissions pathways in Scotland, Wales and Northern Ireland. It is in four parts:

a) Defining pathways for Northern Ireland

b) Balance of sectoral emissions in 2050

c) Scenarios on the path to Net Zero emissions for the UK

d) Range of greenhouse gas removals needed to reach Net Zero

a) Defining pathways for Northern Ireland

We have derived pathways for the devolved administrations in parallel with our UK scenarios as described in Chapter 1 (Figure 4.4). Broadly, this approach entails:

- Deriving a baseline emissions projection for each sector to 2050 for each of the devolved administrations that takes into account, as far as possible, differences in current and projected trends across Scotland, Wales and Northern Ireland.
- Analysing the amount of abatement in each country that is consistent with the UK-wide scenario in each sector.
- Combining these to provide five scenarios for each of Scotland, Wales and Northern Ireland for the period 2020-2050.
- Assessing the costs, savings and co-impacts of these actions.

More detail on sector-specific methodologies for deriving sectoral pathways for Scotland, Wales and Northern Ireland is available in each chapter of the accompanying Methodology Report.

A challenge in defining these scenarios has been to determine where greenhouse gas removals in the UK scenarios could be located geographically as – unlike reductions in existing emissions – these are not tied to a specific geographical location or existing activities.

The Committee's pathway analysis does not allocate specific levels of greenhouse gas removals that are used in UK scenarios. This includes the combustion of biomass to generate electricity with CCS (BECCS power) or the use of direct air capture with carbon capture and storage (DACCS).

Due to the difficulty of allocating UK removals to different parts of the UK, we present results without these.

All of the emissions pathways in this chapter are therefore presented without the inclusion of any engineered greenhouse gas removals.

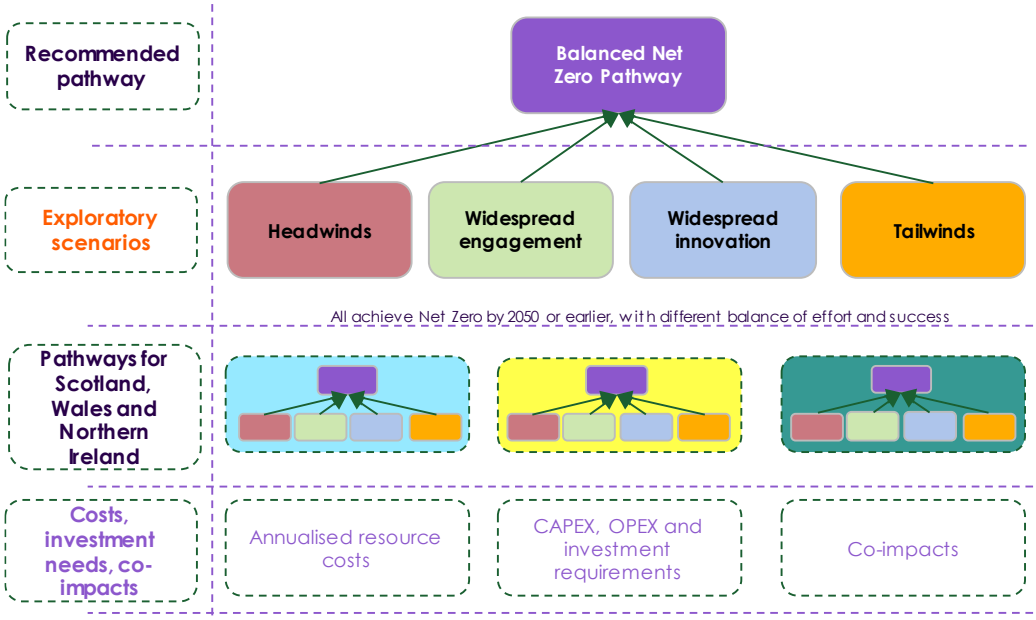
However, we do provide a partial analysis of the potential for removals in two areas in Table 4.2:

- **Wood in construction.** The potential for the use of wood in construction to store biogenic carbon for the lifetime of each building (typically 50-100 years) is included in the range set out in Table 4.2. The potential for emissions removals from the use of wood in construction is much less than 0.5 $MtCO_2$ per year in our scenarios for Scotland, Wales or Northern Ireland.
- **BECCS in industry.** Modelling of the manufacturing & construction sector identified opportunities to use biomass, biogas and biogenic wastes with CCS to generate process heat. These removals are not included in the pathways presented in this Chapter, but the range of potential is presented in Table 4.2.

When recommending targets, we consider pathways without engineered removals and then consider ranges for the share of removals.

When recommending targets (e.g. in our parallel advice for Wales), we consider these pathways without engineered removals and then what different shares of total UK removals might mean for what level of emissions reduction is feasible.

Figure 4.4 Our analytical framework includes five costed pathways for Scotland, Wales and Northern Ireland



Source: CCC

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

b) Scenarios on the path to Net Zero emissions for the UK

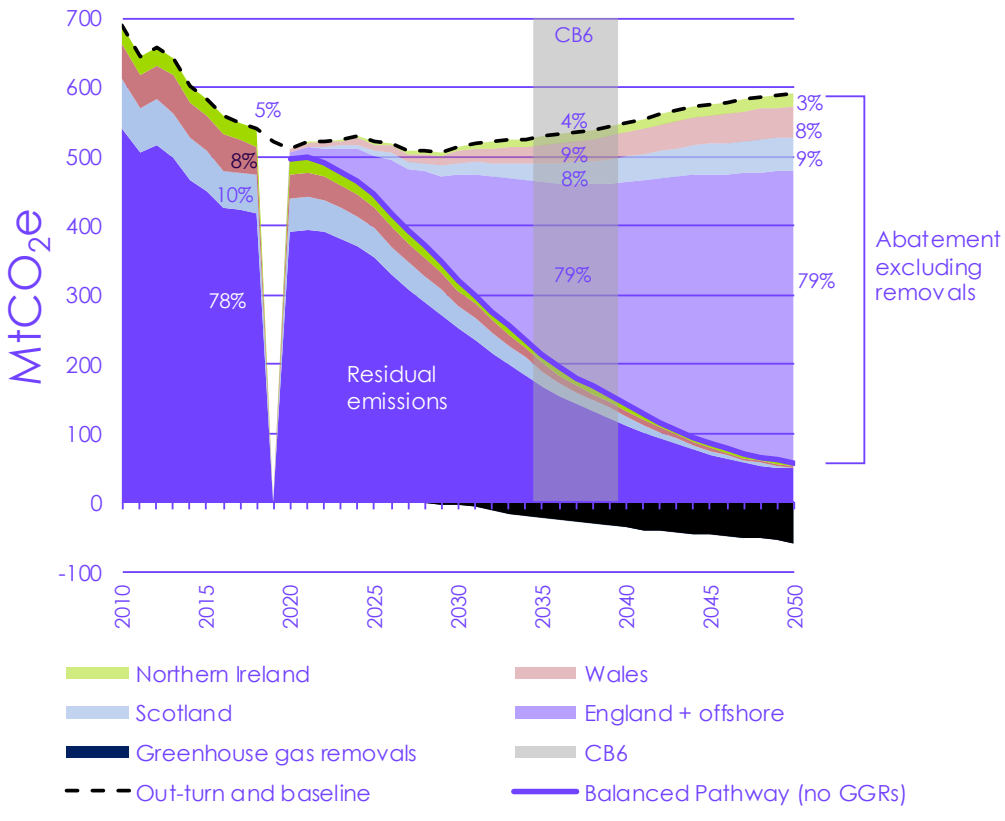
i) Contribution to Net Zero emissions for the UK

Reductions in positive emissions are similar across the UK.

Across the Balanced Net Zero Pathway, the contributions of Scotland, Wales and Northern Ireland to emissions reductions remain comparable to their existing share of emissions (Figure 4.5):

- Scotland contributes to 8% of all abatement action across the Sixth Carbon Budget period and 9% in 2050 in our Balanced Net Zero Pathway, compared to 10% of UK emissions in 2018. Scotland is likely to also have a significant share of UK greenhouse gas removals.
- Wales contributes to 9% of all non-GGR abatement action across the Sixth Carbon Budget period and 8% in 2050 in our Balanced Net Zero Pathway, compared to 8% of UK emissions in 2018.
- Northern Ireland contributes to 4% of all non-GGR abatement action across the Sixth Carbon Budget period and 3% in 2050 in our Balanced Net Zero Pathway, compared to 5% of UK emissions in 2018.

Figure 4.5 Share of UK emissions and abatement during the Sixth Carbon Budget period and 2050



Source: BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019*; NAEI (2020) *Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2019*; CCC analysis.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

ii) Balance of sectoral emissions in 2050

As set out in Chapter 2 of the Sixth Carbon Budget, the balance of sectoral emissions in the UK in our scenarios for Net Zero in 2050 is most sensitive to residual emissions from aviation, agriculture and the amount of CO_2 that can be removed from the atmosphere through forestry and greenhouse gas removals.

As the size of the existing aviation sector in Northern Ireland is much smaller than England, the net emissions for each nation in 2050 are determined mostly by emissions from LULUCF and agriculture, and the amount of greenhouse gas removals that can be deployed.

Figure 4.11 shows the breakdown of residual emissions in each scenario excluding any greenhouse gas removals.

These charts also allow a comparison to the 'Further Ambition' scenario that was set out in our 2019 Net Zero report.[11] Compared to the Further Ambition scenario:

- The Balanced Pathway has lower emissions from manufacturing & construction and fuel supply (defined as 'industry' in our Further Ambition scenario). This is particularly important for Scotland and Wales where our sectoral analysis has focused on clusters at Grangemouth and South Wales.
- The Balanced Pathway typically has comparable - or slightly higher - emissions in the agriculture sector.
- The scenarios are typically lower than in the 2019 Net Zero Report, despite the fact that they do not have any greenhouse gas removals allocated to them.

The Headwinds, Widespread Engagement, Widespread Innovation and Tailwinds scenarios explore a wider range of sectoral pathways in 2050. For Scotland, Wales and Northern Ireland, the sectors which have the biggest impact on emissions in 2050 are:

- The size of the net **land use** sink in 2050 which varies based on the scale of measures to remove carbon from the atmosphere, particularly tree planting.
- The potential for further reductions in the **agriculture sector** due to behaviour changes and technological innovations.

iii) Emissions pathways for Northern Ireland

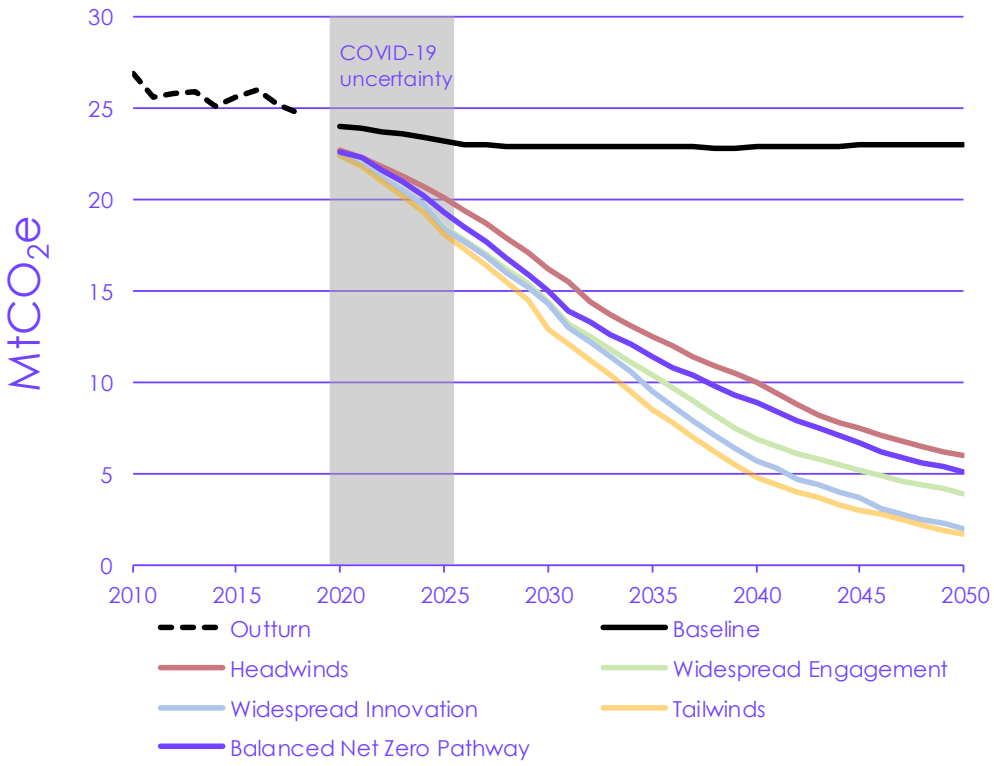
Northern Ireland struggles to get close to Net Zero greenhouse gas emissions, largely due to high agriculture emissions.

Northern Ireland can achieve very significant reductions of greenhouse gas emissions in 2050 without the use of greenhouse gas removals, but none of our scenarios for UK Net Zero see Northern Ireland achieving Net Zero emissions (Figure 4.10):

- The Balanced pathway is on average 60% lower than 1990 levels during the Sixth Carbon Budget period, rising to an 82% reduction by 2050.
- None of the exploratory scenarios reach Net Zero by 2050, with the very stretching tailwinds scenario getting to a 94% reduction (Figure 4.11).
- All of the scenarios see Northern Ireland reaching a further reduction by 2050 than the 'Further Ambition' scenario, particularly due to greater emissions reductions in land use sector.

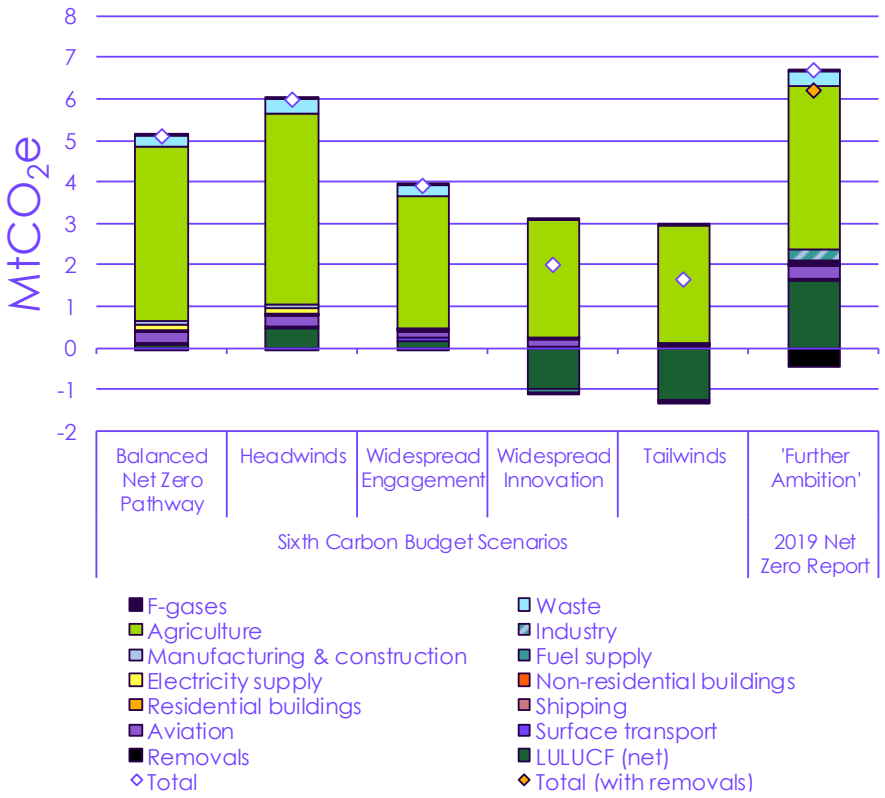
- Emissions from agriculture are marginally higher in the Balanced Pathway compared to the 'Further Ambition' scenario from 2019.

Figure 4.10 Emissions pathways for Northern Ireland without greenhouse gas removals



Source: NAEI (2020) *Greenhouse Gas Inventories for England, Scotland, Wales & Northern Ireland: 1990-2019*; CCC analysis.

Figure 4.11 2050 emissions scenarios for Northern Ireland in comparison to the 2019 Net Zero report



Source: CCC (2019) *Net Zero: The UK's contribution to stopping global warming;* CCC analysis.
Notes: The 'Industry' sector from the 2019 Further Ambition Scenario maps closely to the Manufacturing & Construction and Fuel Supply sectors. Fuel Supply emissions may appear slightly negative in some scenarios due to emissions savings from biomethane in the gas grid being allocated to Fuel Supply rather than to the end-use sectors. These additional emissions savings are larger than the other residual emissions from fuel supply.

c) Range of greenhouse gas removals needed to reach Net Zero

The scenarios set out in previous sections of this chapter are presented without any share of UK greenhouse gas removals. This section explores the range of greenhouse gas removals that would be required to reach Net Zero emissions in any given year (Table 4.2, Figure 4.12).

The conclusions of this analysis are:

It is difficult to see how Northern Ireland can reach Net Zero for all greenhouse gas emissions.

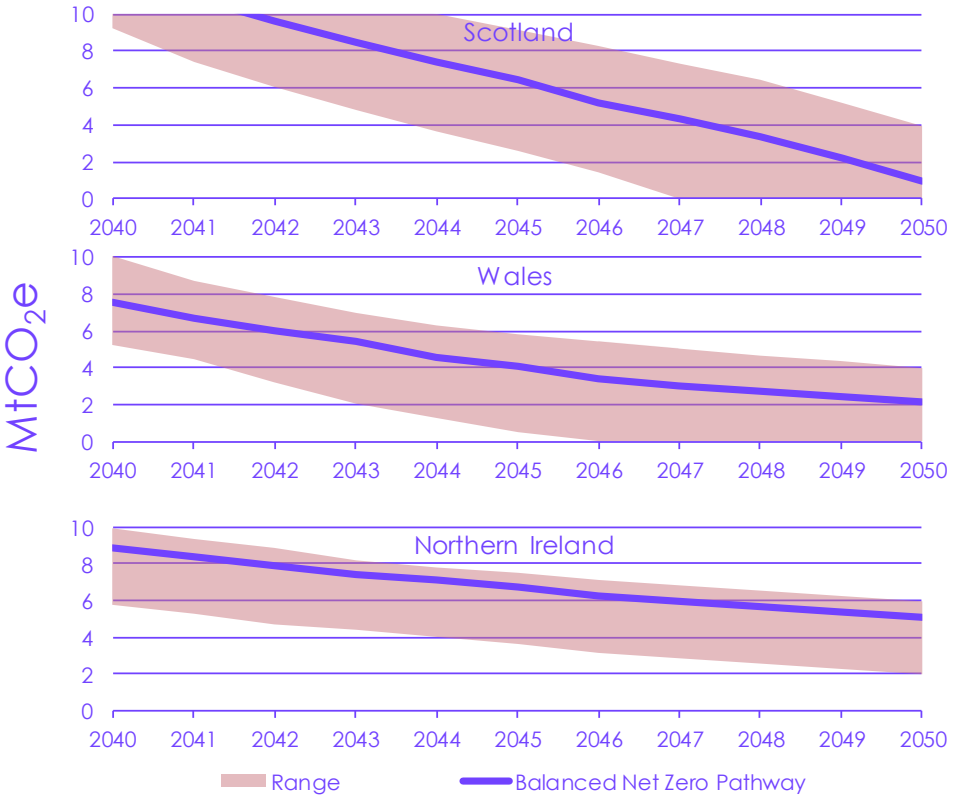
- **Northern Ireland** would not reach Net Zero emissions even in our very stretching Tailwinds scenario, unless a much larger share of UK removals relative to Northern Ireland's expected storage capabilities and size of population and economy were located there.

Table 4.2
Range of greenhouse gas removals required to meet Net Zero in a given year ($MtCO_2$)

	Required in Balanced Net Zero Pathway	Range across Headwinds, Widespread Engagement and Widespread Innovation	Potential for BECCS in manufacturing and wood in construction	Amount of GGRs identified in 2019 Net Zero Report
Northern Ireland 2050	5	2 - 6	0.1 - 0.4	<1

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

Figure 4.12 Amount of greenhouse gas removals that would be required to reach Net Zero in a given year



Source: CCC analysis.
Notes: The range shown is defined by the Headwinds, Widespread Engagement and Widespread Innovation scenarios.

A Climate Change Act for Northern Ireland

Achieving the Net Zero emissions for the UK by 2050 does not necessitate that every part of the UK gets to Net Zero. Some parts of the UK will be 'net sources' of greenhouse gases by 2050 with emissions offset in other parts of the UK that are 'net sinks'.

The analysis carried out for this report suggests that Northern Ireland achieving Net Zero greenhouse gas emissions is not necessary for the UK to meet its climate targets.

Emissions reductions in Northern Ireland are still crucial if the UK is to reach Net Zero overall, though:

- In every scenario for achieving UK Net Zero that we have constructed, Northern Ireland would not get to Net Zero greenhouse gas emissions by 2050.
- In our Balanced Net Zero Pathway, Northern Ireland would reach an 82% reduction in greenhouse gases by 2050 compared to 1990 levels excluding engineered greenhouse gas removals.
- Northern Ireland would achieve Net Zero CO_2 emissions by 2050 as part of the Balanced Pathway to UK Net Zero.

Our current analysis does not show a credible pathway for Northern Ireland to reach Net Zero greenhouse gas emissions.

Our current analysis does not show a credible pathway for Northern Ireland to reach Net Zero greenhouse gas emissions as part of its contribution to the UK Net Zero target. We therefore do not recommend that Northern Ireland set a Net Zero target for all greenhouse gases. Instead, Northern Ireland should aim for at least an 82% reduction in all greenhouse gases by 2050.

There is no purely technical reason why Net Zero is not possible in Northern Ireland. However, compared to the scenarios set out in this report, Net Zero GHGs in Northern Ireland would mean one (or both) of the following:

- A substantial reduction in output from Northern Ireland's livestock farming sector that goes beyond the stretching scenarios we have analysed in this report.
- A much greater than equal share of all UK greenhouse gas removals being located in Northern Ireland compared to its current emissions, population or economic output.

Northern Ireland achieving Net Zero CO_2 emissions would be consistent with the necessary contribution to UK Net Zero.

A target for Net Zero CO_2 emissions in Northern Ireland by 2050 would be consistent with the UK's Net Zero ambition.*

* The Republic of Ireland's Climate Change Advisory Council 'Annual Review 2020' recommends seeking EU agreement to creating a split national target for 2050: Net Zero emissions of long-lived greenhouse gases and anthropogenic methane', with a separate, longer target for biogenic methane. The Committee will comment by letter on what an equivalent target would be for Northern Ireland.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

Table 4.3
Emissions reductions for Northern Ireland in the UK Balanced Net Zero Pathway

Time period	Reduction in all GHG emissions compared to 1990 levels	Reduction in CO_2 emissions compared to 1990 levels
2030	48%	56%
Average over UK Sixth Carbon Budget period (2033-2037)	60%	70%
2040	69%	83%
2050	82%	Net Zero

4. Costs and benefits in Scotland, Wales and Northern Ireland

Chapters 5 and 6 of the Sixth Carbon Budget analyse the costs and benefits of meeting the Sixth Carbon Budget for the UK and how those costs are distributed fairly and efficiently across society.

The economic resource costs of reducing emissions in Northern Ireland will vary by scenario and over time, as the balance of measures to reduce emissions will be different than for the UK as a whole. That is reflected in the cost estimates presented in this Chapter.

We estimate the costs of taking action but do not identify how these will be paid for, either in terms of policy design or who pays. Chapter 6 expands on the distributional considerations of meeting the Sixth Carbon Budget, covering:

- ensuring a just transition;
- jobs and opportunities in the transition;
- distribution of costs, household energy bills and fuel poverty;
- competitiveness; and
- fiscal circumstances.

Estimates of overall resource costs at devolved level do not imply that these costs will be borne locally.

The net resource costs we report in this section should not be interpreted as the costs that would be delivered via devolved budget expenditure, nor as costs that only Scottish, Welsh or Northern Irish businesses and consumers have to bear.

Many of the actions to reduce emissions will likely be paid for at UK level and/or socialised across the whole of the UK. For example:

- The costs associated with building new low-carbon generation will be shared across all consumers of electricity on the GB grid. We have reflected this by allocating resource costs for electricity supply in proportion to consumption, rather than make assumptions on where new zero-carbon generating capacity (e.g. nuclear power stations) are located.

- The costs of decarbonising industrial clusters could be met through a combination of direct financing from the UK Exchequer and/or be passed through to the end-users of low-carbon products.
- A market mechanism for greenhouse gas removals could see the UK aviation industry offsetting emissions by paying for removals, including planting trees, in all areas of the UK.

The extent to which costs and savings are shared across the UK – including the amount of expenditure through devolved administrations' budgets – will be determined by policy at UK and devolved level.

Table 4.4 sets out the range of annualised resource costs* associated with action in the devolved administrations in the Balanced Pathway. A more detailed set of sectoral costs will be available on the CCC website.

Our analysis shows that the costs of decarbonisation in Scotland, Wales and Northern Ireland are roughly proportional to their existing share of UK emissions during the Sixth Budget Period.

Table 4.4
Annualised resource costs over the Sixth Carbon Budget period under the Balanced Net Zero Pathway

	UK	Northern Ireland
Sixth Carbon Budget Period average annualised resource costs (£ billion)	See databook on CCC website for full estimate of costs in Northern Ireland	

* Annualised resource costs are the annualised additional investment, cost of capital and operating cost implications in a given year of a given measure relative to costs in an alternative scenario (generally a hypothetical world with no new climate action or climate damages).

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

5. Recommendations for policy

Delivering extensive decarbonisation in the UK will require a strong policy framework at UK, devolved, regional and local Government level.

While some important policy levers are held in Westminster, powers are fully or partially devolved in most key areas.

Scotland, Wales and Northern Ireland have (fully or partially) devolved powers in a number of areas relevant to emissions reduction. There are also clear overlaps with the need for policies at local level.

While all sectors will require a significant degree of interdependent policies from both the UK and devolved Governments, the nature of the devolution agreements means that the balance of policy action between devolved and UK Governments varies across different sectors and subsectors of the economy (Box Table 4.5).

The categorisation in Table 4.5 is a useful way of framing the challenge, but the policy landscape is far more complex. Many areas of devolved and reserved policies cut across multiple sectors. For example, devolved powers (e.g. carbon trading, education and public engagement), and reserved powers (e.g. energy taxation, monetary policy and international trade) can have significant impacts in almost every sector.

Sole responsibility for any sector of the economy cannot be simply allocated to policymakers in Westminster, Holyrood, Cardiff and Stormont; co-ordinated policy action is required across every sector and by every department.

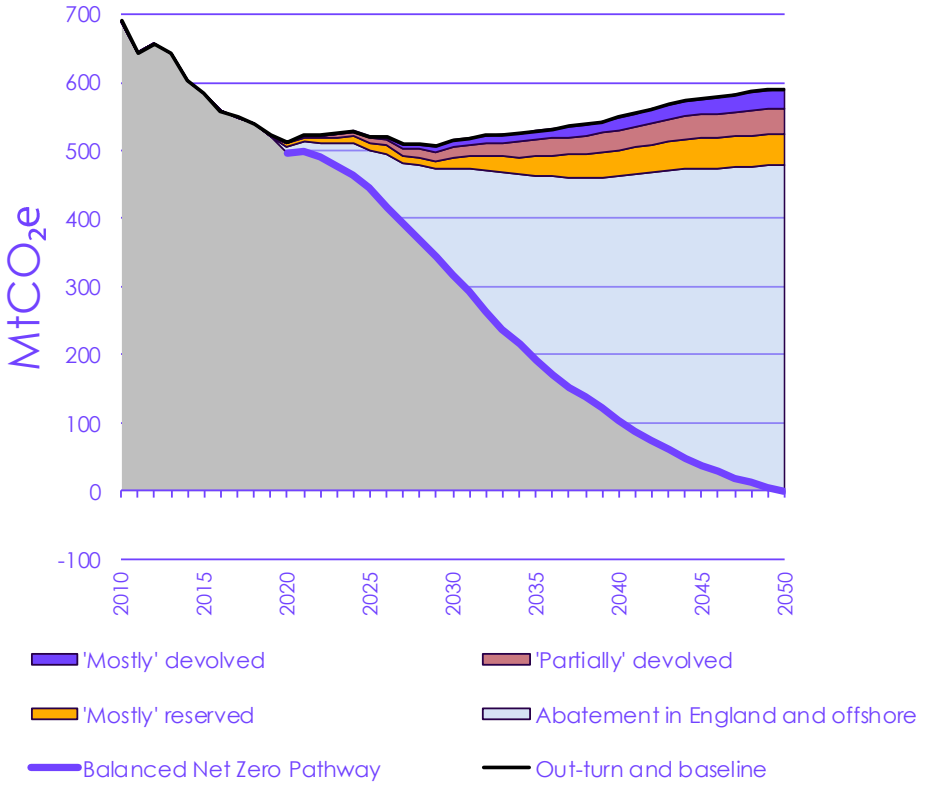
Table 4.5
Balance of devolved powers by sector

Sectors where key policy levers are 'mostly' devolved	Sectors where key policy levers are 'partially' devolved	Sectors where policy levers are 'mostly' reserved
• Agriculture • Land use, land-use change and forestry • Waste • Buildings (NI) • F-gases	• Buildings (S, W) • Surface transport • Electricity supply (NI)	• Electricity supply • Fuel supply • Manufacturing & construction • Aviation • Shipping • BECCS for power generation

Nearly 60% of all the abatement in our pathways for Scotland, Wales and Northern Ireland is in areas where key policies are 'mostly' or 'partially' reserved

In total, 11% of all UK abatement in our Balanced Net Zero Pathway will take place in sectors where key policy levers are 'mostly' or 'partially' reserved to Scotland, Wales and Northern Ireland as classified in Table 4.5 (Figure 4.13). Nearly 60% of all the abatement in our pathways for Scotland, Wales and Northern Ireland is in areas where key policies are 'mostly' or 'partially' reserved.

Figure 4.13 Share of UK abatement that is in sectors where key policy levers are 'mostly' or 'partially' devolved



Source: CCC analysis.
Notes: The range shown is defined by the Headwinds, Widespread Engagement and Widespread Innovation scenarios.

Strong policy action is essential in areas where key powers are largely devolved:

- **Demand-side transport measures.** Devolved administrations must implement effective policies to make it easy for people to walk, cycle and use low-carbon public transport. Electric vehicle charging infrastructure must also be expanded across all parts of the UK to ensure that the electric vehicle switchover works for all road users.
- **Buildings energy efficiency.** Meeting the earliest possible date for Net Zero emissions will require major improvements to the energy efficiency of new and existing buildings, in order to improve comfort levels, lower energy bills and prepare the building stock for a switch to low-carbon heating. Policy to achieve these results in Scotland, Wales and Northern Ireland will largely be delivered through devolved buildings standards and policy.
- **Agriculture and land use.** Low-carbon farming practices, afforestation, agroforestry and peatland restoration all have a crucial role to play in reducing emissions by 2050. The framework to follow the Common Agricultural Policy in each devolved administration provides an opportunity for more closely linked financial support to agricultural emissions reduction and increased carbon sequestration.
- **Waste**. Devolved administrations are responsible for reducing emissions from waste, with a focus on reducing, reusing and recycling waste, diverting biodegradable waste from landfill, and capturing methane from landfill and wastewater.

- **Electricity and heat in Northern Ireland.** Unlike Scotland and Wales, Northern Ireland has devolved control of its power sector, although the operation of Northern Irish I-SEM is affected by both UK and Republic of Ireland policy. For the UK to achieve Net Zero emissions, Northern Ireland must achieve equally ambitious decarbonisation in the power sector.
- **Carbon trading** is a devolved matter and the devolved administrations and UK Government have consulted on a UK-wide Emissions Trading System that is collectively agreed with the rest of the UK.
- **Leadership role**. Effective policies in Scotland, Wales and Northern Ireland can set the standard for the rest of the UK. Recent examples include the Energy Efficient Scotland Programme and the Welsh Government's *Towards zero waste* strategy.

Even where the main policy levers are reserved to Westminster, there is a range of ways that devolved Governments can contribute.

Where powers are reserved to the UK level, the devolved administrations have an important role in ensuring that the emissions reductions take place. In particular, the devolved administrations should focus on the following areas:

- **Planning.** Planning frameworks are another useful lever over infrastructure that needs to be well aligned to objectives for emissions reduction in devolved administrations (e.g. through encouraging walking, cycling and use of public transport, ensuring readiness for or installation of electric vehicle charging points in new developments, and a favourable planning regime for low-cost onshore wind).
- **Procurement.** The public sector in devolved administrations can use procurement rules positively to help drive emissions reductions in a number of areas (e.g. uptake of ultra-low emission vehicles, energy efficiency and low-carbon heat in buildings, low-carbon products).
- **Convening role.** It is important the devolved administrations maximise their potential to bring stakeholders together, and facilitate dialogue and strengthen relationships, to enable the development of mutually beneficial projects that contribute to decarbonisation.
- **Working with the UK Government** to ensure that UK-wide policies work for devolved administrations.
- **Access to UK-wide funding.** The devolved administrations should seek to ensure that households and businesses have good access to UK-wide funding opportunities where possible and appropriate.
- **Communication and public engagement** of climate risks and the options and choices available to reduce emissions across the UK.

Actions by the UK Government will be necessary to deliver the Welsh and Scottish targets, and actions by the devolved administrations will be necessary to deliver the UK target.

Adapted from CCC (2020) The Sixth Carbon Budget: The UK's path to Net Zero

The Sixth Carbon Budget Methodology Report

The Committee's advice on the Sixth Carbon Budget is based on an extensive programme of analysis, consultation and consideration by the Committee and its staff, building on the evidence published in 2019 for our *Net Zero* advice. The Sixth Carbon Budget advice consists of three CCC reports, as well as supporting data and evidence (see Report Map on next page).

A key part of the Committee's approach has been the construction of a set of self-consistent pathways, or scenarios, for emissions in each sector of the UK's emissions from now through to 2050. This *Methodology Report* contains a summary of the CCC's overall analytical approach to these scenarios, and a chapter for each sector of emissions, containing detail on the analysis and evidence used.

In addition to this Methodology Report we have also published:

- **An Advice report**: *The Sixth Carbon Budget – The UK's path to Net Zero*, setting out our recommendations on the Sixth Carbon Budget (2033-37) and the UK's Nationally Determined Contribution (NDC) under the Paris Agreement. This report also presents the overall emissions pathways for the UK and the Devolved Administrations and for each sector of emissions, as well as analysis of the costs, benefits and wider impacts of our recommended pathway, and considerations relating to climate science and international progress towards the Paris Agreement.*
- **A Policy Report:** *Policies for the Sixth Carbon Budget and Net Zero*, setting out the changes to policy that could drive the changes necessary, particularly over the 2020s.†
- **A dataset** for the Sixth Carbon Budget scenarios, which sets out more details and data on the pathways than can be included in this report.
- **Supporting evidence** including our public Call for Evidence, 10 new research projects, three expert advisory groups, and deep dives into the roles of local authorities and businesses.

For ease, the relevant sections from the three reports for each sector (covering pathways, method and policy advice) are collated into self-standing sector documents. A full dataset including key charts is also available alongside this document.

All outputs are published on our website (www.theccc.org.uk). This report is not intended to present the results of the analysis – the key results are presented in the Advice Report, with a fuller set of results in the Sixth Carbon Budget Dataset.

* CCC (2020) The Sixth Carbon Budget – The path to Net Zero.

† CCC (2020) Policies for the Sixth Carbon Budget and Net Zero.

Methodology: Emissions pathways for Northern Ireland

We produce pathways for Scotland, Wales and Northern Ireland, taking into account specific circumstances that affect the pace and overall level of decarbonisation for these nations.

Alongside our analysis of UK emissions pathways, we produce pathways and costs for Scotland, Wales and Northern Ireland, for each sector of emissions, and on an economy-wide basis.

These pathways, which feed directly into our UK-level analysis, are based on specific factors which determine the rate and overall level of decarbonisation achievable in each nation (Table 1.3). This includes:

- different levels of activity and emissions in each sector today;
- existing usage of land, and opportunities for land-based removals;
- existing infrastructure;
- opportunities to remove CO_2 from the atmosphere; and
- existing policies.

The methods of determining pathways for Scotland, Wales and Northern Ireland are set out in each chapter of this report.

Table 2.3
Developing pathways for Scotland, Wales and Northern Ireland

CCC sector	Methodology for allocating emissions and costs in UK scenarios to devolved administrations
Surface transport	– Road vehicle traffic (including HGVs) is based on the Department for Transport's (DfT) National Transport Model (NTM), which produces forecasts by GB country. The NTM model does not include Northern Ireland, so emissions there are scaled based on current vehicle-km use by vehicle type. – Line-specific rail electrification. – National Travel Survey (NTS) data are no longer collected, but our assumption on UK-average changes in travel behaviour is not expected to have a significant impact on DAs' emissions pathways.[12]
Electricity supply	– Our analysis uses a model of the GB network only. To allocate electricity supply emissions to Scotland and Wales, we sum the existing plant-level capacity and projected retirement dates for each generating technology and apply load factors to these based on changes in GB-wide load factors. For Northern Ireland, we forecast demand due to increased electrification and combine this with the Northern Ireland grid emission intensity from the most recent System Operator Northern Ireland (SONI) report.
Aviation	– Emissions are disaggregated by type of flight (international, domestic) and split by DAs' existing share of emissions in the inventory. DfT projections of individual airport demand, including the impact of airport expansion, impact overall UK demand management.
Shipping	– Emissions are disaggregated by type of journey (international, domestic) split by share of emissions in the inventory.
Residential buildings	– Low-carbon heat and energy efficiency measures are deployed in our scenarios using a housing stock model of the UK which integrates regional national housing survey data for England, Scotland, Wales and Northern Ireland, with an accurate mix of building attributes for each of those places. District heating is also modelled at devolved administration level.[13] – Measures for new-build, cooking decarbonisation and energy efficiency relating to lighting and appliances are modelled separately and scaled for DAs based on current energy demand for these services.

Non-residential buildings	– Analysis carried out at a UK level with abatement based on the Buildings Energy Efficiency Survey (BEES) for England and Wales, BEIS's heating study for England and Wales and UK-level district heat analysis. – Emissions pathways are based on existing share of direct emissions from non-residential buildings.
Manufacturing, construction and fuel supply	– Analysis of industry decarbonisation is based largely around site-level emissions data, so the analysis reflects the composition of industry in Scotland, Wales and Northern Ireland.[14] – Assumptions about availability of hydrogen and CO_2 storage will also include some (limited) site-specific considerations.
Agriculture	– UK baseline emissions projections are split, based on share of emissions in the current inventory. – On-farm measures are based on technical potential and cost effectiveness of measures at country level, based on SRUC modelling (including new measures in a 2019 update (for the Net Zero report) and a further 2020 update for the CCC).[15] – Abatement savings from energy use, diet change and food waste reduction based on existing sub-sector share of emissions in the NAEI inventory (Agricultural soils, Enteric fermentation, Livestock wastes, Liming & urea application, Machinery)
LULUCF	– Land use scenarios based on modelling of land across each country of the UK. Accounts for differences in existing land use and in land acquisition costs. Includes peatland, energy crops, afforestation (including on-farm) and forest management, with land released through more efficient farming, food waste reduction and diet changes.
Hydrogen use and production	– Various scenarios for hydrogen roll-out in different distribution networks of the GB gas-grid and industrial clusters over time, including the South Wales industrial cluster and Grangemouth. UK hydrogen production likely located near carbon capture and storage (CCS) clusters (if produced by methane reformation) or near sources of low-carbon electricity generation (if produced by electrolysis).
Waste	– Landfill fugitive emissions are based on DA-specific methane modelling resulting from DA landfill volumes and banning certain streams from landfill.[16] – Other waste sector emissions (e.g. wastewater, composting) are split from UK pathways based on historical share in the inventory.
F-gases	– Emissions are split based on the share of sub-sector F-gas emissions in latest NAEI inventory.

Endnotes

[1] CCC (2020) *The Sixth Carbon Budget – The UK's path to Net Zero*

[2] Climate Assembly UK (2020) *The path to Net Zero*

[3] CCC (2020) *The Sixth Carbon Budget – Methodology Report*

[4] CCC (2020) *The Sixth Carbon Budget – Methodology Report*

[5] CCC (2020) *Policies for the Sixth Carbon Budget and Net Zero*

[6] CCC (2020) *Sixth Carbon Budget and Welsh Emissions Targets Call for Evidence Summary*.

[7] Welsh Government (2019) *Wales accepts Committee on Climate Change 95% emissions reduction target.*

[8] UK Government and Irish Government (2020) *New Decade, New Approach*.

[9] CCC (2019) *Reducing emissions in Northern Ireland.*

[10] BEIS (2018) *Shipping CO_2 – UK Cost Estimation Study.*

[11] CCC (2019) *Net Zero – The UK's contribution to stopping global warming.*

[12] CCC (2017) *Building a low-carbon economy in Wales*.

[13] Element Energy for the CCC (2020) *Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget.*

[14] Element Energy (2020) *Deep decarbonisation pathways for UK industry.*

[15] Scottish Rural College (2020) *Non-CO2 abatement in the UK agricultural sector by 2035 and 2050* and Centre for Ecology and Hydrology (2020) *Updated quantification of the impact of future land use scenarios to 2050 and beyond.*

[16] Based on Ricardo's MELMod model for the National Atmospheric Emissions Inventory (NAEI)