June 2023

Progress in reducing emissions

2023 Report to Parliament

Climate Change Committee

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Contents

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Foreword

This is my final report as Chairman of the Climate Change Committee, containing our clearest analysis of UK progress yet. The Climate Change Act and the Committee were originally seen as a bold experiment in climate governance; they are now an essential legal framework and a trusted institution. We should cherish the central role that objective, robust analysis of climate change now plays in the debate over our economy and society. The UK continues to avoid the polarised climate politics that plague other countries, but that must never be taken for granted.

My particular privilege has been to lead this organisation over a crucial decade, where the Committee has informed and supported Governments across the UK to raise their climate ambition. Much has been said of the UK's climate leadership, including here, but the willingness of UK Ministers to embrace Net Zero, and accept a legal obligation to meet targets on that path, represented genuine leadership.

However, the true test of leadership is delivery. And here, I am more worried. The commitment of Government to act has waned since our COP26 Presidency. There is hesitation to commit fully to the key pledges.

This will not win the fight. Our successes have come when we have been bold, harnessing the power of the private sector to work collectively towards lower emissions, to the benefit of people across the UK. Our much-heralded approach to offshore wind has been successful precisely through this effort. It was Government commitment to delivery that made possible this cleaner, cheaper generation.

In this report, we comment on a curious situation. This year, the Government has published more detail on their climate programme than ever before, cajoled to do so by the Courts. But Ministers seem less willing to put that programme at the centre of their stated aims. Our confidence in the achievement of the UK's 2030 target and the Fifth and Sixth Carbon Budgets has markedly declined from last year.

Leadership is required to broaden the national effort to every corner of our economy. That means investing now in low-carbon industries to deliver lasting economic benefits to the UK. It means committing with confidence to the key dates and policies that will deliver zero-emission buildings and transport and facing down the critics. It demands that we earn the support of farmers and rural communities with policies that bring together our climate and food security aims. It requires our unambiguous commitment to the fossil fuel phase out, accepting that global reserves are already too great. And it means providing people in the UK with positive choices that benefit the climate. That is where enduring public support lies. In fighting climate change, we are not only averting disaster, we are building a better, cleaner, fairer world.

All of this is still within our grasp, but this is a key moment to remake the arguments for faster progress. I urge Government to find the courage to place climate change once again at the heart of its leadership. It would be a terrible error if we in Britain hesitate just as the rest of the world wakes up to the opportunity of Net Zero.

Lord Deben,
Chairman of the Climate Change Committee

The Committee

The Rt. Hon John Gummer, Lord Deben,
Chairman

Lord Deben was the UK's longest-serving Secretary of State for the Environment (1993 to 1997). He has held several other high-level ministerial posts, including Secretary of State for Agriculture, Fisheries and Food (1989 to 1993). Lord Deben also runs Sancroft, a corporate responsibility consultancy working with blue-chip companies around the world on environmental, social and ethical issues.

Professor Keith Bell

Keith Bell is a co-Director of the UK Energy Research Centre (UKERC), a Chartered Engineer and a Fellow of the Royal Society of Edinburgh. He has been at the University of Strathclyde since 2005, was appointed to the Scottish Power Chair in Smart Grids in 2013 and has been involved in energy system research in collaboration with many academic and industrial partners.

Professor Michael Davies

Michael Davies is Professor of Building Physics and Environment at the UCL Institute for Environmental Design and Engineering (IEDE). At UCL his research interests relate to the complex relationship between the built environment and human wellbeing. He is also Director of the Complex Built Environment Systems Group at UCL and a member of the Scientific Advisory Committee of 'Healthy Polis'.

Professor Piers Forster

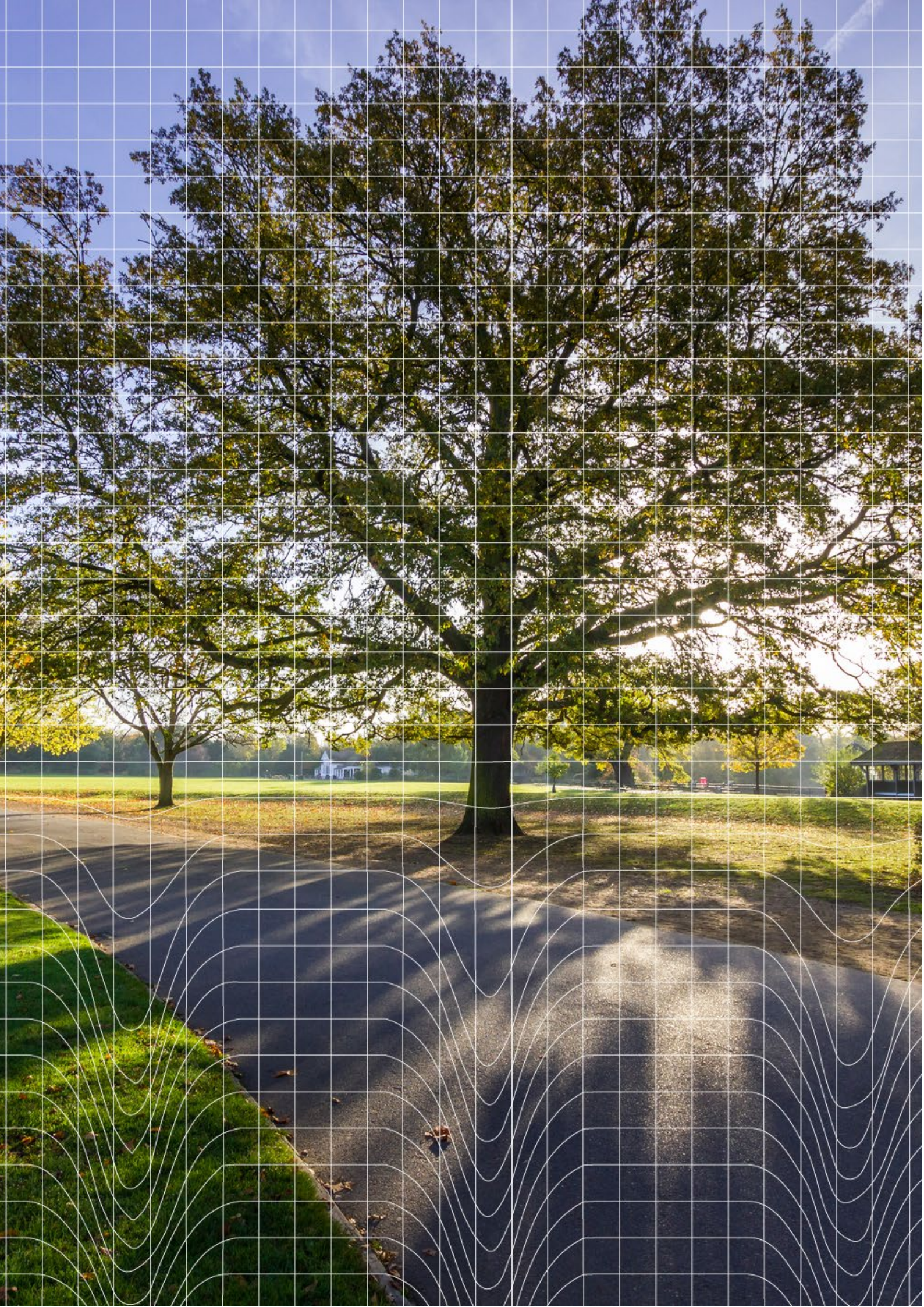
Piers Forster is Director of the Priestley International Centre for Climate and Professor of Physical Climate Change at the University of Leeds. He has played a significant role authoring Intergovernmental Panel on Climate Change (IPCC) reports, and is a coordinating lead author role for the IPCC's sixth assessment report.

Professor Corinne Le Quéré FRS

Corinne Le Quéré is a Royal Society Research Professor at the University of East Anglia (UEA), specialising in the interactions between climate change and the carbon cycle. She was lead author of several assessment reports for the UN's Intergovernmental Panel on Climate Change (IPCC) and she currently Chairs the French Haut Conseil pour le Climat.

Nigel Topping CMG

Nigel Topping was appointed by the UK Prime Minister as UN Climate Change High Level Champion for COP26. In this role Nigel mobilised global private sector and local government to take bold action on climate change, launching the Race To Zero and Race To Resilience campaigns and, with Mark Carney, the Glasgow Financial Alliance for Net Zero.



Executive summary

For many in the UK, 2022 was the year that climate change arrived, with the UK's first ever 40°C day.* It was the UK's warmest recorded year and one of the six warmest years on record globally. The record-breaking temperatures seen in the UK in summer 2022 brought unprecedented numbers of heat-related deaths, wildfire incidents and significant infrastructure disruption. Human activities are causing our climate to change. Only decisive action will slow further changes.

The UK has lost its clear global leadership position on climate action. We are no longer COP President; no longer a member of the EU negotiating bloc. Our response to the recent fossil fuel price crisis did not embrace the rapid steps that could have been taken to reduce energy demand and grow renewable generation. We have backtracked on fossil fuel commitments, with the consenting of a new coal mine and support for new UK oil and gas production – despite the strong wording of the Glasgow Climate Pact. And we have been slow to react to the US Inflation Reduction Act and the EU's proposed Green Deal Industrial Plan, which are now a strong pull for green investment away from the UK. It is critical that the UK re-establishes its climate leadership with a clearer strategy to develop Net Zero industries and technologies in the UK and capture the economic benefits of Net Zero, with actions that create demand-pull for the critical technologies that will shape the UK's progress over the next decade.

This year saw the release of new detail on the Government's plans for Net Zero with the publication of the Carbon Budget Delivery Plan (CBDP) prompted by last year's High Court judgement. But policy development continues to be too slow and our assessment of the CBDP has raised new concerns. Despite new detail from Government, our confidence in the UK meeting its medium-term targets has decreased in the past year. The increased transparency embodied in the CBDP is welcome, but a key opportunity to raise the overall pace of delivery has been missed.

At COP26, the UK made stretching 2030 commitments in its Nationally Determined Contribution (NDC) – now only seven years away. To achieve the NDC goal of at least a 68% fall in territorial emissions from 1990 levels, the rate of emissions reduction outside the power sector must almost quadruple. Continued delays in policy development and implementation mean that the NDC's achievement is increasingly challenging. Some of the key planks of the UK Net Zero Strategy have substantial lead-times (e.g. hydrogen storage, greenhouse gas removals and carbon capture and storage (CCS) more generally). Progress in other areas is also too slow, including tree planting and the roll-out of low-carbon heating. There continues to be an overly narrow approach to solutions, which crucially does not embrace the need to reduce demand for high-carbon activities. A more realistic approach to delivery is needed. This cannot wait until after the next General Election.

* Without human activity, the 40°C heatwave would have been extremely unlikely. World Weather Attribution (2022) *Without human-caused climate change temperatures of 40°C in the UK would have been extremely unlikely.*

The key messages in this report are:

- **A lack of urgency.** While the policy framework has continued to develop over the past year, this is not happening at the required pace for future targets. The Net Zero target was legislated in 2019, but there remains a lack of urgency over its delivery. The Net Zero transition is scheduled to take around three decades, but to do so requires a sustained high-intensity of action. This is required all the more, due to the slow start to policy development so far. Pace should be prioritised over perfection.

- **Stay firm on existing commitments and move to delivery.** The Government has made a number of strong commitments, notably on the 2030 fossil fuel vehicle phase-out, the 2035 decarbonisation of the electricity system, the commitment to install 600,000 heat pumps per year by 2028, and the deployment at scale of new industries such as hydrogen and greenhouse gas removals. These must be restated and moved as swiftly as possible towards delivery, including by ensuring the UK has the skills base it needs to deliver on its commitments and building on its promising plans to guide private sector action and investment. The recent announcement of up to £20 billion funding for CCS is welcome – we look forward to the detail and implementation of these spending plans.

- **Retake a clear leadership role internationally.** The UK will need to regain its international climate leadership. This means taking urgent action to reduce emissions in line with delivering the UK's ambitious NDC for 2030 and fulfilling other pledges made in international climate negotiations, ensuring that decisions on UK fossil fuel production and infrastructure are consistent with Net Zero and the UK's expectations of others, and putting climate back at the front and centre of UK diplomacy from the highest level.

- **Immediate priority actions and policies.** Action is needed in a range of areas to deliver on the Government's emissions pathway. New policies are urgently needed in industry, especially in the steel sector where the Government has high ambitions for decarbonisation but no policy to deliver it, as well as wider incentives for electrification of industry. Policies are required to step up the rates of tree planting and peatland restoration. The Government needs to overcome the uncertainty being caused by its planned 2026 decision on the role of hydrogen in heating, to accelerate deployment of electric heating and press ahead with low-regret energy infrastructure decisions. We welcome the commitment to rebalance electricity and gas prices by spring 2024, which will support electrification.

- **Develop demand-side and land use policies.** The Government's current strategy has considerable delivery risks due to its over-reliance on specific technological solutions, some of which have not yet been deployed at scale. This lack of balance carries considerable and increasing risks to meeting the emissions targets. Recent experience on societal changes (e.g. to travel patterns) following the pandemic has shown that substantial changes to behaviours are possible, although these have not been due to climate policy. It is essential that policies to empower and support people to make low-carbon lifestyle choices are implemented now, especially on home energy use, shifting to healthier and more sustainable diets, and reducing air and car travel. Further strengthening of policy in these areas may be required subsequently given risks of shortfalls in delivery elsewhere.

- **Empower and inform households and communities to make low-carbon choices**. Despite some positive steps to provide households with advice on reducing energy use in the last year, a coherent public engagement strategy on climate action is long overdue. Increased concern about climate change and relatively high knowledge about Net Zero provide a potentially favourable context for engaging with the public. People should be empowered to make green choices, through a better understanding of how they can play their part and supported by a positive vision and leadership from Government about the societal changes required. Information alone is not sufficient – it must be accompanied by implementation of policies that both make low-carbon choices easy, attractive and affordable. Deliberative processes should be considered for navigating challenging policy decisions, building on the insights and lessons from the UK Climate Assembly.

- **Planning policy needs radical reform to support Net Zero.** In a range of areas, there is now a danger that the rapid deployment of infrastructure required by the Net Zero transition is stymied or delayed by restrictive planning rules. The planning system must have an overarching requirement that all planning decisions must be taken giving full regard to the imperative of Net Zero.

- **Expansion of fossil fuel production is not in line with Net Zero.** As well as pushing forward strongly with new low-carbon industries, Net Zero also makes it necessary to move away from high-carbon developments. The decision on the Cumbrian coal mine sent a very concerning signal on the Government's priorities. The UK will continue to need some oil and gas until it reaches Net Zero, but this does not in itself justify the development of new North Sea fields.

- **The need for a framework to manage airport capacity.** There has been continued airport expansion in recent years, counter to our assessment that there should be no net airport expansion across the UK. No airport expansions should proceed until a UK-wide capacity management framework is in place to assess annually and, if required, control sector CO_2 emissions and non-CO_2 effects.

We present the rest of this Executive Summary in six sections:

1. Progress in reducing emissions
2. Indicators of progress
3. Policy risks and gaps
4. The urgent need for action and strategy
5. Progress against last year's recommendations
6. Priority recommendations in this report

1. Progress in reducing emissions

Emissions in 2022 were 0.8% higher than in 2021, remaining 9% below pre-pandemic levels in 2019 and 46% below 1990 levels.

UK greenhouse gas emissions were 450 $MtCO_2e$ in 2022, including the UK's share of international aviation and shipping, which is 46% below 1990 levels. This is an increase of 0.8% since 2021, but remains 9% below pre-pandemic (2019) levels.

Changes in emissions in 2022 were mainly driven by transient differences in demand and temperature (Figure 1):

- Aviation emissions almost doubled in 2022 compared with 2021 as the sector recovered from the pandemic, but remained 25% lower than in 2019.
- Surface transport emissions increased by 3%, but remained 8% below pre-pandemic (2019) levels, with some evidence that car-kilometres have reached a reduced steady state.

The change in emissions in 2022 was driven by an almost doubling of aviation emissions balanced by a 16% decrease in emissions from residential buildings, due to mild winter months and high gas prices.

- There was a 16% decrease in emissions from homes, largely driven by winter temperatures but with some effect due to very high fossil fuel prices.
  - The headline fall in emissions was predominantly due to a relatively mild winter in 2022 (compared to the colder winter of 2021). After adjusting for winter temperatures, emissions from homes fell by only 6% in 2022, which is likely to have been driven by a behavioural response to the record-high gas prices.
  - However, it is unclear what the balance was between improvements in efficiency (e.g. reducing boiler flow temperatures) and people having colder homes due to the unaffordability of energy.
- The UK became a net exporter of electricity in 2022 rather than a net importer, as has typically been the case in previous years. This increased gas-fired electricity production above what it otherwise would have been, although increased renewable generation meant that power sector emissions were stable.
  - Shortfalls of energy in mainland Europe, due to the lack of Russian gas supply and low generation from French nuclear plants, meant that the UK imports of liquefied natural gas were then re-exported to the rest of Europe both as gas and gas-fired electricity.
  - While it is difficult to estimate the precise impact of the additional emissions from gas power plants, we estimate that emissions might otherwise have been lower by around 3 $MtCO_2e$ (6% of electricity supply emissions) in 2022 without this export effect.

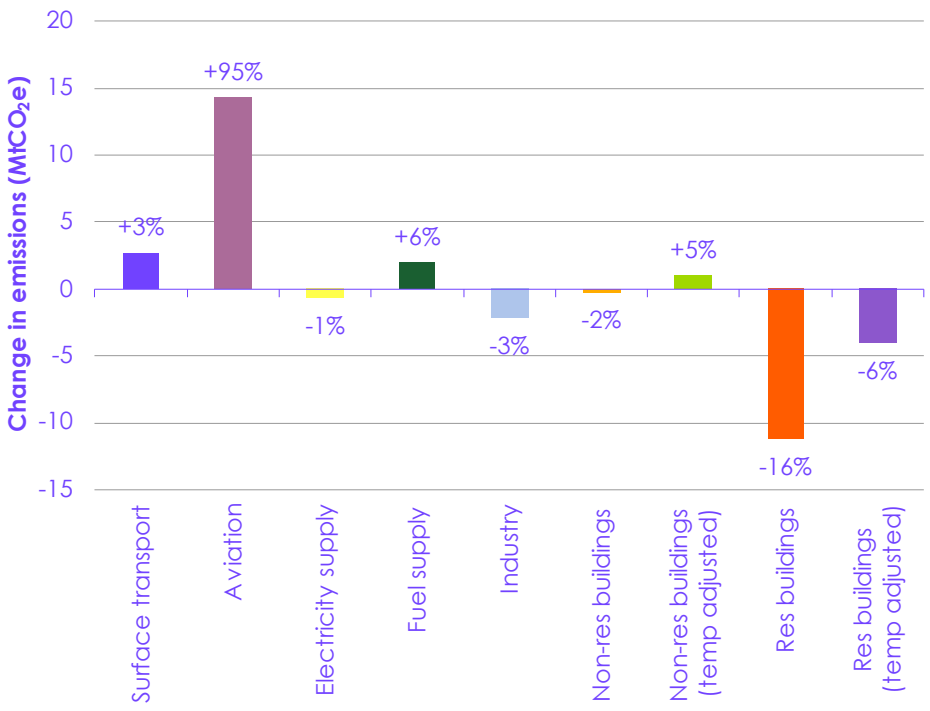
Given that much of the recent change in emissions has been driven by exceptional circumstances, it is more instructive to look back further in time to see the overall rate of progress. The pace of emissions reduction has been slow in recent years in all sectors apart from electricity supply (Figure 2). In agriculture and land use, emissions are essentially unchanged from a decade ago. Significant risks and policy gaps remain in these sectors, and elsewhere.

If the UK is to achieve its 2030 NDC, the rate of emissions reduction outside electricity supply must almost quadruple.

The rate of emissions reduction will need to significantly increase for the UK to meet its 2030 NDC and the Sixth Carbon Budget. If the UK is to achieve its NDC, the rate of emissions reduction outside the electricity supply sector must almost quadruple, from 1.2% annual reductions to 4.7%. The Government's quantified plans in the CBDP fall slightly short of this, falling by an annual average of 4.4%, with the Government taking the position that unquantified plans will make up this shortfall (Figure 3). We set out the necessary immediate actions in section 4.

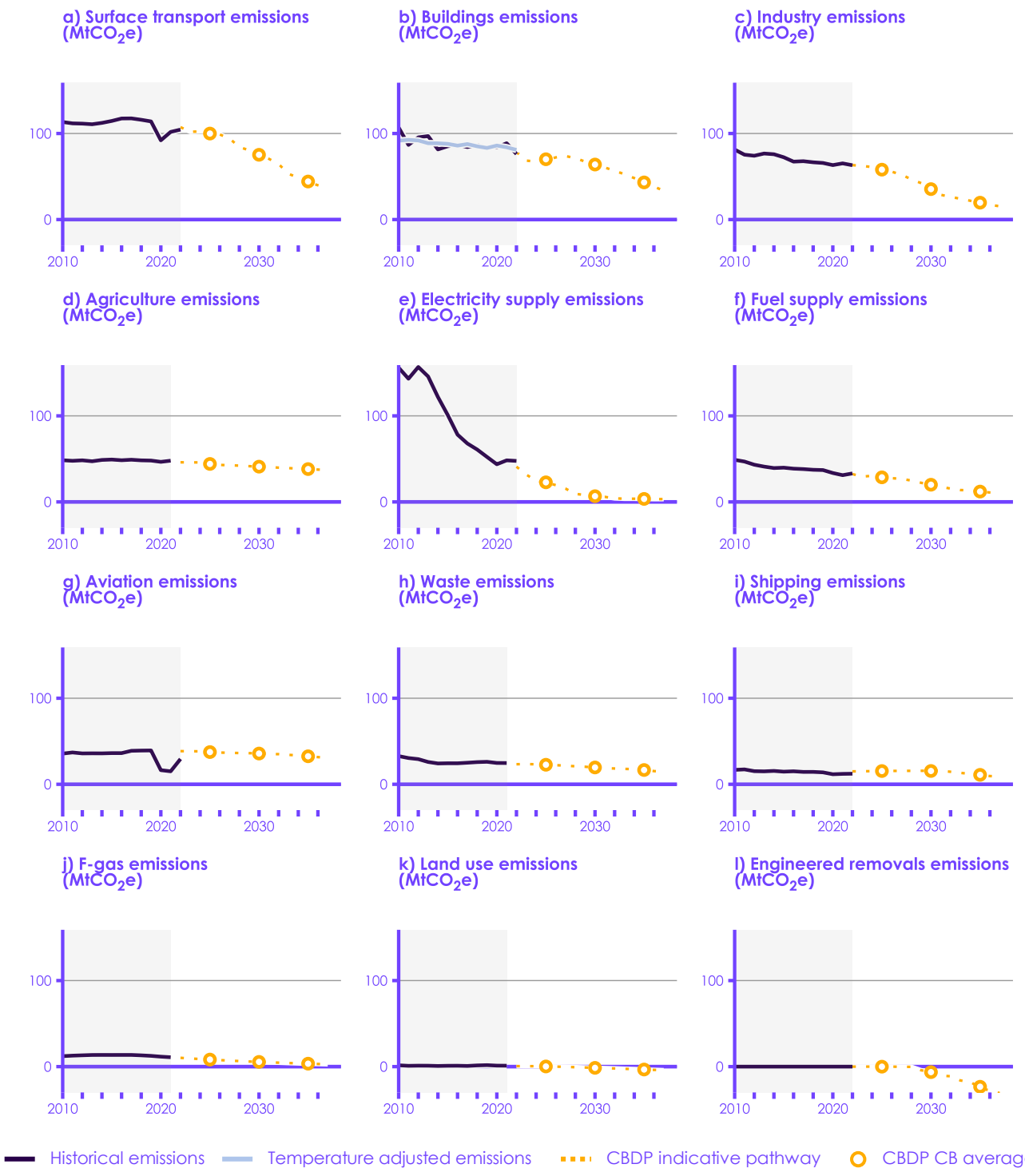
Emissions in 2022 increased slightly by 0.8% due to an almost doubling of aviation emissions balanced by a 16% decrease in emissions from residential buildings.

Figure 1 Change in UK emissions for key sectors (2021 to 2022)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; CCC analysis.
Notes: Global warming potentials from IPCC AR5 without feedback are used. Provisional 2022 estimates are not made for non-CO_2 greenhouse gases, so the change in 2022 agriculture emissions is not shown.

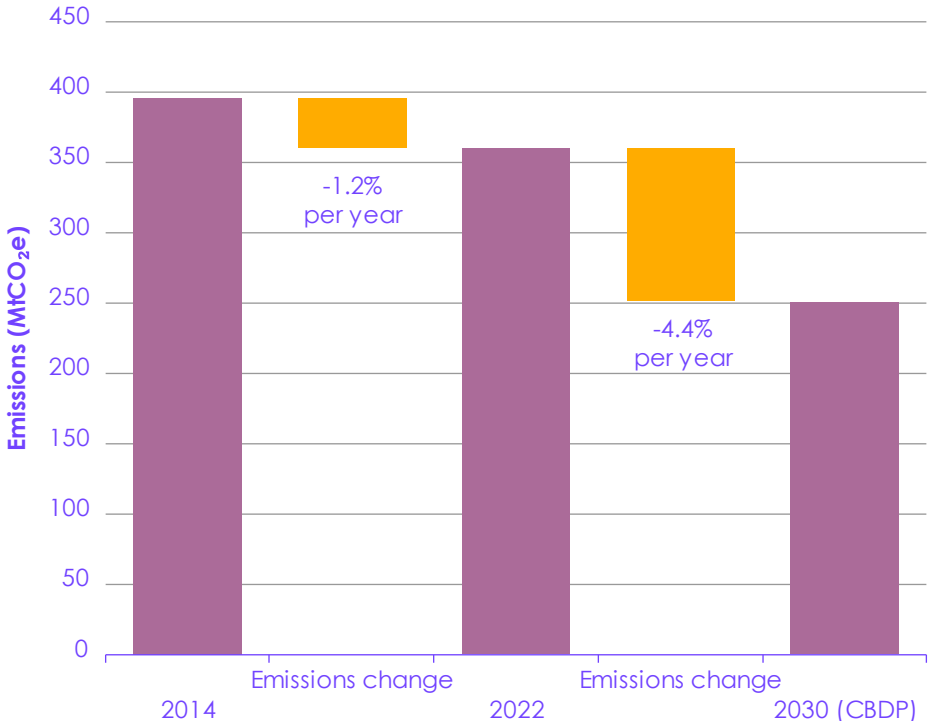
Figure 2 UK historical emissions by sector compared to the Government's pathway



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; DESNZ (2023) *Carbon Budget Delivery Plan*.
Notes: (1) The Carbon Budget Delivery Plan (CBDP) projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (2) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. (3) We have adjusted the Government's CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

If the UK is to achieve its 2030 NDC, the rate of emissions reduction outside the electricity supply sector must almost quadruple.

Figure 3 Change in total emissions excluding electricity supply, aviation and shipping (2014 to 2022 and required from 2022 to 2030)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; DESNZ (2023) *Carbon Budget Delivery Plan*.
Notes: (1) Aviation and shipping omitted due to ongoing pandemic effects on 2022 emissions. (2) The Carbon Budget Delivery Plan (CBDP) projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (3) We have adjusted the Government's published CBDP pathway for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

2. Indicators of progress

In our 2022 UK Progress report, we introduced our new Monitoring Framework and increased our focus on tracking against real-world indicators of progress. We continue this approach in this report, with recent progress in different sectors and in cross-cutting issues discussed in the following chapters.

While there have been some positive developments, our indicators show action being significantly off track in a range of areas.

Table 1 summarises the progress seen this year in key sectors. While there have been some positive developments, we see action being significantly off track in a range of areas:

- **Surface transport.** Sales of new electric cars are continuing to grow ahead of our pathway, although electric van sales are still lagging and remain significantly off track. This is particularly concerning given that van traffic is also increasing fast, already exceeding our pathway.

- **Electricity supply.** Renewable electricity capacity increased in 2022, but not at the rate required to meet the Government's stretching targets, particularly for solar deployment. Given short lead-times, rapid deployment of onshore wind and solar could have helped to mitigate dependence on imported gas during the fossil fuel crisis.

- **Buildings.** The Government proposes to scale-up the market for heat pump installations to 600,000 by 2028, but current rates are around one-ninth of this and are not increasing fast enough. Installation rates of energy efficiency measures continue to be below necessary levels and fell further in 2022.

- **Electricity prices.** The Government's decision to take policy costs off electricity prices as part of financial support on energy bills means that the ratio of electricity prices to gas prices has fallen. It is now essential that this improvement in relative prices is made permanent, in the rebalancing of electricity and gas prices which the Government has committed to implement by March 2024.

- **Land use.** Tree-planting rates continue to be too low and are not increasing at the rate required. Rates will need to double by 2025 for the Government to reach its target of 30,000 hectares per year of woodland creation. Peatland restoration rates increased slightly in 2022 but remain a factor of five less than our recommended rates.

- **Agriculture.** Livestock numbers are on track despite no policy support in this area to support the current momentum in the right direction. Reported meat consumption is also on track, but data on meat availability shows a less clear picture; further policy intervention on diets is therefore required.

- **Industry.** Progress in this sector is hard to track due to poor availability of data, but is off track for most available indicators. As we recommended last year, the Government should review, invest in and reform industrial decarbonisation data collection and reporting.

Table 1
Summary of progress against key indicators

Surface transport	Energy supply	Buildings	Industry	Agriculture and land
Electric car sales (G)	Grid storage (G)	Electricity to gas price ration (G)	Bioenergy use in industry (G)	Livestock numbers (G)
Battery cell prices (O)	Dispatchable low-carbon capacity in development (G)	Greening Government commitments (G)	Electricity use in industry (O)	Livestock exports (G)
Petrol / diesel car intensity (O)	Offshore wind (O)	Low-carbon share of heat supply (O)	Energy consumption per unit of GVA (O)	Food waste (G)
Petrol/diesel van intensity (O)	Onshore wind (O)	Energy efficiency measures (R)	Private sector targets (R)	Woodland management (O)
Van km (O)	Unabated gas (O)	Heat pump installations (R)	Industrial process emissions (R)	Crop yields (O)
HGV km (O)	Refineries emissions (O)	Heat pump costs (R)	Hydrogen use in industry (W)	New woodland (R)
Electric van sales (R)	Solar PV (R)	Trained heat pump installers (R)	Pipeline of hydrogen projects (Gr)	Peatland restoration (R)
Car km (W)	Active demand response (W)	Residential energy demand (W)	Industrial energy efficiency (Gr)	Anaerobic digestion (R)
Public chargepoints (W)	Low-carbon hydrogen production (W)	Non-residential energy demand (W)	Pipeline of industrial CCS projects (Gr)	Energy crops (W)
Public transport demand (LGr)	Oil and gas production emissions (W)	Non-residential buildings energy intensity (W)	Industry consumption emissions (LGr)	Meat consumption (W)

Key:

- On track (G)
- Slightly off track (O)
- Significantly off track (R)
- Too early to say (W)
- Data not reported (Gr)
- No benchmark or target (LGr)

Notes: An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path and considering wider contextual factors.

(a) Latest assessment of the risks to meeting emissions targets

The increased transparency embodied in the CBDP sets a minimum standard for the detail in which the Government plans on Net Zero are set out.

The increased transparency embodied in the CBDP sets a minimum standard for the detail in which the Government plans on Net Zero are set out, enabling scrutiny from Parliament, the CCC and wider stakeholders. The CBDP was published in response to the High Court ruling that the Government's 2021 Net Zero Strategy (NZS) did not comply sufficiently with the Climate Change Act due to it lacking this detail. The Government has therefore had to provide a firmer public commitment to its plans, which has resulted in some changes in approach and ambition.

Our assessment of the prospects of meeting the NDC for 2030 and the Sixth Carbon Budget for the mid-2030s has worsened since last year.

Despite the new detail provided in the CBDP, our assessment of the prospects of meeting the NDC for 2030 and the Sixth Carbon Budget for the mid-2030s has worsened since last year. This is due to a combination of delays in action leading to increased delivery risk, together with a more detailed assessment of the Government's plans, enabled by the publication of the CBDP. There has been some improvement in prospects for meeting the Fourth Carbon Budget due to an improved outlook for transport emissions.

- **The Carbon Budget Delivery Plan has highlighted areas in which commitment may be lacking.** The CBDP has some changes in approach and ambition compared to the NZS, most notably the decision not to quantify potential emissions savings from policies aiming to reduce car-kilometres, and a reduction in ambition in the land use sector.

- **Our confidence in the UK meeting the Fourth Carbon Budget (2023-2027) has slightly increased in the last year.** This is largely driven by an approximately 5% decrease in vehicle-kilometres due to societal changes following the pandemic that appears to have reached a steady state, and increased confidence in the transition to electric vehicles in the near term, as sales continue to grow.

- **However, our confidence in the UK meeting the 2030 NDC and the Sixth Carbon Budget (2033-2037) has decreased since last year (Table 2, Figure 4 and Table 3).** This is driven by a combination of delays in action leading to increased delivery risk and the extra detail in the CBDP allowing for a more thorough assessment. While we would expect policies to be less developed for targets further away in time, the NDC is now only seven years away.

  - There is an increase in the risk to emissions reduction from surface transport and electricity supply, predominantly due to delays in developing the zero-emissions vehicle mandate and the continued lack of a strategy for decarbonising the electricity system, alongside increasing delivery risks.

  - There have been more policy gaps identified in industrial electrification and resource efficiency; in agriculture and land, due to a lack of long-term funding and a more apparent reliance on the voluntary uptake of low-carbon measures; and in engineered removals due to delays in funding and guidance.

Table 2
Summary policy scorecard for sectors to meet the 2030 NDC and the Carbon Budgets

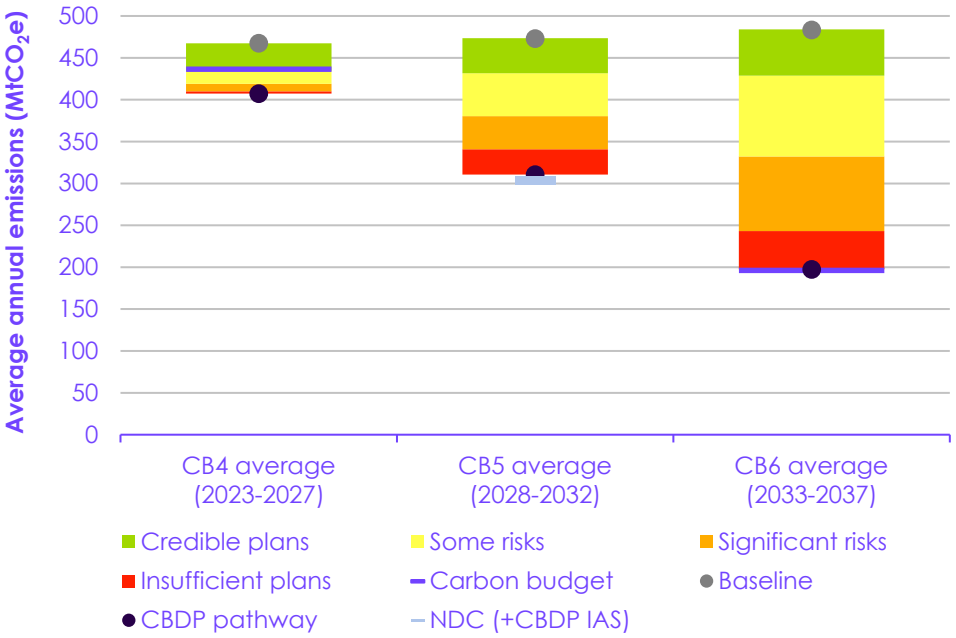
Sector	Change in emissions 2022-2035	Delivery mechanisms & responsibilities	Funding and other financial incentives	Enablers in place / barriers overcome	Timeline for future policies	Overall sector assessment
Surface transport	-61 $MtCO_2e$ (-58%)	G	Y	O	Y	Y
Electricity supply	-44 $MtCO_2e$ (-93%)	G	G	O	Y	Y
Industry	-44 $MtCO_2e$ (-69%)	O	O	O	R	O
Buildings	-33 $MtCO_2e$ (-43%)	O	O	O	O	O
Engineered removals	-25 $MtCO_2e$	Y	O	O	R	O
Fuel supply	-21 $MtCO_2e$ (-64%)	Y	Y	O	O	O
Agriculture	-10 $MtCO_2e$* (-20%)	O	R	R	O	R
Land: sources	-4 $MtCO_2e$*	O	O	O	O	O
Land: sinks		Y	Y	O	O	O
Aviation	-7 $MtCO_2e$** (-17%)	O	O	O	O	O
F-gases	-8 $MtCO_2e$* (-69%)	G	G	G	G	G
Waste	-7 $MtCO_2e$* (-30%)	O	Y	O	O	O
Shipping	-3 $MtCO_2e$** (-22%)	O	Y	O	O	O

Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022;* BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021;* DESNZ (2023) *Carbon Budget Delivery Plan;* BEIS (2021) *Net Zero Strategy;* CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) *Provisional 2022 estimates are not made for non-CO_2 greenhouse gases, so the change is relative to 2021. **Relative to 2019 due to ongoing pandemic effects on emissions.

Plans are insufficient or at significant risk for approximately half the required emissions reduction for the 2030 NDC.

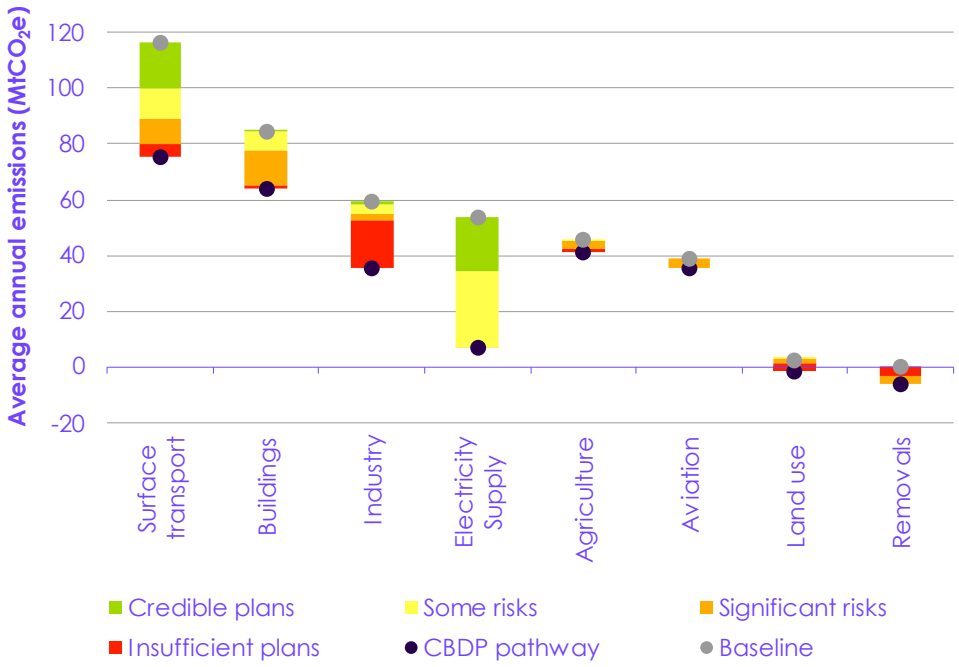
Figure 4 Assessment of policies and plans

a) Overall assessment of policies and plans



For the 2030 NDC insufficient plans come predominantly from industry.

b) Assessment for the 2030 NDC for key sectors



Source: DESNZ (2023) *Carbon Budget Delivery Plan;* DESNZ (2023) *Energy and emissions projections: 2021 to 2040;* BEIS (2021) *Net Zero Strategy;* CCC (2020) *The Sixth Carbon Budget;* CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The baseline is an adjustment to the Government's CBDP baseline, with the impact of some policies removed so that they can be assessed. Refer to each sector chapter for additional notes on our methodology. (3) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories. (4) The CBDP projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (5) For comparability, the CBDP's emissions pathway for international aviation and shipping (IAS) has been added to the target values for CB4 and the NDC.

Table 3
Assessment of Government plans in cross-cutting areas

	Ambition & timeline of proposals	Delivery mechanism (including funding and incentives)	Overall assessment
Public engagement and green choices	O	Y	O
Workers and skills	R	O	O
Business and finance	Y	O	O
Innovation	Y	O	O
Fair funding and affordability	R	O	O
	Current structures & processes	**Mechanisms & timelines for overcoming barriers**	**Overall assessment**
Governance	O	Y	O

Source: CCC analysis.
Notes: See Annex 1 for the assessment criteria.

(b) Risk management and contingency plans

The Government's decarbonisation framework is currently missing coherent plans to mitigate the delivery risks to meeting the UK's 2030 NDC and the Sixth Carbon Budget.

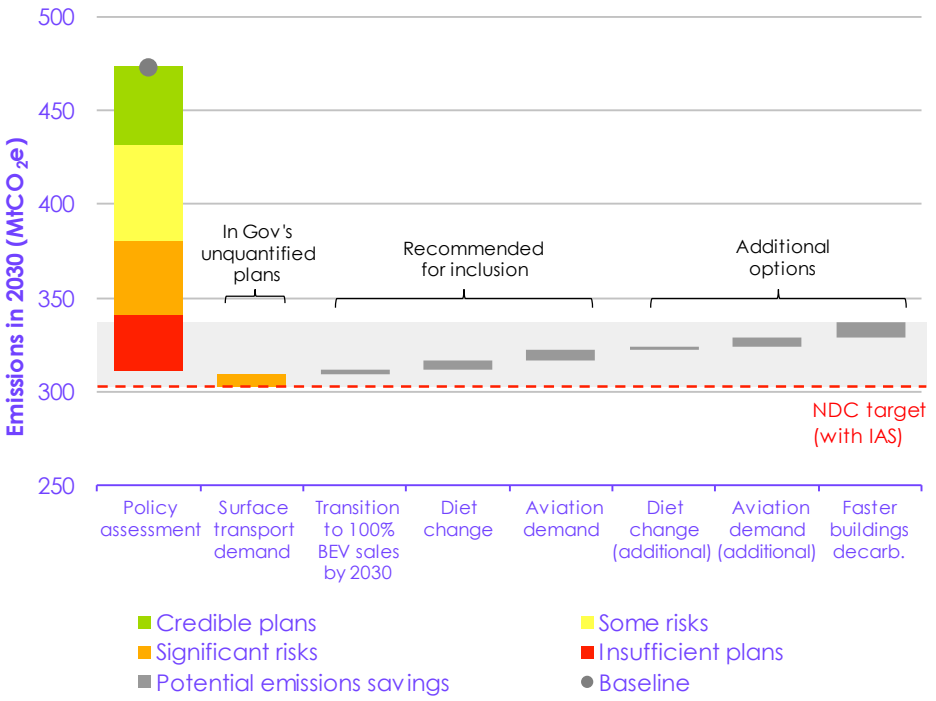
The Government's decarbonisation framework is currently missing coherent plans to mitigate the delivery risks to meeting the UK's 2030 NDC and the Sixth Carbon Budget. The current strategy has considerable delivery risks due to its over-reliance on specific technological solutions, some of which have not yet been deployed at scale. This lack of balance carries considerable and increasing risks to meeting the emissions targets.

There is already a clear case for demand-side policies to reduce emissions. These should be implemented now, as a core part of the decarbonisation strategy, especially on home energy use, shifting to healthier and more sustainable diets, and reducing air and car travel. Further strengthening of policy in these areas may be required subsequently given the risks of shortfalls in delivery elsewhere.

With the 2030 NDC only seven years away, it is vital that alternative plans are developed that identify decarbonisation options beyond those quantified in the CBDP and could deliver an appropriate amount of additional emissions reduction on the required timescale. The plans should ensure there is sufficient time for policies to be implemented in a sensible, cost-effective and fair way and ensure that there is a governance framework for their implementation on a timely basis. We present some suggested measures in Figure 5.

Developing contingency plans would significantly reduce delivery risk for the NDC, but current plans must also be strengthened.

Figure 5 Contingency options for 2030



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; DESNZ (2023) *Energy and emissions projections: 2021 to 2040*; BEIS (2021) *Net Zero Strategy*; CCC (2020) *The Sixth Carbon Budget*; CCC analysis.
Notes: (1) The policy assessment uses Government plans listed in Annex B, Tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The baseline is an adjustment to the Government's CBDP baseline, with the impact of some policies removed so that they can be assessed. Refer to each sector chapter for additional notes on our methodology. (3) The CBDP projections include only the quantified plans. Unquantified plans may lead to further emissions reductions.

4. The urgent need for action and strategy

The slow progress to date on delivery towards Net Zero means that it is no longer tenable for the Government to develop strategies that do not contain committed policies.

The slow progress to date on delivery towards Net Zero means that it is no longer tenable for the Government to develop strategies that do not contain committed policies. Policies with immediate delivery are needed, in parallel with development of new strategic visions. In most sectors, there is a clear set of actions that can be taken now and should be pursued while the longer-term picture is clarified. Alongside ambitious plans to reduce emissions, steps to integrate measures to adapt to the UK's changing climate should be taken wherever possible.

Land use. Last year, the UK Government committed to delivering a Land Use Framework that will set out how England will manage land use for multiple functions such as food security, recreation, climate mitigation and adaptation, and nature recovery. Originally indicated for publication for summer 2023, this has been pushed to the autumn with no formal date scheduled. Land use and agriculture in England remains one of the few sectors where the Government has not set out a coherent, strategic approach to coordinated policy to meet the multiple needs for land. This is vital if current barriers to climate action are to be overcome and for action to be aligned across the UK and devolved administrations. In parallel, there is an urgent need to scale up key land use mitigation measures such as tree planting and peatland restoration.

The lack of a strategic direction on the roles of electrification and hydrogen in providing low-carbon heat is creating systemic uncertainty.

Buildings. The Government has committed to take strategic decisions by 2026 on the roles of electrification and hydrogen in providing low-carbon heat. However, the lack of a strategic direction is creating systemic uncertainty. This is actively hindering the growth of supply chains for low-carbon heat and limiting progress on power and hydrogen infrastructure. Waiting three more years to set a clear direction will lead to further lost progress in buildings, and hinder infrastructure development more widely.

The Government should push forward on areas where there are no-regret and low-regret options, and seek to develop and move forward with a strategic approach:

- In our assessment, this is likely to entail pushing ahead with electrification wherever this is feasible, with – at most – a small, focused, role for hydrogen use in buildings.

- Rapid and forceful pursuit of zero-carbon new-build, energy efficiency improvements to existing buildings, low-carbon heat networks and electrification will reduce emissions and cut fossil fuel dependence this decade, while developing the supply chains and public trust that are crucial enablers for subsequent acceleration of electrified heating solutions.

In parallel with this, the Government should develop a strategic approach to low-carbon heating. This should: provide confidence that the UK can reach zero buildings emissions by 2050, including substantial progress on reducing these emissions by 2030; give medium-term clarity for infrastructure and supply-chain development; form the basis of a fair, deliverable transition that builds and sustains public consent while delivering ever-greater progress; and fit into the overall strategic approach to reducing the UK's energy import dependence and to delivering progress towards the 2040 net exporter target.

Electricity decarbonisation. The Government has committed to decarbonising electricity supply by 2035, subject to ensuring security of supply, together with ambitious targets for building new renewables and nuclear. However, the Government has not yet published an overarching standalone plan or strategy for delivering a decarbonised and reliable electricity system by 2035 that is resilient not only to average weather, but to plausible future extreme weather and demand scenarios. Doing so would facilitate a more coordinated and strategic approach to delivery and improve visibility and confidence for investors. In parallel with this, there is an immediate need for policy to move ahead with ensuring adequate network capacity and connections, bringing forward low-carbon flexibility solutions, and reforming electricity market design.

An overarching strategy for public engagement and communications is lacking.

Cross-cutting enablers. There has been some sector-specific progress in engaging with the public on green choices, but an overarching strategy for public engagement and communications is lacking. A strategic approach to fiscal and policy levers that ensures low-carbon options are affordable and costs are distributed fairly, including by rebalancing policy costs on electricity and gas, is needed. Government's Net Zero and Nature Workforce Action Plan planned for early 2024 is welcome; it is important that it goes beyond high level aims and into detail on priority sectors, regions and associated actions to grow the UK skills base. Work is underway to improve green finance and corporate reporting, but the private sector response is being held back in many sectors by weak policy signals, uncertainty, and barriers to investment.

Waste. Greater strategic coordination of plans to decarbonise the waste sector is needed including: much greater emphasis on waste prevention, clarity on future residual waste capacity needs, and the suitability of incentives and interactions with other sectors such as waste as a feedstock for Sustainable Aviation Fuels. Energy from Waste (EfW) emissions are already higher than the Government's CBDP anticipates and EfW capacity is set to increase in the coming years. A comprehensive systems-approach to control and reduce EfW emissions is urgently needed, including clarity on carbon pricing. We recommend a moratorium on additional EfW capacity until a review of capacity requirements has been completed and an updated assessment of residual waste treatment capacity requirements published.

Industry. The Government's commitment to steep reductions in industrial emissions (69% by 2035, relative to 2022) requires urgent and radical change in the UK's manufacturing sector. There is little evidence this change is underway. Furthermore, our assessment is that current plans are insufficient to reduce emissions at the required pace and scale. The lack of ambition of current industrial policies also increases the risk of manufacturers relocating to countries with a more attractive investment environment. It is vital for Government to do more to support industrial decarbonisation. In particular it should act to accelerate the electrification of industrial heat, the decarbonisation of dispersed sites and pursue opportunities to reduce consumption of industrial products.

Biomass. The Government's Biomass Strategy was due for publication by the end of 2022, but has still not been published at the timing of writing. This should be published as soon as possible.

5. Progress against last year's recommendations

There has been some progress against the recommendations we made last year, but overall the progress has been insufficient. Broadly speaking, in most areas policy development has proceeded too slowly, and has not led to the necessary action on the ground (Figure 6).

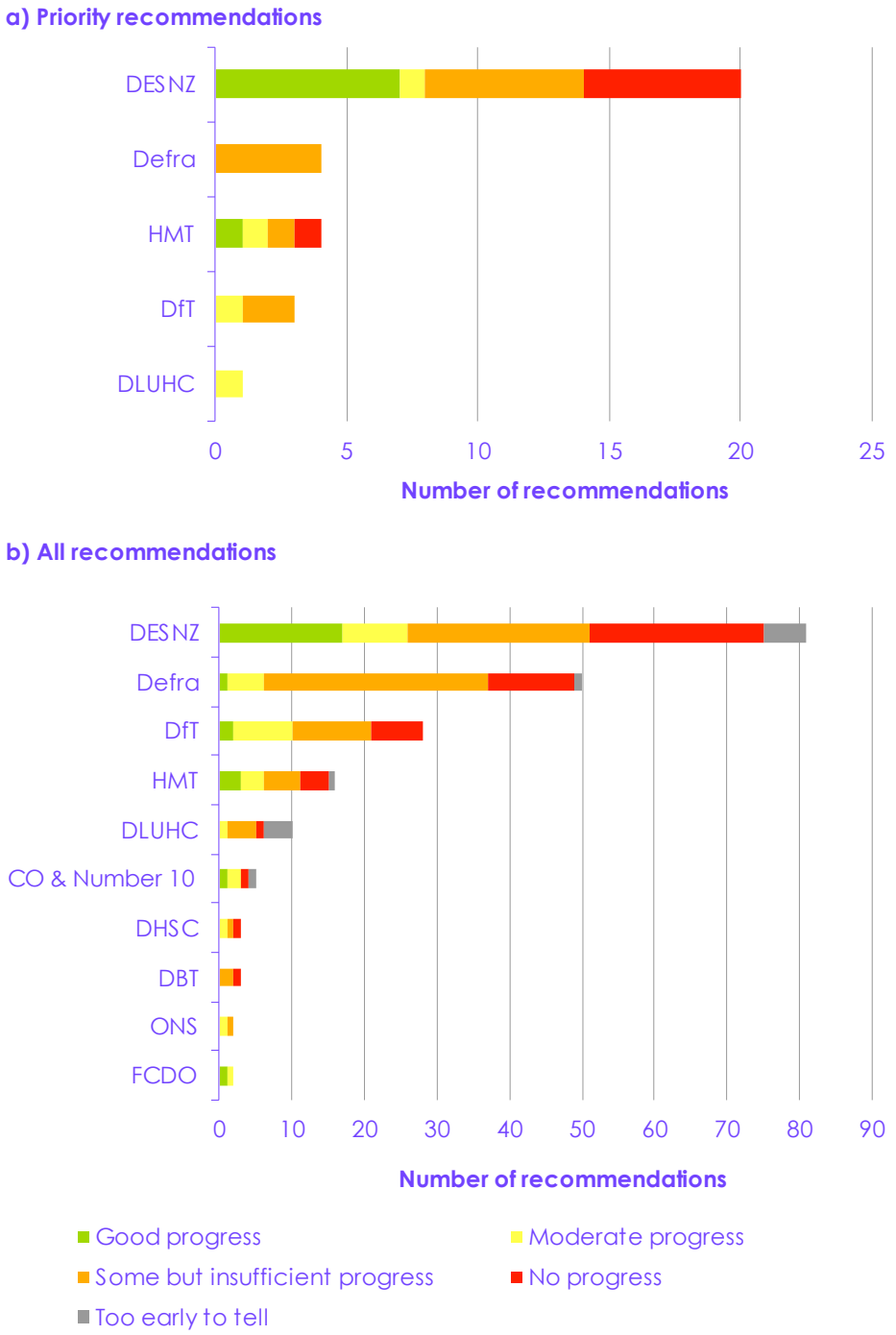
While DESNZ has made progress in a range of areas, overall insufficient progress has been made. In particular, no progress appears to have been made on seven of the priority recommendations we made in last year's progress report:

- Develop and publish new policies (with a clear implementation timeline) to ensure that owner-occupied homes reach a minimum energy performance of EPC C by 2035.
- Develop and begin to implement contingency plans to address the range of risks to meeting carbon budgets. These should broaden the set of emissions reductions pursued, in particular by including demand-side policies, and avoid increasing reliance on engineered removals.
- Publish a comprehensive long-term strategy for electricity decarbonisation, including the roles for low-carbon flexibility options.
- Develop minimum emissions-intensity standards for domestic oil and gas production by the next licensing round.
- Consult on a funding mechanism(s) to support the additional operational and capital costs of electrification in manufacturing, enabling electrification to compete on a level playing field with other means of decarbonisation.
- Review, invest in, and initiate reform of industrial decarbonisation data collection and annual reporting to enable effective monitoring and evaluation, and policy implementation.
- In line with the Glasgow Climate Pact commitment to phase out inefficient fossil fuel subsidies, undertake a review of the role of tax policy in delivering Net Zero.

These recommendations all remain essential, and the Government should enact them as soon as possible.

While other departments had fewer recommendations, both Defra and DLUHC have failed to achieve any priority recommendations and have made insufficient or no progress on a large majority of the non-priority recommendations.

Figure 6 Progress on last year's recommendations



Source: CCC analysis.
Notes: Some recommendations are not scored. See the supplementary material for our assessment of each individual recommendation.

6. Priority recommendations

The 27 priority recommendations made in this report are set out in full immediately following this executive summary, and are summarised in Table 4. Our recommendations to each department for the next year are available in Annex 2 to this report and in sortable and filterable tables in our accompanying webpage.

Table 4
Summary of priority recommendations

<table>
<tr><th>Cross-cutting</th><th>Surface transport</th><th>Energy supply</th><th>Aviation</th></tr>
<tr><td rowspan="2">Re-balancing the costs of electricity and gas.
Guidance for business use of carbon offsets.
Risk mitigation and alternative plans e.g. empowering people to make green choices.
Public engagement on green choices.
Action plan for Net Zero skills.
Coordinated energy planning at different geographical scales.
Make the National Planning Policy Framework consistent with Net Zero.</td><td>Confirm ZEV mandate details in regulation.</td><td rowspan="3">Strategy for full decarbonisation of electricity by 2035.
Identify low-regret electricity and hydrogen investments.
Create a minister-led infrastructure delivery group.
Planning frameworks to presume against new coal.
Stringent test for new oil and gas extraction.
Clarify institutional responsibilities for planning and delivery.</td><td>No airport expansion without UK-wide capacity-management framework.</td></tr>
<tr><td>Buildings</td><td>Waste</td></tr>
<tr><td>Narrow scope of strategic decision on role of hydrogen for heat.
Confirm regulatory mechanism for fossil-fuel boiler phase-out.
Implement plans for EPC C in privately rented homes by 2028.</td><td>Address rising energy from waste emissions.</td></tr>
<tr><td rowspan="2">International
Announce a Secretary of State-level Climate Envoy.</td><td>Industry</td><td>Agriculture and land use</td><td>Engineered removals</td></tr>
<tr><td>Policies for electrification.
Incentives for non-ETS decarbonisation.
Strategy for decarbonising iron and steel.</td><td>Publish the land use framework.
Funding and delivery support for tree planting.
Delivery mechanism for peatland restoration.</td><td>Business model for large-scale deployment.</td></tr>
</table>

ID	Sector	Priority recommendations	Timing
Priority: R2022-200	Cross-cutting: Fair funding and affordability	As part of reforms to electricity pricing, remove legacy policy costs associated with the historical deployment of less-mature low-carbon electricity generation from electricity prices. The rebalancing of policy costs should remove market distortions, and manage any adverse distributional impacts of a 'polluter pays' approach. **Primary responsibility: HMT** Supporting actors: DESNZ	2022 Overdue
Priority: R2023-165	Cross-cutting: Business	Publish guidance for businesses on what activities it is appropriate to 'offset' and when. This guidance should include confirmation that a business can only accurately use carbon credits to claim to be 'Net Zero' once nearly all emissions are reduced and the remaining are neutralised by high-quality permanent removals. Formalise this by: establishing 'Net Zero' as a statutory definition; drawing on consumer protection law or advertising standard rules to ensure businesses don't claim 'Net Zero' based on an inappropriate reliance on 'offsetting'; and setting out in UK Environmental Reporting Guidelines and the Net Zero Transition Plan Standard a requirement for businesses to disclose why carbon credits are used rather than direct emissions reduction in net emissions claims. **Primary responsibility: DESNZ** Supporting actors: Defra; HMT	2024
Priority: R2022-119	Cross-cutting: Governance	Develop and begin to implement alternative options to address the range of risks to meeting the NDC and carbon budgets. These should broaden the set of emissions reductions pursued, in particular by implementing policies aiming to empower the public to make green choices and stating clearly how they will contribute to emissions reduction. The timeline for implementing the plans should consider the time it takes policies to take effect. **Primary responsibility: DESNZ**	Q1 2023 Overdue
Priority: R2023-162	Cross-cutting: Public engagement	Empower people to make green choices by communicating the most impactful ways to reduce emissions, such as changing car travel, home energy use and dietary behaviours and reducing air travel, and support people to make these choices including through regulation and incentives. Government should lead by example by visibly adopting these green choices. **Primary responsibility: DESNZ**	2024
Priority: R2022-128	Cross-cutting: Workers and skills	Publish an evidence-based Action Plan for Net Zero Skills that includes a comprehensive assessment of when, where, and in which sectors there will be skills gaps specific to Net Zero. This should include consideration of particular barriers to inclusive and accessible labour market entry into occupations needed for the transition and Government plans for action on the skills system to facilitate entry into these occupations. **Primary responsibility: DESNZ** Supporting actors: DfE; DWP; DLUHC; Home Office	2022 Overdue

ID	Sector	Priority recommendations	Timing
Priority: R2023-176	Cross-cutting; Buildings; Electricity supply	Set out a clear process and governance framework for delivering credible, coordinated energy planning across local, regional and national levels. This should include guidance on responsibilities for producing, feeding into and implementing plans at each level (e.g. clarifying the respective roles of local authorities, Ofgem, the Future System Operator, network operators and the Government among others); their scope and the decisions to be made at each level; and a required methodology and standardised assumptions framework. This should include providing appropriate support and funding for delivery, ensure that proposals complement existing initiatives (e.g. on heat network zoning) and put in place processes for coordinating across boundaries and incorporating meaningful public engagement into decision-making. **Primary responsibility: DESNZ** Supporting actors: DLUHC; Scotland; Wales; Northern Ireland	Q1 2024
Priority: R2023-155	Cross-cutting: Governance	Review and update the National Planning Policy Framework to ensure that Net Zero outcomes are consistently prioritised through the planning system, making clear that these should work in conjunction with, rather than being over-ridden by, other outcomes such as development viability. **Primary responsibility: DLUHC**	2023
Priority: R2023-111	International: UK Climate Envoy	Announce a Secretary of State-level Climate Envoy that acts as the ministerial Head of Delegation before the 2023 UN General Assembly. **Primary responsibility: DESNZ**	Q3 2023
Priority: R2022-272	Surface transport: Electric cars and vans	Confirm the details of the ZEV mandate in regulation. As set out in the consultation, this should impose targets on manufacturers that are at least as ambitious as those in the Transport Decarbonisation Plan and should drive consistent growth in sales of EV cars and vans through the 2020s to meet the 2030 phase-out date. **Primary responsibility: DfT** Supporting actors: Scotland; Wales; Northern Ireland	Q1 2023 Overdue
Priority: R2023-190	Buildings: Low-carbon heat	Narrow the scope of the strategic decision prior to 2026 by: publicly affirming that electrical heat is the default option in all new buildings and existing properties off the gas grid; prohibiting connections to the gas grid for new buildings from 2025; setting out clear routes for other properties or areas where electrification or heat networks represent low-regret options; and clarifying the Government's position on the economy-wide priority of use-cases for hydrogen – in particular its potential to help manage peak demands for both heat and electricity, and its role in hybrid heating systems. **Primary responsibility: DESNZ**	2023
Priority: R2022-072	Buildings: Low-carbon heat	Finalise and ensure the timely implementation of plans to prohibit fossil fuel boiler replacements in off-gas grid buildings from 2026 (2024 for large non-residential buildings). Confirm the proposed regulatory mechanism for phasing out fossil fuel boilers, and clarify whether the required powers are devolved or reserved. **Primary responsibility: DESNZ**	2022 Overdue

ID	Sector	Priority recommendations	Timing
Priority: R2022-073	Buildings: Energy efficiency	Respond to the 2020 consultation by finalising and implementing plans to require privately rented homes in England and Wales to reach EPC C by 2028 (as the Government committed to in autumn 2021). **Primary responsibility: DESNZ**	2022 Overdue
Priority: R2023-080	Industry: Electrification	Develop policies for industrial electrification that address general barriers such as investment constraints, as well as specific barriers for different industrial sub-sectors. **Primary responsibility: DESNZ**	H1 2024
Priority: R2022-241	Industry: Fuel switching	Create clear incentives for manufacturing facilities not currently covered by the UK ETS to decarbonise. **Primary responsibility: DESNZ** Supporting actors: HMT	Q1 2023 Overdue
Priority: R2023-088	Industry: Steel	Publish a strategy and timeline for the decarbonisation of the iron and steel industry in line with the Carbon Budget Delivery Plan. **Primary responsibility: DBT** Supporting actors: DESNZ	Q1 2024
Priority: R2023-138	Electricity supply: Strategy	Publish a comprehensive long-term strategy for the delivery of a decarbonised, resilient, power system by 2035. This should comprise a portfolio approach to developing the full range of low-carbon flexibility options, including demand flexibility, storage, hydrogen, gas CCS and interconnection capacity. It should set out how the low-carbon flexibility required to replace unabated gas will be delivered (12-20 GW of low-carbon dispatchable capacity by 2035), as well as clarifying any minimal residual role unabated gas is expected to play by 2035 (up to around 2% of annual electricity production) and the strategy for unabated gas phase-out. It should cover the strategic decisions required, the milestones and timeline for delivery and the governance and oversight arrangements. It must set out plans and contingencies for addressing key risks on a co-ordinated basis (e.g. network development and connections, planning and consenting, CCS, hydrogen and nuclear). **Primary responsibility: DESNZ**	2023 Overdue
Priority: R2023-128	Electricity supply; Fuel supply; Cross-cutting	Identify a set of low-regret electricity and hydrogen infrastructure investments that can proceed now. Either prior to, or as part of publication of the cross-sectoral infrastructure strategy, identify on a whole system and economy-wide basis which areas are unlikely to be suitable for hydrogen (such that electrification and alternatives can be progressed), alongside potential candidate areas for hydrogen. This should be used to inform a set of low-regret investments that can proceed immediately. **Primary responsibility: DESNZ** Supporting actors: FSO	2024

ID	Sector	Priority recommendations	Timing
Priority: R2023-129	Electricity supply: Networks; Governance	Create a Minister-led infrastructure delivery group, advised by the new Electricity Networks Commissioner, to ensure enabling initiatives for energy infrastructure build are taken forward at pace and necessary policy changes are implemented across the UK, to deliver a decarbonised and resilient power system by 2035. This should bring together key senior parties in DESNZ, Ofgem, Defra, DLUHC, the Scottish and Welsh Governments, the Future System Operator and asset owners, to deliver necessary policy changes and monitor progress across the initiatives so that swift action can be taken where required to expedite progress. Priorities include overhauling planning and consenting (with strategically important projects prioritised); adequately resourcing regulatory, planning and environmental consenting bodies; reforming the connections process; driving strategic investment; and ensuring the necessary strategic planning and skills/supply chain development is taking place. **Primary responsibility: DESNZ** Supporting actors: Ofgem; Defra; DLUHC; Scottish Govt; Welsh Govt; FSO; Electricity Networks Commissioner	2023
Priority: R2023-092	Fuel supply: Fossil fuel supply	Ensure that planning frameworks and guidance across the UK support a clear presumption against new consents for coal production. New coal extraction, whether in new mines or through the extension of existing infrastructure, should only be permitted for safe decommissioning, or where firm policy can be demonstrated to require the coal produced to be used (domestically or internationally) in a way that is compatible with Net Zero pathways (e.g. with at least 95% CO_2 capture and storage). Planning Frameworks should reflect the declining role of coal in the context of binding UK and international GHG emissions targets. At present local plans are still required to proactively identify sites for future coal extraction. This practice is outdated and encourages new coal development. This practice should be ended immediately. **Primary responsibility: DLUHC** Supporting actors: Scotland; Wales; N. Ireland; DESNZ	2023
Priority: R2023-093	Fuel supply: Fossil fuel supply	Strengthen and clarify the tests in place for allowing any further exploration and extraction of oil and gas. Stringent tests, in line with the advice in our 2022 oil and gas letter, should be applied at each stage of the licensing and consenting process. These tests should be underpinned by a presumption against exploration and tighter limits on production, be assessed against more ambitious decarbonisation targets (well beyond the 50% target set out in the North Sea Transition Deal), and make use of the best available technology to minimise emissions associated with production. The criteria for approval, including with regard to decarbonisation targets, should be set out clearly and transparently. **Primary responsibility: DESNZ** Supporting actors: NSTA; OPRED; DLUHC	2023

ID	Sector	Priority recommendations	Timing
Priority: R2023-126	Electricity supply; Fuel supply	Clarify urgently and formalise the institutional responsibilities of the FSO, Ofgem and Ministers, for strategic planning and delivery of a decarbonised, resilient energy system. As part of this, Ofgem's objectives and duties must be updated to drive explicitly the delivery of the statutory Net Zero target, and to ensure climate and weather resilience. In addition to its Net Zero objective, the FSO must have responsibility for ensuring weather and climate resilience through its strategic planning role. The critical role of strategic investment in delivering these outcomes must be recognised, with appropriate mandates and powers for Ofgem and the FSO. The formalisation of responsibilities should be implemented through the Energy Bill and revisions to the Strategy and Policy Statement. As part of the phased approach to the implementation of the FSO, expanding the remit with respect to hydrogen should be considered as a priority. **Primary responsibility: DESNZ** Supporting actors: Ofgem; FSO	2023
Priority: R2023-102	Agriculture & land use: Agriculture and land use strategy	Publish the land use framework. Set out how this feeds into a wider agriculture and land use strategy that brings together how land can deliver its multiple functions including: reducing emissions and sequestering carbon, adapting to climate change, food security, biodiversity, domestic biomass production and wider environmental goals. The strategy must clearly outline the relationships and interactions with other relevant strategies and action plans across the UK, be spatially and temporally targeted, and aligned with action in the devolved administrations. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q3 2023
Priority: R2023-192	Agriculture & land use: Trees and woodland	Ensure that funding and support are set at the correct level to meet the UK Government afforestation target of 30,000 hectares per year by 2025, and illustrative Net Zero Strategy targets of 40,000 hectares and 50,000 hectares by 2030 and 2035 respectively. Further clarity is required regarding funding beyond 2025. Support for delivery of new woodland creation should integrate with nature and adaptation objectives, and also address contractor availability, capacity to process funding applications, and advice for farmers to transition to woodland management approaches. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2023 Overdue
Priority: R2023-171	Agriculture & land use: Peatlands	Implement a comprehensive delivery mechanism to address degraded peatland and extend current restoration ambition set out by the UK government and the devolved administrations beyond existing timeframes, including through addressing barriers to increasing capacity. Peat restoration targets include the need to remove all low-productive trees (i.e. less than YC8) from peatland (equivalent to 16,000 hectares by 2025), and restore all peat extraction sites by 2035 (equivalent to 50,000 hectares by 2025). **Primary responsibility: Defra** Supporting actors: Scotland; Wales; Northern Ireland	2024

ID	Sector	Priority recommendations	Timing
Priority: R2023-037	Aviation: Demand	No airport expansions should proceed until a UK-wide capacity management framework is in place to annually assess and, if required, control sector GHG emissions and non-CO_2 effects. A framework should be developed by DfT in cooperation with the Welsh, Scottish and Northern Irish Governments over the next 12 months and should be operational by the end of 2024. After a framework is developed, there should be no net airport expansion unless the carbon-intensity of aviation is outperforming the Government's emissions reduction pathway and can accommodate the additional demand. **Primary responsibility: DfT**	H1 2024
Priority: R2023-073	Waste: Energy from Waste / Incineration	Implement a whole-systems approach to address Energy from Waste (EfW) emissions, including setting out the implications of rising EfW use for waste decarbonisation and confirming plans to include EfW within the UK ETS. A moratorium on additional EfW capacity should be introduced subject to a review of capacity needs and how they align with Government emissions pathways. Further clarity is also needed on how decisions on allowing further EfW plants will be made. **Primary responsibility: DESNZ** Supporting actors: Defra	H1 2024
Priority: R2022-207	Engineered removals: Funding	Publish a proposal on the business model for deployment of large-scale (>1 $MtCO_2$/year) engineered removals. **Primary responsibility: DESNZ**	Q1 2023 Overdue

Chapter 1: State of the climate

Introduction and key messages

Devastating heatwaves and droughts have meant that climate change, and its impacts on the planet, have been making headlines across the world over the past year. 2023 has a high likelihood of an approaching El Niño event and greater warming than seen in previous years, signalling a likely increase in the combined risks of climate change and extreme weather events.

This chapter examines what has happened to global temperatures, climate impacts and emissions over the past year.

Our key messages are:

- **Global climate change.** 2022 was one of the six warmest years on record, and the warmest year on record for the UK. 2023 is likely to be warmer than 2022. In 2022, the Earth was 1.15°C (± 0.13°C) warmer than the pre-industrial (1850 – 1900) average.[1]

- **Climate impacts.** Extreme weather events have drawn attention to climate impacts across the globe, making it clear that adverse impacts pose threats to developed as well as developing countries. Climate impacts and risks will escalate with every increment of global warming, with risks becoming increasingly complex and difficult to manage.[2]

- **Global emissions.** Preliminary estimates for 2022 show relatively small increases in fossil CO_2 emissions, with no signs yet of decreasing emissions beyond fluctuations related to the COVID-19 pandemic. There are some signs of progress through continued strong growth in renewables, but this growth must be supported by improved permitting processes for renewable projects, management of supply chain risks and financing that supports rapid deployment across the globe.

This chapter covers the key indicators of global climate change in three sections:

1. Global climate change

2. Global climate impacts

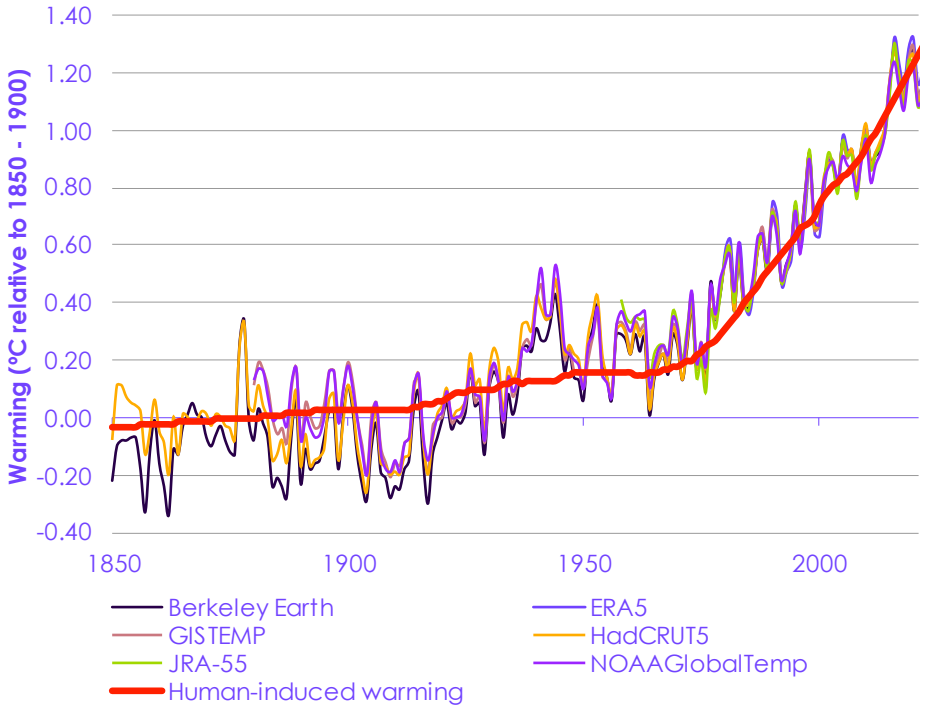
3. Global greenhouse gas emissions

2022 was one of the six warmest years on record. 2023 is likely to be warmer than 2022.

2022 was one of the six warmest years on record globally. Natural climate variability has meant that warming from human activities has been temporarily offset by cooling effects from a triple-dip La Niña* event in recent years. Global temperatures can fall by around 0.2°C in a La Niña episode, meaning the size of the human-induced warming effect is likely to have been greater than presently observed.[3] However, these cooling effects are coming to an end and conditions are favourable for the development of a warming El Niño event this year,[4] suggesting 2023 is likely to be warmer than 2022.[5] 2022 was the warmest year on record for the UK (Box 1.1).[6]

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Cycle Synthesis Report (Box 1.2) states that observed temperature increases are unequivocally the result of greenhouse gas (GHG) emissions resulting from human activities (Figure 1.1).[2]

Figure 1.1 Global average surface temperature relative to pre-industrial levels



Source: Met Office (2023) *Climate Dashboard – Tracking the Changing Climate with Earth Observations*.; IPCC (2021) *Climate Change 2021: The Physical Science Basis*; CCC analysis.
Notes: Each thin line represents a different global temperature dataset. All datasets are expressed relative to 1850-1900. The human-induced warming line uses the best estimate for total anthropogenetic forced warming from the IPCC Sixth Assessment Report up until 2019 with data for 2020-2022 derived using linear extrapolation.

* La Niña and El Niño refer to the respective cooling and warming of the sea surface temperature in the Pacific that affect climate worldwide.

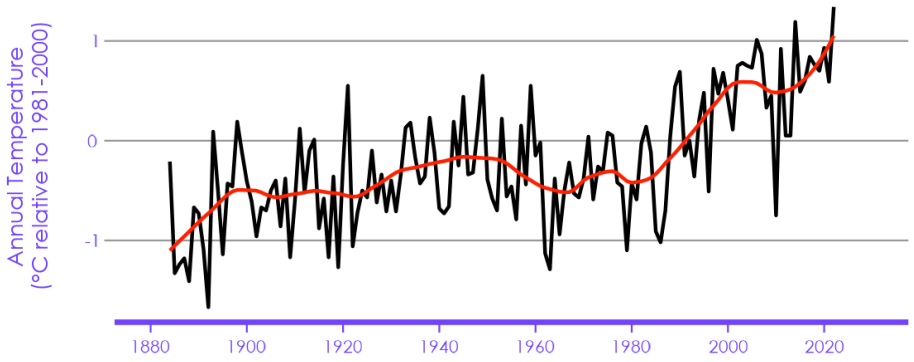
Box 1.1
Observed climate change in the UK

2022 was an unprecedented year for the UK's climate. It was the warmest year on record and the first year to exceed an average temperature of 10°C. All four seasons were in the top-ten warmest on record for the UK. The mid-July heatwave broke the previous UK maximum temperature by 1.6°C, exceeding 40°C for the first time with a temperature of 40.3°C recorded at Coningsby in Lincolnshire on 19 July.

In 2022 the UK was also drier and generally sunnier than average. Storm Eunice on 18 February was a notable extreme storm with a new wind gust speed record for England (122mph) recorded in the Isle of Wight.

These record-breaking extremes are consistent with continued global warming and are likely to occur more frequently in the coming decades.

Figure B1.1 Observed changes in UK annual temperature



Source: Met Office; Hollis, D. et al. (2018): *HadUK-Grid gridded and regional average annual temperature observations for the UK. Centre for Environmental Data Analysis*; CCC analysis.
Notes: The red line is a 30-year weighted smoothing of the black line and shows the average trend across the time-series.

Source: Climate Change Committee (2023) *Progress in adapting to climate change: 2023 Report to Parliament*; Met Office (2023) *Climate Summaries: Monthly, seasonal and annual summaries 2022: Annual.*

Box 1.2
IPCC Sixth Assessment Synthesis Report

The IPCC Synthesis Report draws together evidence from across the Sixth Assessment Reports (AR6). Reports in this assessment cycle include Working Groups 1: The Physical Science Basis; 2: Impacts, Adaptation and Vulnerability; and 3: Mitigation of Climate Change; as well as three Special Reports: Global Warming of 1.5°C; Climate Change and Land; and The Ocean and Cryosphere in a Changing Climate.

The key messages are:

- **Global climate.** Human activities have unequivocally caused global warming. Global surface temperatures have increased by 1.15°C in 2013-2022 since1850-1900 and rapid changes across the atmosphere, ocean, cryosphere and biosphere have occurred, affecting every region across the globe.
- **Climate risk.** The risks and projected adverse impacts from climate change escalate with every increment of global warming. Climate change impacts are becoming increasingly complex and difficult to manage, with multiple climate hazards occurring simultaneously and interacting.
- **Progress in adaptation.** Adaptation to climate change is reducing climate risks and vulnerability in some cases, but gaps are widening and progress is unevenly distributed. There are feasible and effective adaptation actions which can reduce risks to people and ecosystems but there are also adaptation limits. With increasing global warming, some adaptation options that are feasible today will become constrained and less effective in the future.
- **Progress in mitigation.** There has been an expansion in policies and laws targeting emissions reduction in recent years, but gaps remain between required global ambition and declared national ambitions (NDCs) and between NDCs and implemented policies. Well-targeted climate policy, increased volume and quality of financial flows towards low-carbon investment and international cooperation are key enablers of a strengthened mitigation response.
- **Emissions pathways.** Reducing CO_2 emissions to Net Zero is essential in limiting human-caused global warming. In most cases, modelled pathways that limit warming to 1.5°C require deep and immediate GHG reductions in all sectors this decade. Any overshoot will entail additional risks and some irreversible impacts.
- **Mitigation, adaptation and development.** Accelerated action on mitigation and adaptation is required for sustainable development. Inclusive development choices that prioritise risk reduction, equity and justice can enable climate-resilient development.

Source: Intergovernmental Panel on Climate Change (2023) *Synthesis Report of the Sixth Assessment Report Cycle (AR6): Summary for Policymakers.*

2. Global climate impacts

Extreme weather events in 2022 had severe impacts on lives and livelihoods and highlighted resilience risks.

According to the IPCC AR6 Synthesis Report, human-induced climate change is already affecting weather and climate extremes in every region. Many extreme weather events can be linked to climate change, with human-induced warming affecting both the intensity and frequency of events. A number of extreme weather events took place over the past year that were notable in terms of the resulting loss of lives and livelihoods. These events have drawn attention to climate risks across the globe and have highlighted the severity of the impacts that could be faced, particularly by climate vulnerable nations, with future warming:

- Flooding in Pakistan caused widespread devastation in the summer of 2022, with over 1,700 lives lost and eight million people displaced. Impacts disproportionately affected the most vulnerable groups, with many women suffering losses to livelihoods in agriculture and stagnant floodwater increasing the risk of water-borne disease in poor districts. The World Bank estimates the total economic losses at $15 billion.[7] While the range of natural variability in rainfall makes it difficult to quantify the role human-induced warming played in this particular disaster, there is a clear relationship between warming and increased peaks in extreme rainfall in Pakistan.[8]

- Prolonged heatwaves in China in the summer of 2022 led to drought in the Yangtze River Basin that affected inland shipping and crops. The drought also impacted hydropower generation, leading to power rationing and a slowdown in industrial activity, demonstrating the need for power systems that are resilient to future climate impacts.[9] Human-induced climate change made the 2022 drought in the Northern Hemisphere (excluding tropical regions) more likely.[10]

- 2022 had the hottest summer on record for Europe.[11] Heat-related deaths are estimated at above 20,000 across the continent in 2022.[12] A study of heatwaves over the last 20 years suggests that resulting damages amount to 0.3 – 0.5% of Europe's GDP.[13] Human-induced climate change made the 2022 drought in West and Central Europe more likely.[11]

Gaps remain in adaptation action and financing.

Adaptation is key to avoiding and limiting the adverse impacts of climate change. The United Nations Environment Project (UNEP) found that while adaptation actions were increasing, they were not keeping up with climate impacts. A step change is needed both in the quality and quantity of adaptation projects, with estimated needs five to ten times higher than current international financial flows to adaptation.[14]

3. Global greenhouse gas emissions

The IPCC AR6 Synthesis Report highlighted the urgent need to cut global GHG emissions. Modelled pathways limiting warming to 2°C (with a probability of greater than 67%) require rapid, deep and, in most cases, immediate emissions reductions across all sectors this decade.

Global GHG emissions are expected to have grown by a small amount, potentially reaching a new high.

Preliminary estimates suggest that global fossil CO_2 emissions (i.e. CO_2 emissions excluding emissions from land-use) increased by around 1% in 2022 and that global GHG emissions are expected to have grown by a small amount, potentially reaching a new high (Figure 1.2).

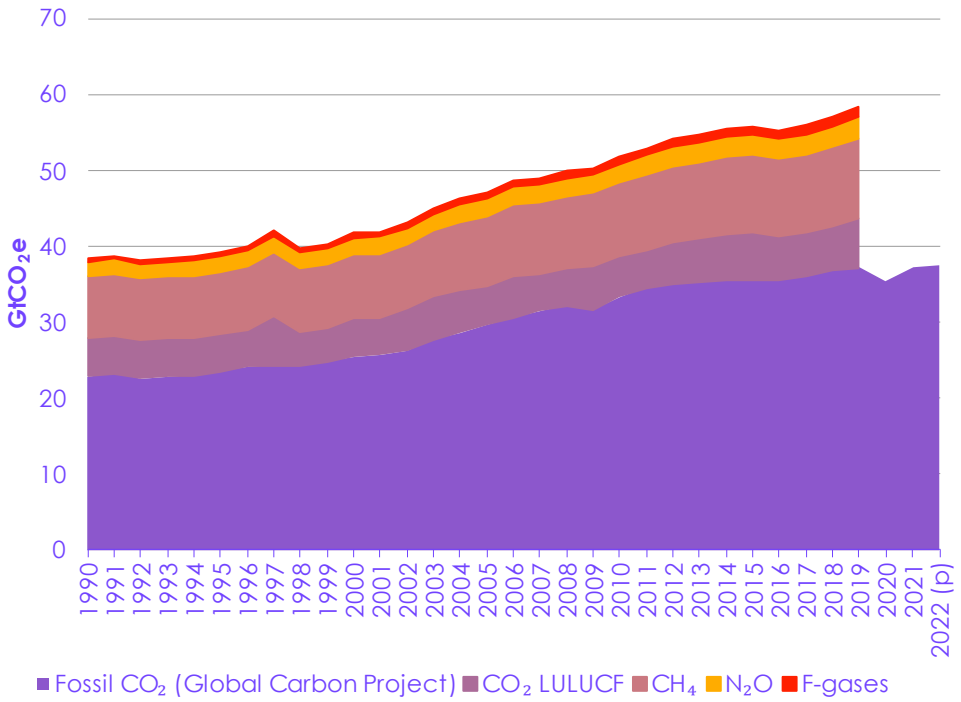
- The Global Carbon Project estimates that fossil CO_2 emissions increased by 1% on 2021 levels in 2022 (range 0.1% - 1.9%). These estimates are based on energy statistics and cement production data. Emissions from coal use may reach a new peak in 2022 while gas-related emissions are set to slightly decline relative to 2021.[15]

- The International Energy Agency (IEA) estimates that global energy-related CO_2 emissions increased by 0.9% on 2021 levels in 2022. Its figures suggest that reductions in emissions from natural gas of 1.6% were more than offset by increases in emissions from gas-to-coal switching.[16]

- An emissions growth rate of 1% would suggest a continuation of the growth trend of the past decade (with global GHG emissions growing at an average annual rate of 1.3% between 2010 and 2019).[7] Although this represents a reduction in the 2.1% average annual rate of growth between 2000 and 2009, there is no sign of a decrease in emissions beyond the temporary pandemic-related fluctuations in 2020.

Global CO_2 emissions are expected to have increased by a small amount in 2022.

Figure 1.2 Global GHG emissions 1990–2019 and fossil CO_2 emissions 2020-2022



Source: IPPC, Global Carbon Project, CCC analysis.
Notes: The fossil CO_2 data are taken from Global Carbon Project, with data for all other greenhouse gases use taken from the IPCC AR6 WGI report. The fossil CO_2 figure for 2022 is a projection. Aggregation of greenhouse gas emissions is done using the global warming potential metric at a time horizon of 100 years. Values from the IPCC 6th Assessment report are used.

Increases in fossil fuel use have been partially countered by reductions in industrial output and continued strong growth in renewables (Figure 1.3).

Renewable capacity continues to expand in the midst of energy market disruptions.

2022 was a strong year for investment in renewables, with the global energy crisis emphasising the energy security benefits of domestic renewable generation and high fossil fuel prices further improving the competitiveness of wind and solar. The IEA expect that global renewable capacity grew by 8% in 2022, representing an increase on the 6% rate of growth seen in 2021.[17] Delays in global supply chains, high commodity and mineral prices and lengthy domestic permitting processes must be managed carefully if global renewable energy capacity is to continue growing at the same or higher rates. The past year has also seen advances in international climate and energy policy that are expected to provide a further boost to the rollout of clean technologies in future years (see Chapter 2 on international progress for further details).

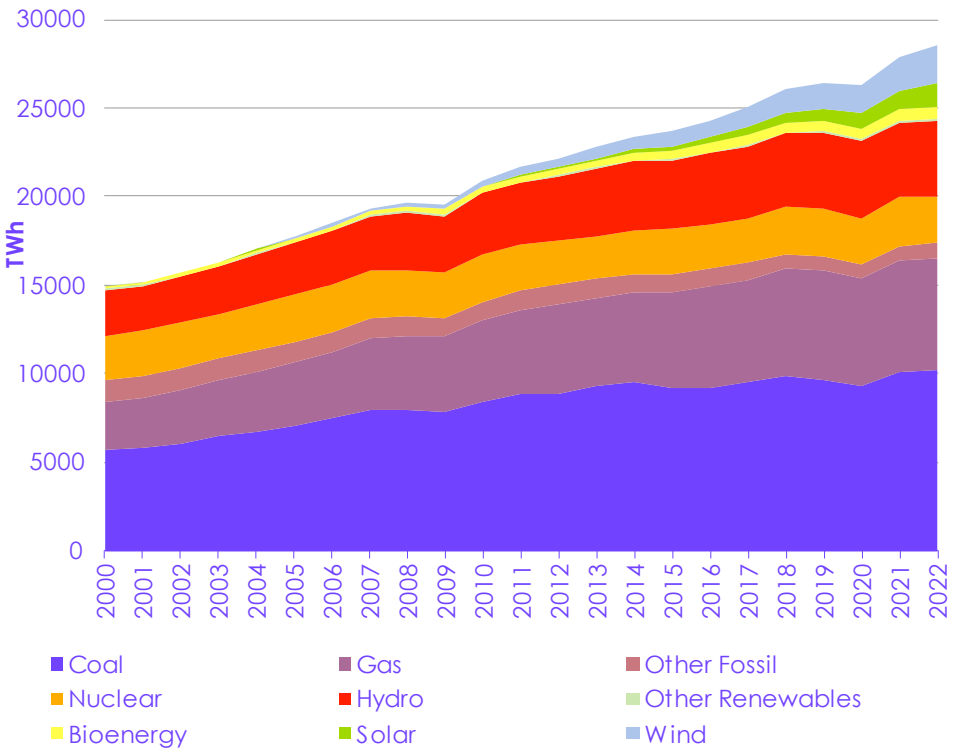
It is likely that reductions in industrial production in China have also placed a downward pressure on global emissions. Contractions in the Chinese construction sector have led to lower output in steel and cement, reducing emissions from these energy intensive industries.[18]

Increases in CO_2 emissions from coal are expected to be almost twice the size of reductions in emissions from gas.

Less progress has been seen in reducing global fossil fuel use. Price shocks following COVID-19 recovery and Russia's invasion of Ukraine have led to gas-to-coal switching, resulting in increases in CO_2 emissions from coal (243 Mt CO_2) that are almost twice the size of reductions in emissions from gas (118 Mt CO_2). Similar increases were seen in emissions from oil.[18] These trends pose substantial risk to global progress towards Net Zero, both in terms of growth in emissions and in terms of disrupting the downward trend in coal consumption.

The share of renewables in the global electricity generation mix is increasing, but coal and gas still comprise over half of all generation.

Figure 1.3 Global electricity generation by source



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Chapter 2: International climate progress

Introduction and key messages

The past year saw countries reassess the resilience of their energy systems in response to disruptions following Russia's invasion of Ukraine, and come together at COP27 and COP15 to forge new agreements on climate and nature. While some progress has been made, much more must be done, particularly when it comes to UK action.

2023 is a critical year for climate action. As governments, businesses and consumers respond to major policy shifts from the US and the EU and countries prepare to gather in the UAE for COP28, there is a window of opportunity for the UK to reassert its position as a competitive player on the international stage.

The UK has lost its clear global leadership position on climate action and is in a weaker position on international climate than it was a year ago. Though some positive steps have been taken, the Government's retreat from progressive, public leadership, its support for new fossil fuel production and its failure to keep pace with policy shifts and low-carbon investments overseas all point to a need for an increase in the scale and ambition of the UK's international climate action over the next year.

Our key messages are:

- **Leadership.** The UK has had an impressive history of climate leadership. However, a muted response to the energy crisis, support for new fossil fuel production and a retreat from public leadership within the COP process all pose risks to the UK's international reputation. These must all be addressed to reinstate the UK as a credible, impactful climate leader on the international stage.

- **Delivery against the NDC.** As we approach the conclusion of the Global Stocktake, all countries must demonstrate that they are delivering against their 2030 NDCs. The Government must address the remaining gaps to the 2030 NDC and mitigate delivery risks to demonstrate best practice within this process.

- **International commitments.** International pledges launched at COPs must begin to deliver real-world action to accelerate emissions reduction this decade. While the UK has had a role in advancing progress on initiatives on forests and ZEVs, its contribution to the Global Methane Pledge remains weak. The UK must also ensure that all international agreements to which it is party support efforts to transition to Net Zero. It is therefore necessary to reassess both the UK's lack of climate trade principles and membership of the Energy Charter Treaty (ECT) in line with this aim.

In the rest of this chapter, we discuss progress in three sections:

1. Low-carbon competitiveness and responses to the energy crisis

2. Progress in international climate and nature policy

3. UK international climate action

Since 2020, countries have faced significant disruption to their economies, including their energy markets, due to the COVID-19 pandemic and Russia's invasion of Ukraine. Concerns around a resulting regression in climate and energy matters have been partially realised through gas-to-coal switching. However, there has also been a reassuring push by some countries to respond to these crises in a sustainable, resilient way by reducing energy demand, investing in renewables and providing support for low-carbon industries.

The UK risks being left behind as other countries introduce bold climate and energy policy responses to the energy crisis.

The UK has a history of climate leadership, bolstered by being the first major economy to legislate for Net Zero and setting an ambitious 2030 NDC. However, the scale and ambition of its policy response to the energy crisis leaves much room for improvement and risks the UK being left behind in a race to the top as the EU, US and, to some extent, China make bold moves in this area.

This section will explore low-carbon competitiveness and responses to the energy crisis in two subsections:

(a) International policy: climate, energy and competitiveness

(b) The UK response to international policy shifts and the energy crisis

(a) International policy: climate, energy and competiveness

The US, EU and China are making concerted efforts to improve their low-carbon competitiveness.

The ongoing shocks to energy markets resulting from Russia's invasion of Ukraine have produced ambitious energy and climate policy responses in some major economies (Box 2.1). These responses are diverse in approach, with policies from the US, the EU and China shaped by each country or bloc's specific principles and political realities. However, what they have in common is their scale and their focus on growth and competitiveness:

- The US Inflation Reduction Act makes a strong play for green industries to locate in the US, offering tax credits for the production of green hydrogen, renewable energy and sustainable aviation fuel and the capture and storage of CO_2. In addition, domestic production criteria that require goods to be made or processed in the US to qualify for additional support provide a boost for domestic businesses and incentivise multinationals to set up US manufacturing bases. The more recent proposal to require organisations to have emissions reduction targets in line with the Science Based Targets initiative in order to be eligible for US Government procurement contracts complements these measures.[1]

- The EU's proposed Net Zero Industry Act looks to boost domestic manufacturing, setting an intention for 40% of the EU's deployment needs for 'strategic Net Zero technologies' to be met through domestic production by 2030.[2] The Act also includes provisions to simplify and streamline permitting processes for green projects, making it faster and easier for developers to invest in the EU.

- China has made substantial investments in overseas critical minerals assets and developed large-scale processing and refining facilities, giving it significant market power in materials needed to manufacture many low-carbon technologies.[3] Its extensive renewables development programme

also supports fast-growing domestic solar PV and wind turbine production and enhances energy security.

Climate policy packages in other countries could help to bring down technology costs in the UK.

It is too early to judge the overall impact of these policies. However, if successfully implemented, they could help to bring down global technology costs, direct future investment towards renewables and away from fossil fuels and improve countries' energy security, supply-chain resilience and low-carbon competitiveness credentials.

To have maximum effect, these policy packages should be complemented by commitments to ensure that new low-carbon infrastructure is resilient to future climate impacts and increased pressure on major fossil fuel companies to reinvest recent windfall profits in renewables and carbon capture and storage (CCS).

Box 2.1
Major clean energy policy initiatives and progress

The past year has seen major developments in climate and energy policy across the globe.

US Inflation Reduction Act

This Act, passed in August 2022, is estimated to provide $370 billion in investments to support American households, businesses and public bodies to develop and adopt low carbon solutions. Key elements of the Act include:

- **Renewables.** Tax credits for investing in renewables, battery storage and interconnection and production tax credits for renewable generation, battery storage and critical minerals processing. There are additional incentives for projects that meet prevailing wage and apprenticeship requirements and thresholds on the amount of US-manufactured materials used in their construction, and for projects that are located in historically coal-focussed communities.
- **Hydrogen.** Production tax credits for low-carbon hydrogen of up to $3/kg for ten years. The full tax credit is reserved for the lowest emission projects (electrolysis with renewables) that also meet prevailing wage and apprenticeship requirements.
- **CCS and removals.** Carbon capture tax credits of up to $85/tCO$_2$ for CCS and up to $180/tCO$_2$ for Direct Air Capture with Carbon Storage. These amounts will be lower if the carbon is used and not stored.
- **Electric vehicles.** Tax credits of up to $7,500 for the purchase of Electric Vehicles (EVs) for low and middle-income consumers. To be eligible for the full credit amount, the vehicle must be assembled in the US, meet domestic production thresholds for battery components and source battery minerals from the US or countries with which the US has a Free Trade Agreement. There are lower credits available for the purchase of second-hand EVs and higher credits available to fleet operators for electrifying their fleets.
- **Buildings.** Tax rebates of up to $8,000 are available for households carrying out energy efficiency measures, with the full amount only available to low-income households. The Act also includes incentives for energy efficiency improvements to affordable housing and commercial buildings and tax deductions for installing heat pumps and rooftop solar. On the supply side, there are provisions for training programmes for installers and payments to contractors carrying out electrification measures.

EU Initiatives

The EU has come forward with multiple pieces of legislation that aim to deliver the EU's emissions targets, address the energy crisis and improve the bloc's low-carbon competitiveness.

- **Fit for 55 package.** The Fit for 55 package includes a number of updates to the EU Emissions Trading Scheme (EU ETS).

  - **Carbon Border Adjustment Mechanism (CBAM).** The EU has now adopted the world's first CBAM. The CBAM will be gradually phased in from October 2023 with an initial focus on the sectors at highest risk of carbon leakage, such as cement and steel. The full system will apply from 2026 and will be accompanied by a phasing out of EU ETS free allowances.
  - **Aviation and shipping.** The EU ETS will apply for intra-European flights (including departing flights to the United Kingdom and Switzerland) with free emission allowances gradually phased out to 2026.[4] From 2024, emissions from shipping will be phased into the EU ETS and will cover all emissions from 2027.[5]
  - **Green Hydrogen.** The Innovation Fund derived from ETS revenues will hold auctions for the support of green hydrogen production, with the potential to kickstart EU growth in this industry.
  - **Buildings and transport.** The EU will create a new emissions trading scheme to cover buildings, road transport and small emitters with a hypothecated Social Climate Fund to support the transition for low-income citizens.

- **REPowerEU.** This plan aims to reduce EU dependence on Russian fossil fuels and improve EU energy system resilience. The plan proposes increases in binding 2030 targets for renewable energy generation and energy efficiency, as well as efforts to accelerate planning processes for solar and wind projects and grow green hydrogen production this decade. The plan was accompanied by an 'EU Save Energy' communication that sets out how energy efficiency policy and household action can be combined to have significant impact. However, REPowerEU also includes plans to establish new gas and oil supplies through purchase agreements with exporting countries and investment in new Liquified Natural Gas (LNG) and oil import and pipeline facilities. These plans risk incentivising additional global fossil fuel production.
- **Green Deal Industrial Plan (GDIP).** The Commission has proposed the GDIP to shore up the EU's low-carbon competitiveness through a simplified regulatory landscape, streamlined funding processes, addressing skills gaps and maintaining open trade. This plan encompasses the Net Zero Industry Act (see above) that aims to fast-track permitting of clean energy projects and the Critical Raw Materials Act that aims to secure adequate access to minerals needed for green transition.

Renewables policy in China

China released its 14th Five Year Plan in June 2022, committing to renewables meeting at least 50% of all additional electricity consumption from 2021-2025. Carbon Brief analysis of central and provincial government plans suggests that China is set to add at least 570 GW of wind and solar to its energy systems over this period if targets are met. Subject to actions taken on the running of coal plants to better accommodate this scale of renewables expansion it is suggested that China's emissions might peak up to five years earlier than the 2030 target.

Source: The White House (2022) *Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action*; World Resources Institute (2022) *A Brief Summary of the Climate and Energy Provisions of the Inflation Reduction Act of 2022*; Clean Air Task Force (2022) *Carbon Capture Provision sin the Inflation Reduction Act of 2022*; Resources for the Future (2022) *Incentives for Clean Hydrogen Production in the Inflation Reduction Act*; National Resources Defense Council (2022) *A Consumer Guide to the Inflation Reduction Act*; European Commission (2023) *REPowerEU: affordable, secure and sustainable energy for Europe*; European Commission (2023) *The Green Deal Industrial Plan: putting Europe's net-zero industry in the lead*; European Commission (2023) *Carbon Border Adjustment Factsheet*; Carbon Brief (2022) *Will China's new renewable energy plan lead to an early emissions peak*; Carbon Brief (2022) *What do China's gigantic wind and solar bases mean for its climate goals?*

(b) The UK response to international policy shifts and the energy crisis

The UK has missed opportunities to respond to the energy crisis with ambitious climate and energy policy.

The UK policy response to the energy crisis has not matched the response of the US and the EU in scale or ambition. As explored in the rest of this report, much more must be done to accelerate domestic delivery in key sectors and comprehensively address the UK's low-carbon competitiveness to reduce risks of the UK falling behind other climate-progressive developed economies.

There are several factors that determine a country's low-carbon competitiveness, including policy landscape for low-carbon technologies, supply-chain resilience, investment environment, trade policy and domestic skills and expertise. The UK is strong on research and expertise, but the Government must provide greater policy certainty on low-carbon technologies to ensure it continues to attract investment and avoids being locked out of the development of key products and services required for the Net Zero transition as China, the US, the EU and others increase their market share.

The Government has made some progress on low-carbon competitiveness but gaps remain.

There has been some progress on low-carbon competitiveness but more remains to be done:

- In 2022, the Government commissioned the Rt Hon Chris Skidmore MP to carry out the Independent Review of Net Zero (the Skidmore Review) to identify efficient and effective routes to delivering Net Zero in the UK. This review called for the Government to clarify its competitive advantage and green industrial policy and to provide long-term clarity for industries including hydrogen, biomass and carbon capture, utilisation and storage (CCUS).

- In March 2023, the Government published:

  - A Government response to the Skidmore Review.

  - A refresh of the 2022 Critical Minerals Strategy in July 2022, that launched a Task and Finish Group on Critical Minerals Resilience for UK Industry and referenced new critical minerals partnerships with South Africa and Canada.[6]

  - A consultation on policy measures to address carbon leakage, covering options including Carbon Border Adjustment Mechanisms and Mandatory Product Standards.[7]

  - The Green Finance Strategy, setting out steps to establish the UK as an international hub for low carbon transition finance and demonstrator of best practice in aligning of financial flows with climate and nature objectives.[8]

  - A 2022-2025 Delivery Plan for the 2021 Net Zero Research and Innovation Framework. This plan summarises government Net Zero research and innovation programmes with the aim of increasing private sector clarity on priority areas for investment.[9]

- A Memorandum of Understanding with the North Seas Energy Cooperation members (after forgoing membership after exiting the EU), opening up possibilities for joint renewables projects in the North Sea focusing on linking offshore wind with interconnectors.[10]

- Announcement of up to £20 billion of funding to support early deployment of CCUS and launch of the Track 2 of the CCUS Cluster Sequencing programme.

More must be done to establish incentives and policy certainty for potential low-carbon investors in the UK.

While these actions represent progress, they have been accompanied by delays to existing commitments and have not been complemented by a clear, comprehensive vision for the UK's place in a competitive global Net Zero future. Ambitious, decisive action has been shown in wind and nuclear, supported by ministerial leadership and effective stakeholder engagement; we now need to see this extended to other Net Zero-critical sectors. There is a competitive international landscape for green growth (Box 2.1) and strong policy signals are needed to compete with large economies and assure investors that the UK is an attractive place to develop and deploy low-carbon technologies.

To avoid being left behind in a race to the top, the UK should ensure that timely policy development and investor clarity in sectors such as CCS, hydrogen and engineered removals is prioritised. The Government must also utilise trade, diplomacy and research levers to develop the UK's supply chains and understand supply chain risks for key Net Zero industries.

International policy comparisons demonstrate opportunities to both reduce emissions and cut household and business costs in the UK.

The UK has particularly missed opportunities to respond to the energy crisis with policies that both reduce emissions and cut household and business costs – policies that other countries implemented to increase their energy security. There are substantial opportunities in home energy retrofit, public engagement and green choices, business energy savings and policies targeted at low-income households that the UK should seize to improve its domestic delivery and ease the impacts of the cost-of living crisis on UK households and businesses. Box 2.2 explores international examples of policies that have been introduced in response to the energy crisis to meet these objectives.

Box 2.2
Initiatives to reduce emissions and households and business costs

Energy Saving Trust and Green Alliance have carried out research for the CCC, identifying and analysing polices introduced in other countries in response to the energy crisis that aim to both cut costs and reduce emissions.

The project screened policies in other countries and produced detailed analyses of the following policies which provide useful examples for the UK: France's MaPrimeRénov' and Sobriété Énergétique, Canada's Greener Homes Initiative and Strategic Energy Management programmes, the Republic of Ireland's One Stop Shop, SME Support Scheme for energy audits and Reduce Your Use campaign, US Benchmarking and Building Performance Standards, public transport subsidies in Spain and Germany, California EV grants for low-income households and New York State's Inclusive Community Solar Adder.

Analysing these polices with respect to the UK's policy gaps produced the following insights:

- **Home energy.** England needs a comprehensive home energy retrofit scheme. Long-term funding to provide certainty for consumers and supply chains is a key success factor. Integration of support for heat pump installation and energy efficiency measures and whole building support that includes incentives for upgrading blocks of flats are also important aspects for the policy design.
- **Public engagement and green choices.** There is a need for a UK Government public engagement campaign that focuses on reducing energy demand. This should be aimed at both businesses and households and its effectiveness would be strengthened by combining informing 'quick win' bill-saving measures with programmes supporting longer-term actions.
- **Business energy.** A comprehensive and coherent strategy on business energy that covers a wide range of businesses from SMEs to energy intensive industries. Policy can help to embed energy and carbon management into decision making and there are gains to be made through making businesses aware of energy saving opportunities and, in some cases, requiring them to act on these.
- **Low-income households.** UK policy should place more focus on providing access to low-carbon technologies for low-income households. To avoid low-income groups being locked out of the cost savings that low-carbon technologies will increasingly provide, the Government should consider targeted support for the take-up of key technologies such as EVs.

Source: Energy Saving Trust and Green Alliance (2023) *Climate policy that cuts costs: International policy comparison.*

Over the past year, the energy crisis and extreme weather events such as the floods in Pakistan have highlighted the need for international cooperation that accelerates the transition to clean energy and builds a more sustainable, resilient world. While COP15 and COP27 reached agreement in a few landmark areas, progress has faltered on issues including fossil fuel phase out, adaptation action and climate finance.

This section will assess international climate and nature progress under five subsections:

(a) COP27

(b) Biodiversity COP15

(c) Key climate moments in 2023

(d) COP28

(e) Financing the transition

(a) COP27

COP27 saw movement on Loss and Damage and JETPs but limited progress was made on NDC ambition, finance and adaptation.

COP27 saw momentum successfully gather around the need for the COP to address support needs for Loss and Damage and the launching of additional Just Energy Transition Partnerships (JETPs) but made slower progress on mitigation, adaptation and implementation of COP26 pledges. The key developments were:

- **Agreement to establish a Loss and Damage fund.** COP27 saw agreement to establish new funding arrangements for assisting developing countries that are particularly vulnerable to the adverse effects of climate change to address impacts which cannot or have not been adapted to. Though this only marks the beginning of a difficult process in agreeing the underlying detail, this agreement overcoming historically polarised positions nonetheless shows that the COP process can broker consensus and act as a forum for change.

- **Limited progress on 2030 emissions reduction ambition.** Despite agreement in the Glasgow Climate Pact for 2030 Nationally Determined Contributions (NDCs) to be brought in line with Paris temperature goals, near-term target ambition remained largely unchanged. Advances outside of the NDC process included announcement of the Vietnam JETP.

- **Small steps on adaptation.** Some progress was made on operationalising the Global Goal on Adaptation, but substantial questions about definitions and precise aims for the goal are still being discussed.

- **Renewed focus on finance.** The long-promised $100 billion per year in climate finance from developed countries has still not been met. There was a broader focus on the availability of finance for emissions reduction and adaptation, as well as the speed and ease with which it can be accessed. Various proposals for improving this were discussed, including the reform of lending practices from international financial institutions (IFIs).

- **Sectoral pledges begin to shift towards implementation.** There was some progress against COP26 sector pledges. The Global Methane Pledge now has over 150 signatories.[11] The Forest and Climate Leaders' Partnership was established, building on the Glasgow Leaders Declaration on Forests and Land Use to bring together government and non-government actors to scale up action to protect, conserve and restore forests. The Accelerating to Zero Coalition was launched, building on the ZEV Declaration with over 200 signatories (countries, regions, cities and business including some vehicle manufacturers) committed to supporting a rapid transition to zero emission cars and vans.[12] With permanent structures and governance arrangements now decided, these initiatives should look to demonstrate tangible policy and implementation progress by COP28.

(b) Biodiversity COP15

The Kunming-Montreal Global Biodiversity Framework represents progress on the integration of biodiversity and climate action.

Human-induced climate change and biodiversity are inextricably linked. Climate change has caused major changes to ecosystems beyond that expected through natural climate variability.[13] Climate solutions have the potential to put biodiversity at risk (e.g. large-scale bioenergy) or help restore nature (e.g. nature-based solutions).[14] Biodiversity protection and enhancement can also deliver adaptation and mitigation co-benefits, such as forest and soil restoration. Conversely, destroying nature (e.g. deforesting the Amazon) can release huge amounts of stored carbon.

The Convention on Biological Diversity (CBD) COP15 saw agreement on key elements of the Kunming-Montreal Global Biodiversity Framework, including an overarching mission to halt and reverse biodiversity loss by 2030, together with targets and milestones relating to conservation, restoration and finance, amongst others.[15] Several targets under the Framework integrate climate aspects, such as minimising the impact of climate change on biodiversity and increasing ecosystem resilience through mitigation and adaptation.

(c) Key international climate moments in 2023

The following international events and processes will need to build momentum for ambition and implementation and develop strong positions towards the annual UNFCCC COP summit in December.

The G7 and G20 are important fora for building momentum and demonstrating major economy commitment on issues such as fossil fuel phase-out.

- **G7 and G20.** The top ten GHG-emitting countries comprise two-thirds of global emissions.[16] High-emitting developed and emerging economies should use these fora to demonstrate progress in areas in which they have high impact such as the phase-out of fossil fuels and IFI reform. The 2022 UN Emissions Gap Report found that collectively the G20 is presently on course to fall short of their 2030 NDCs by 1.8 $GtCO_2e$ (central estimate).[17]
  - The recent Japan G7 reaffirmed commitments to Net Zero but did not advance on agreeing clear timelines for the phase-out of coal and backed investment in LNG as a temporary response to the invasion of Ukraine.[18]
  - The G20 under the Indian Presidency is building towards the Leaders' Summit in September which will be a key opportunity to corral the major economies to produce strengthened commitments that set the scene for COP28.
- **UNFCCC Bonn climate change conference.** The annual Bonn intersessional conference in June will undertake preparatory negotiations for COP28. Key

amongst these will be work on the first Global Stocktake (GST), which will assess the world's progress against the Paris Agreement's mitigation, adaptation and finance goals and identify the remaining gaps.

- **UN General Assembly and Climate Action Summit.** These summits should be used to progress discussions on early emerging priorities for COP28 and to act as a pledging push for countries to come forward with mitigation, adaptation and finance commitments.

(d) COP28

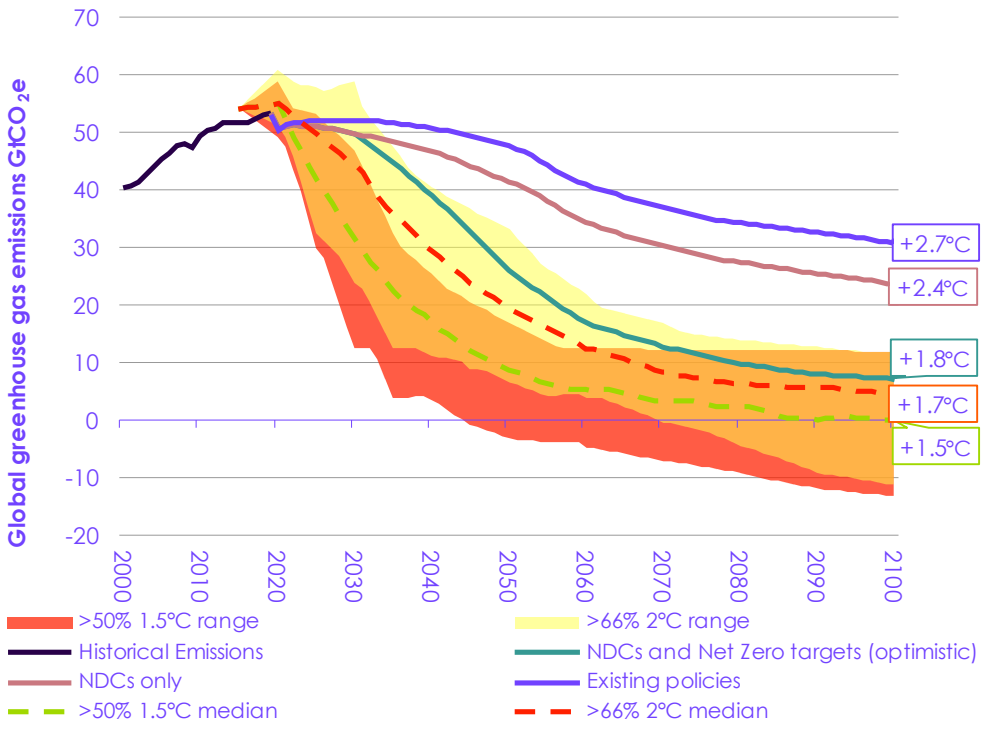
COP28 will see countries come together to address gaps identified in the Global Stocktake.

COP28 in December hosted by the United Arab Emirates will be the culmination of international climate policy processes in 2023. As part of the conclusion of the GST, countries will be expected to produce solutions that address the gaps identified and carve a path back to limiting warming to as close to 1.5°C as possible (Figure 2.1).

Alongside on the agenda will be the operationalisation of the Loss and Damage Fund, and adoption of a framework for the Global Goal on Adaptation. In the cover text negotiations, there will be a major focus on strengthening the commitments on phasing out fossil fuels made at COP26 and repeated at COP27 to explicitly require phasing out of all emissions from all fossil fuels.

Current NDCs and Net Zero targets have the possibility to limit warming to under 2°C, but this will require a step-change in emissions reduction in the near term.

Figure 2.1 Post-COP27 global emissions pathways 2000 - 2100



Source: Climate Action Tracker (2022) *Warming Projections Global Update*; IPCC, *AR6 Scenario Explorer*; CCC analysis.
Notes: The shaded ranges represent the upper and lower bounds of the scenarios that limit warming to a) 1.5°C with a >50% probability and b) 2°C with a >67% probability from the scenario database used by the IPCC Sixth Assessment Report. The dashed lines represent the medians of these ranges. Ranges for median end of century warming are +2.2°C to +3.4°C for the existing policies scenario, +1.9°C to +2.9°C for the NDCs only scenario ('2030 Targets only') and +1.5°C to +2.3°C for the NDCs and Net Zero targets (optimistic) scenario ('Optimistic scenario – Net Zero pledges'). Aggregation of greenhouse gas emissions is done using the global warming potential metric at time horizon of 100 years. Values from the IPCC 5th Assessment report are used.

(e) Financing the transition

Significant improvements in the quantity and quality of financing are needed to support a rapid global transition.

Financing is still a barrier to rapid transition, with developing countries unable to access adequate finance options despite holding many opportunities for impactful emissions reduction and adaptation action. A key issue is addressing the cost of capital developing countries face, which can be over three times that of countries that issue reserve currencies (such as the US, UK and Japan).[19] The 2022 Songwe-Stern report estimates that the global transition will require $2.4 trillion of investment per year by 2030.* The Energy Transitions Commission estimate that $3.5 trillion in capital investment will be needed on average per year between now and 2050.[20]

The past year has seen some progress towards addressing these barriers, but there is an urgent need for faster action and the UK has potential to play a significant role (see Section 4 and the CCC 2022 COP27 report).[21] Key developments include:

- **JETPs.** Just Energy Transition Partnerships (JETPs) offer strong potential to blend public and private finance with a targeted focus on high-impact energy transitions. In 2022, partnerships with Vietnam and Indonesia were announced, and at COP27 the international group supporting South Africa's JETP endorsed South Africa's JETP Investment Plan. The ability of these partnerships to deliver financial support and emissions reductions has not yet been fully demonstrated; donors should not underestimate the complexities of these countries' energy transitions. There is a need to maintain concerted efforts to secure more detailed agreement and operationalise these deals.

- **International Financial Institutions.** The Bridgetown Agenda proposed a widespread reform of international financial institutions such as the World Bank and the International Monetary Fund (IMF) to increase affordable lending for developing countries to reduce their emissions and improve their ability to deal with climate impacts.[22] The Spring Annual Meetings this year saw some progress, with the World Bank Group proposing a set of measures that would boost its lending capacity by $50 billion over the next decade and introducing new checks to ensure that all board-approved projects align with the goals of the Paris Agreement.[23] However, much remains to be done to improve the quantity and quality of finance available to low- and middle-income countries and to address debt vulnerability for developing countries dealing with adverse climate impacts.

- **Private finance.** Following the commitment by financial institutions representing over $124 trillion of assets in the runup to COP26, financial institutions covering a further $5 trillion in assets set Net Zero targets in the first half of 2022.[24] Ensuring the credibility of these commitments remains an important area for international cooperation. At COP27 the UN Secretary General's High Level Expert Group on the Net Zero Commitments of Non-State Entities published principles and recommendations that set out a clear process for ensuring that high ambitions on emissions reductions are both set and realised.[25]

* The Independent High-Level Expert Group on Climate Finance led by Dr Vera Songwe and Lord Stern estimated that investment of $1 trillion per year by 2025 and $2.4 trillion per year by 2030 is needed to transform energy and agriculture systems, restore forests, land and water, and increase resilience in developing countries (excluding China).

3. UK international climate action

The UK needs to take action to keep its role as an international climate leader.

The UK can influence global climate progress through domestic action on emissions reduction and adaptation, international policy and utilising UK convening power in international climate fora. As the UK transitions away from the influence it held as COP26 President and its experience negotiating as part of the EU, it will need to redefine and recommunicate its position to keep its role as an international climate leader.

There are important opportunities over the next year for the Government to act on the ambitions it has set out in its 2030 Strategic Framework. A cohesive, all-of-Government approach is needed to ensure that the UK makes the most of its capabilities in climate diplomacy, technical expertise and domestic delivery to shift the dial internationally. The UK should ensure that its international climate reputation is not undermined by perceived retreat from leading and convening climate discussions on the international stage and domestic policy decisions that contradict the UK's international messaging.

This section will cover priority areas for UK international climate action under two subsections:

(a) UK international climate policy assessment

(b) The UK as a climate leader

(a) UK international climate policy assessment

The 2030 Strategic Framework provides an overview of the Government's international climate ambition.

The UK has set out a vision for its international climate and nature ambition in the 2030 Strategic Framework (see Box 2.3). The overall aim of the strategy is commendable; it is positive to see reaffirmation that the Government wants to deploy joined-up efforts using domestic levers such as trade, aid and finance to meaningfully contribute to global climate and nature goals. The Strategic Framework expresses a clear intention to maintain the UK's strong legacy in this space. However, over the coming year, more must be done to support the ambitions expressed in the document with detailed future actions. The intentions set out for trade are less ambitious and represent a missed opportunity to make effective use of trade policy to support climate action in the UK and help drive progress abroad.

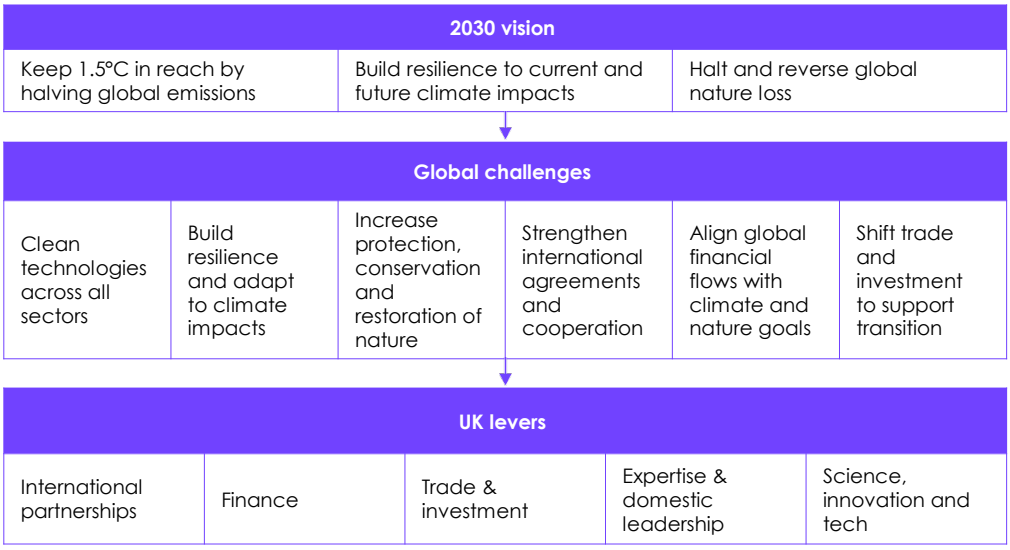
Policies and commitments announced and implemented over the coming year will be the true test of the Strategic Framework. The Government should track policy progress against the aims of this document, acknowledging that both domestic and international policy decisions have potential to contribute to realising its 2030 vision. The CCC will look to assess progress against this Framework in future reports.

While the publication of the 2030 Strategic Framework demonstrates an increase in Government ambition across mitigation, adaptation and finance, substantial risks remain in the Government's delivery against their stated aims. Table 2.1 provides a summary and assessment of recent progress and what still needs to be addressed. Our assessment is based on the criteria outlined in Annex 1. The detailed recommendations are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 2.1.

Box 2.3
UK 2030 Strategic Framework

In March 2023, the UK Government released the 2030 Strategic Framework for International Climate and Nature Action. This is a cross-Government document that sets out the Government's strategic aims for contributing to global climate and nature challenges. The global vision the Government wishes to contribute towards achieving, the key global challenges to achieving this vision and the levers it plans to use to support these efforts are set out below.

Figure B2.3 UK 2030 Strategic Framework



Source: UK Government (2023) *2030 Strategic Framework for International Climate and Nature Action.*

Source: UK Government (2023) *2030 Strategic Framework for International Climate and Nature Action.*

Table 2.1
Policy scorecard for UK international climate action

Theme	Ambition	Delivery	Overall assessment
International overall assessment	Y	O	Y
Strategy	Y	O	O

Progress:

- The UK Government published its 2030 Strategic Framework. This cross-Government strategy sets out how the UK will capitalise on its domestic leadership and expertise and diplomatic capability to contribute to halving global emissions, halting and reversing nature loss and building resilience to climate impacts.

To be addressed:

- With the disbandment of the COP Unit there is a need to establish clear arrangements for coordinating international climate priorities across departments.
- Clarity is needed on which minister will lead engagement on international climate (including within the COP process) and whether there will be a Ministerial Envoy for international climate. Delays to these announcements and the decision not to maintain roles such as the FCDO's Climate Envoy risk weakening diplomatic relationships ahead of a key COP (priority recommendation R2023-111).
- At COP27, the UK's positions on key issues were difficult to ascertain, especially when compared to more vocal delegations such as the EU and US. Communicating priority areas ahead of COP28 and the Global Stocktake would help the UK to shape its post-Presidency leadership. The Government should consider NDC best practice, fossil fuel phase-out, Loss and Damage financing arrangements, IFI reform, Voluntary Carbon Market standards and business engagement as possible areas for UK leadership (recommendation R2023-114).
- The UK has not produced a comprehensive response to international policy developments such as the US Inflation Reduction Act and EU GDIP (recommendation R2023-172). Policy certainty, streamlined permitting and innovative funding mechanisms can all work to re-establish the UK as an attractive country for the development of green technologies and industries. Further delays to producing this response risk the UK falling behind other key players.
- The UK can play a visibly progressive role at key climate events throughout the year, not just at the COP. The G7, G20, UNGA and various climate action summits all provide opportunities for leader-level UK representatives to demonstrate climate as a top priority for the Government and to use its diplomatic capabilities to gather momentum behind key agendas such as fossil fuel phase-out.
- The 2030 Strategic Framework is relatively weak on setting a clear Government position on trade-climate interactions. A clear and strong position is needed to make sure that future trade arrangements do not run contrary to the Government's aims on climate and biodiversity, either in the UK or abroad (recommendation R2023-115).

Mitigation	G until 2030	Y after 2030	O	O

Progress:

- The UK Government strengthened its 2030 NDC in advance of COP27. The recommunicated UK 2030 NDC met some of the CCC's 2022 Progress Report recommendations, such as

	inclusion of COP26 sectoral pledges, but failed to meet others, like addressing the risks to Net Zero delivery posed by climate impacts. • The UK played an important role in coordinating governments and finance institutions to reach agreement on JETPs with Vietnam and Indonesia in 2022.[26,27] These agreements can accelerate mitigation in countries with heavy coal use and strong potential for renewables. • The UK has continued to lead and input into initiatives such as the Breakthrough Agenda, Mission Innovation, the Forest and Climate Leaders Partnership and the Accelerating to Zero Coalition, working with other governments and non-state actors to unlock a faster green transition. **To be addressed:** • Domestic delivery is essential for maintaining the UK's role as a climate leader. While announcements in the Carbon Budget Delivery Plan and Powering Up Britain reports are important steps towards delivering emissions reductions this decade, gaps remain to meeting the 2030 NDC. Meeting this target is critical to maintaining trust in the ability of the country-determined, bottom-up nature of NDCs to deliver on the Paris Agreement's temperature goal. The Government should strengthen existing plans and set out alternative options to mitigate the risk of not meeting the 2030 NDC (see Chapter 3). • The UK Government should begin planning for its 2035 NDC to be announced by February 2025. A high-ambition, transparent NDC announced to timetable is an important opportunity for the UK to show its commitment to the COP process (recommendation R2022-230). The Government should also consult the public on the ambition level of the NDC (recommendation R2022-227). The CCC will offer its recommendation on the emissions goal for the 2035 NDC as part of its Seventh Carbon Budget advice. • The UK's recent decisions on fossil fuel exploration and production have damaged its international reputation. Developments such as the approval of the Cumbria coal mine undermine the UK's reputation on energy transition and the legitimacy of its Glasgow Climate Pact commitments. These decisions can also limit the UK's credibility when encouraging other countries to end and avoid fossil fuel projects and pushing for fossil fuel phase-out in international discussions. (Recommendation R2023-195). • The UK's action on methane is insufficient. The Government has not set out a UK-specific 30% reduction on 2020 levels by 2030 commitment to support the Global Methane Pledge and the Methane Memorandum brought forward high-level intentions rather than detailed plans for sectoral reductions. (Recommendation R2022-229). • With uncertain prospects for further reform, continued membership of the Energy Charter Treaty (ECT) represents risks to both a timely climate transition and to the taxpayer. There is a strong case for the UK to reconsider its membership, noting the opportunities for potential agreements with other exiting parties that could limit residual risks associated with ECT sunset clauses (Box 2.4). (Recommendation R2023-110).		
Finance	Y	O	Y
	Progress: • The Government has published its International Climate Finance Strategy. This document outlines the Government's priorities and principles for delivering the £11.6 billion of International Climate Finance (ICF) they have pledged to spend between 2021 and 2026. • The Government has maintained its balance between adaptation and mitigation ICF spending. • The UK played an important role in coordinating governments and finance institutions to reach agreement on JETPs with Vietnam and Indonesia in 2022, mobilising $15.5 billion and $20 billion of public and private finance for each deal respectively.[26,27] • The Government published a new Green Finance Strategy in 2023, setting out actions to establish the UK as an international leader in aligning of financial flows with climate and nature objectives.[8]		

To be addressed:

- The use of Official Development Assistance (ODA) to meet domestic costs of refugee support has created pressure on international aid programming. Even if they are compensated for in future years, temporary cuts cause disruption to programmes and can make outcomes less effective. Transparency is needed about where cuts are likely to occur and to manage and communicate risks to the £11.6 billion ICF target being met, noting the damage that missing the target would cause to both climate and development outcomes and the UK's international reputation (recommendation R2023-113).
- The UK could lead other countries by moving past general statements of support and communicating its views on specific measures covered by the Bridgetown Agenda and on IFI reform more generally. The UK should then use shareholder votes and diplomatic capital to push for near-term progress on these outcomes. When solidifying its position, it is important that the UK considers the global mitigation benefits of addressing the high costs of capital faced by some emerging and developing economies and the unsustainable debt burdens faced by climate vulnerable nations after extreme weather events.
- Developed countries will need to agree a new climate finance goal by 2025 within the COP process. The UK is well-placed to draw on the relationships built up through the COP Presidency to facilitate constructive discussions between Parties and identify potential landing zones on the level of the goal, how it is delivered and who contributes.

Climate impacts and nature	Y	Y	Y

Progress:

- In Montreal in January 2023, the UK played an important role in securing international agreement on the Kunming-Montreal Global Biodiversity Framework. The UK also established the Global Ocean Alliance and became the Ocean Co-chair of the High Ambition Coalition for Nature and People.
- At COP27, the Government announced that it would triple the international climate finance that is spent on adaptation (from £500 million in 2019 to £1.5 billion in 2025).
- At COP27, UK Export Finance (UKEF), the UK Government's export credit agency, announced that it would introduce Climate Resilient Debt Clauses in direct sovereign lending. These clauses provide the option for low-income and small island state governments to delay repayments when they experience severe climate-related shocks. UKEF was the first export credit agency to offer such provisions.[28]
- The UK Government pledged £120 million in support for disaster risk financing. Some of this money will support the Global Shield against Climate Risk initiative. The Global Shield was launched by the G7 and the V20 group of climate vulnerable countries to provide climate risk finance and disaster preparedness solutions that can be rapidly accessed in emergencies.
- The 2030 Strategic Framework expresses ambition to secure agreement on new funding arrangements for Loss and Damage. The UK's public support in this area following COP27 is positive and should be echoed in other areas of its negotiation position.

To be addressed:

- Risks to UK ODA programming for adaptation and resilience have arisen from temporary cuts to the budget for international aid spending. Further detail is provided in the finance section of the policy scorecard (recommendation R2023-113).
- The UK can play an important role in UNFCCC processes aiming to produce proposals on future financing arrangements for Loss and Damage through using its membership of the Transitional Committee to ensure robust, detailed proposals are brought to COP28 that have potential to deliver for climate vulnerable nations.
- The UK can demonstrate best practice in communicating adaptation needs and plans in an international setting through UNFCCC Adaptation Communications and National Adaptation Plans, to encourage other countries to do the same.
- Further steps are needed to address climate risk in the UK's overseas supply chains. The lack of mention of climate in the Department of International Trade's Supply Chains Resilience Framework suggests coordination is needed across Government to ensure all departments are aware of their exposure to overseas climate risk.[29] There is also a need for Government to

encourage businesses to assess the climate risks affecting their supply chains with clear reporting standards and information.

- UK expertise on climate risk assessment and adaptation metrics can contribute to discussions on the Global Goal on Adaptation and to help increase national capabilities in other countries. The CCC will contribute to these efforts through the International Climate Councils Network (ICCN) Just Adaptation Working Group and international engagement on adaptation through UK PACT.[30]

(b) The UK as a climate leader

The Strategic Framework sets out notable aims on the UK's ambition to contribute towards meeting international climate and nature goals. However, many of the actions underneath these ambitions focus on past policies and programmes with little detail on what will be done in future. In some areas, such as trade, there are almost no actions at all.

The UK has retreated from the climate leadership position it established during the COP Presidency.

There has been a clear decline in profile for international climate issues in Government over the past year. Coupled with domestic policy decisions that clash with the UK's international messaging, such as the new Cumbrian coal mine, this represents a retreat from the strong leadership position established during the UK's COP Presidency. Overall, the UK has lost its clear global leadership position on climate action, although examples of leadership do remain such as research and international efforts on aviation and shipping.

The UK needs to redefine its role in the international climate space. Regaining its role as a clear climate leader following its COP Presidency will require concerted action in the following areas:

The UK can lead on domestic delivery by addressing the remaining policy gaps for the 2030 NDC.

- **Domestic action.** The UK's ability to advocate for progressive international outcomes relies on a credible record on domestic delivery. Filling the policy gaps in the Carbon Budget Delivery Plan to meeting the 2030 NDC and developing alternative policy options for areas with substantial delivery risks (see Chapter 3) would demonstrate best practice and allow the UK to lobby other countries to do the same. Domestic decisions need to align with the ambition we encourage abroad and avoid repetition of reputation and leadership-damaging mistakes such as the approval of the new coal mine in Cumbria.

Membership of outdated agreements such as the Energy Charter Treaty risks slowing momentum on low-carbon transition.

- **Keeping pace with global change.** As well as producing a policy response to measures such as the US Inflation Reduction Act and EU Green Deal Industrial Plan, the UK should reconsider its membership of outdated agreements such as the Energy Charter Treaty (Box 2.4) to ensure it is well placed to keep pace with the growing momentum of the low-carbon transition.

The Government needs to present a clear plan and identify ministerial leadership for COP28.

- **Negotiations.** The Government should set out its ministerial leadership arrangements and negotiating priorities well in advance of COP28, continue to advocate for the highest-ambition outcomes on mitigation, adaptation and support for developing countries and consider joining a progressive COP negotiating bloc. With COP28 expected to involve detailed discussions on the future role of fossil fuels, the UK should set out in advance a clear position on exiting oil and gas that avoids ambiguous references to, for example, hydrogen-ready infrastructures, and strengthen its language on this in all international climate fora including the G7 and G20.

The UK can demonstrate leadership by delivering progress against existing JETP agreements.

- **Delivering on international commitments.** The coming year has many opportunities for the UK to show leadership and help to deliver tangible progress against COP and CBD commitments on methane, forests and nature. Demonstrating progress against existing JETPs with South Africa, Vietnam and Indonesia is also vital for showing that this model of financing can deliver real world results.

- **International sector ambition.** The UK can continue to demonstrate leadership through supporting and coordinating increased ambition on emissions reductions for international aviation (through the International Civil Aviation Organization – ICAO) and international shipping (through the International Maritime Organisation – IMO). A notable opportunity for this will be the forthcoming revision of the IMO's long-term target in 2023. Further details on aviation and shipping are provided in Chapter 10 and Chapter 11 respectively.

The process of determining the UK's 2035 NDC should begin.

- **NDC best practice.** The UK Government will need to begin the process of determining its 2035 NDC (Box 2.5).

Box 2.4
Energy Charter Treaty explainer

The Energy Charter Treaty (ECT) is a legally binding international agreement that was developed to address barriers to cross-border energy cooperation in the early 1990s. The ECT established a framework for signatories to invest in energy assets in each other's countries and to trade and transport energy, underpinned by principles of both open competition and national sovereignty over energy resources. At the time of inception, the energy addressed in the treaty was mostly from fossil fuels. There are over 50 parties to the Treaty, currently including both the UK and the EU. Some of the investment protection elements of the ECT now pose a risk to climate progress in signatory countries. The Treaty includes a mechanism for Investor-State Dispute Settlement (ISDS) that allows investors to legally challenge signatory states if national legislation or regulation leads to depreciation of their energy investments. This provides a route for fossil fuel companies to sue governments for climate and energy policies that seek to phase out the use of fossil fuels. The Netherlands is currently facing a $1.4 billion ISDS challenge over its phase-out of coal. These elements of the ECT represent risk to both a timely climate transition and to the taxpayer.

There have been multiple efforts to reform the ECT. The most recent round of reforms in 2022 produced UK carve-outs that remove protections for new fossil fuel investments and provisions to phase in carve-outs that remove protections for existing fossil fuel investments. Overall, these reforms do not provide sufficient protection. Firstly, they retain protections for new gas pipelines that are 'capable' of transporting renewable and low-carbon gases (such as hydrogen) even if the pipelines are not being used for that purpose. Secondly, carve-outs for existing unabated gas investments will take at least ten years to come into force, leaving ample time for investors to launch claims. Thirdly, the recent reforms may face lengthy delays in coming into force due to Treaty ratification processes. This opens the door to investors frontloading their new investments to secure protections before carve-outs take effect. While further reform is technically possible, it looks increasingly unlikely given the number of climate-progressive parties signalling their intent to leave the ECT. Leaving the ECT does not fully remove risk as exiting parties will still be bound by a 20-year sunset clause for existing assets. However, as momentum gathers behind ECT exit, departing parties may come together to agree not to apply the sunset clause to each other. The Government should reconsider its judgement that the 2022 reforms bring the ECT into alignment with its Net Zero ambition and Paris Agreement commitments and strongly consider leaving the ECT, noting the opportunities associated with potential agreements with other exiting parties.

Source: Haut Conseil pour le Climat (2022) *Report on the Modernisation of the Energy Charter Treaty*; E3G (2022) *Is the new Energy Charter Treaty Aligned with the Paris Agreement? A Reform That Still Falls Short*; UK Government (2022) *UK strengthens protections for taxpayers in energy treaty negotiations.*

Box 2.5
Process for UK 2035 NDC

COP26 demonstrated that the timing of NDC announcements and having a critical mass of ambition was integral for increasing global mitigation ambition. The UK should be at the forefront of efforts to increase ambition again at COP30, using lessons learned from its COP26 Presidency.

The UK can also demonstrate leadership through its 2035 NDC by submitting a high-ambition and transparent NDC to the Paris Rulebook's timeline. This requests NDCs be submitted 9-12 months prior to that year's COP (held in November/December) so the UK Government should announce its 2035 NDC by February 2025 at the latest.

The CCC's Sixth Carbon Budget (2033-2037) analysis suggests emissions, including the UK's share of international aviation and shipping (IAS) emissions, should reduce by 78% on 1990 levels by 2035 (82% excluding IAS).

- As part of its forthcoming work on the Seventh Carbon Budget, the CCC will prepare 2035 NDC advice that considers both the emissions reduction required over the Sixth Carbon Budget period and the outcomes of the GST.
- This advice will also provide options for target ambition and will consider how IAS emissions could be reflected in the overall NDC, noting the inclusion of IAS in the Sixth Carbon Budget and UNFCCC emissions accounting rules.
- The UK must also demonstrate best practice when setting the NDC target based on the principles of transparency. This includes providing quantified estimated GHG savings that will achieve the target level and undertaking a comprehensive public engagement and/or consultation process.
- The Committee also recommended in our 2022 Progress Report that Government set out the governance and accountability structures for tracking progress against all UK NDC targets, noting the UK NDC is not in the scope of the Climate Change Act (2008) and therefore not accountable to Parliament.

Source: UNFCCC (2015) *Paragraph 25, Decision 1/CP.21, Adoption of the Paris Agreement* https://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf

Endnotes

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[2] European Commission (2023) *European Commission released the Net-Zero Industry Act and European Critical Raw Materials Act*, https://www.intelligentcitieschallenge.eu/news/european-commission-released-net-zero-industry-act-and-european-critical-raw-materials-act-0.

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Policy and emissions

Introduction and key messages

Our confidence in the Government's plans for meeting the UK's emissions reduction targets in the 2030s has decreased since last year. With little substantial progress, timelines are slipping. Urgent action is now needed to strengthen existing policies, fill policy gaps and develop alternative plans to mitigate the risk posed to the UK's international and domestic commitments. With the 2030 Nationally Determined Contribution (NDC) only seven years away, the next year will prove crucial for the UK Government to show how it will achieve this and demonstrate that outcomes are being delivered in all areas.

On the 30th of March this year, the Government published a suite of documents, aiming to map out its decarbonisation plans and how they align with economic growth and energy security in the UK.[1,2] The documents contained a summary of previous plans and a few new announcements, but nothing that significantly improved the overall picture. A key output was the Carbon Budget Delivery Plan (CBDP), laying out a set of decarbonisation policies and proposals. Most, but not all, of these have an associated quantification of how they contribute to the emissions reductions required to meet future targets. The CBDP provides a welcome and significant increase in detail and transparency. It was published in response to a High Court ruling that the Government's 2021 Net Zero Strategy (NZS) did not comply sufficiently with the Climate Change Act due to lacking this detail.[3]

In this and the following chapters, we discuss the UK's decarbonisation progress in the past year. We track progress against emissions reductions and a set of indicators and provide an assessment of policies and plans. Details on how we monitor progress are outlined in our accompanying Monitoring Framework.

Our key messages are:

- **Emissions.** UK greenhouse gas emissions were 450 $MtCO_2e$ in 2022, including the UK's share of international aviation and shipping, which is 46% below 1990 levels. This is an increase of 0.8% since 2021, but emissions remain 9% below pre-pandemic (2019) levels.
  - **Emissions changes 2021 to 2022.** Changes in the last year were mainly driven by transient differences in demand and temperature. There was an almost doubling of aviation emissions, due to the lifting of travel restrictions following the pandemic. Residential buildings emissions fell 16%, primarily due to mild winter months, with a smaller contribution from record high fuel prices reducing demand.
  - **Emissions reduction needs to accelerate** in all sectors outside of electricity supply, with the pace needing to almost quadruple over the next eight years. In agriculture and land use there has been no progress in reducing emissions in the last decade. Significant risks and policy gaps remain in these sectors.
- **The Carbon Budget Delivery Plan has highlighted areas in which commitment may be lacking.** As a result of last year's High Court ruling the Government has had to provide a firmer public commitment to its plans via the CBDP. This has resulted in some changes in approach and ambition, most notably the decision not to quantify potential emissions savings from reducing car-kilometres, and a reduction in ambition in the land use sector. Where possible, the emissions savings coming from unquantified plans should be estimated, even if they cannot be attributed on a policy-by-policy basis.

- **Our confidence in the UK meeting the Fourth Carbon Budget (2023-2027) has slightly increased in the last year.** This is largely driven by an approximately 5% decrease on 2019 levels of vehicle-kilometres that appears to have reached a steady state, and increased confidence in the transition to electric vehicles in the short-term, as sales continue to grow.

- **Our confidence in the UK meeting the 2030 NDC and the Sixth Carbon Budget (2033-2037) has decreased since last year.** This is driven by a combination of delays in action leading to increased delivery risk and the extra detail in the CBDP allowing for a more thorough assessment. While we would expect policies to be less developed for targets further away in time, the NDC is now only seven years away.

  - There is an increase in the risk to emissions reduction from surface transport and electricity supply, predominantly due to delays in the zero-emissions vehicle mandate and the continued lack of a strategy for decarbonising electricity by 2035.

  - There have been more policy gaps identified in industrial electrification and resource efficiency; in agriculture and land, due to a lack of long-term funding and a more apparent reliance on the voluntary uptake of low-carbon measures; and in engineered removals due to delays in funding and guidance.

  - Significant risks identified last year remain for a number of areas including the decarbonisation of heat in homes, new nuclear capacity and conventional vehicles efficiencies.

  - With current plans, it is unlikely that the UK would achieve a reduction in methane emissions in line with the Global Methane Pledge of a 30% reduction in methane emissions compared to 2020 levels.

- **Risk management and contingency plans.** The Government's decarbonisation framework is currently missing coherent plans to mitigate the delivery risks to meeting the UK's 2030 NDC and the Sixth Carbon Budget. With the 2030 NDC only seven years away, it is vital they be developed in the next year. Risk management plans should:

  - Identify and begin to implement decarbonisation options beyond those quantified in the CBDP that could deliver an appropriate amount of additional emissions reduction on the required timescale. These should include empowering and incentivising the public to make low-carbon choices in how they travel and what they eat. Such measures also bring co-benefits for energy security and health. The plans should ensure there is sufficient time for policies to be implemented in a sensible, cost-effective and fair way.

  - Track indicators of progress against pathways consistent with the emissions reduction targets and establish governance structures for co-ordinating the implementation of additional alternative plans should things go off-track.

The rest of this chapter discusses progress in the following sections:

1. Progress in reducing UK emissions
2. Energy demand
3. Assessment of the UK Government's policies and plans
4. Mitigation of delivery risk and contingency plans

(a) UK total territorial emissions

Emissions in the UK have been steadily falling in the last three decades and in 2022 were 46% below 1990 levels.

Emissions in the UK have been steadily falling in the last three decades and in 2022 were 46% below 1990 levels (Figure 3.1).* The UK met its first two carbon budgets and is likely to have met its third, which ran from 2018 to 2022 (Figure 3.2).

Emissions in 2021. Emissions were 446.0 $MtCO_2e$ in 2021, 47% below 1990 levels. This was an increase of 4% from 2020, although they remained 10% below pre-pandemic (2019) levels (Figure 3.2).[4] The increase was driven by a partial rebound in surface transport emissions following the pandemic, an increase in emissions from electricity supply due to low wind speeds and nuclear outages, and higher heating requirements in residential buildings due to cold winter months. Emissions in agriculture increased due to an increase in combustion emissions (Figure 3.3a).

Emissions in 2022 were 0.8% higher than in 2021, remaining 9% below pre-pandemic levels in 2019.

Emissions in 2022. A provisional estimate of 2022 emissions is 449.6 $MtCO_2e$, an increase of 0.8% on 2021 levels, remaining 9% below pre-pandemic levels and 46% below 1990 levels (Figure 3.2).[5]

- Aviation emissions almost doubled in 2022 as the sector rebounded following the pandemic but remained 25% lower than in 2019 (Figure 3.4).
- Surface transport emissions increased by 3% but remain 8% below pre-pandemic (2019) levels (Figure 3.4), with some evidence that vehicle-kilometres have reached a reduced steady state (see Chapter 4).

The change in emissions in 2022 was driven by an almost doubling of aviation emissions balanced by a 16% decrease in emissions from residential buildings, due to mild winter months and high gas prices.

- There was a 16% decrease in emissions from residential buildings, predominantly due to milder than usual winter months in 2022 and the contrast to the cold winter months in 2021.
  - After adjusting for the effect of temperatures on heating requirements,† emissions from residential buildings fell by only 6% in 2022. This is likely to be driven by a behavioural response to the record-high gas prices (see Section 2 on energy demand).
  - Non-residential buildings emissions increased by 5% in 2022, after adjusting for temperatures. This was driven by increases in emissions in public buildings and there may be a contribution from an increase in office working following the pandemic (Figure 3.3b).

The Third Carbon Budget (2018-2022). Using the provisional estimate for 2022 emissions, total emissions over the Third Carbon Budget period were 2,327 $MtCO_2e$. The Third Carbon Budget is set at 2,544 $MtCO_2e$ and the provisional data indicate that the UK has achieved it (Figure 3.2). A full assessment will be made in our 2024 Progress Report, when final emissions data for the period are available, with 2018-2020 emissions adjusted for net EU ETS trading.

* All emissions values in this report use Global Warming Potentials from the IPCC's Fifth Assessment Report, without climate-carbon feedback effects (AR5-low).

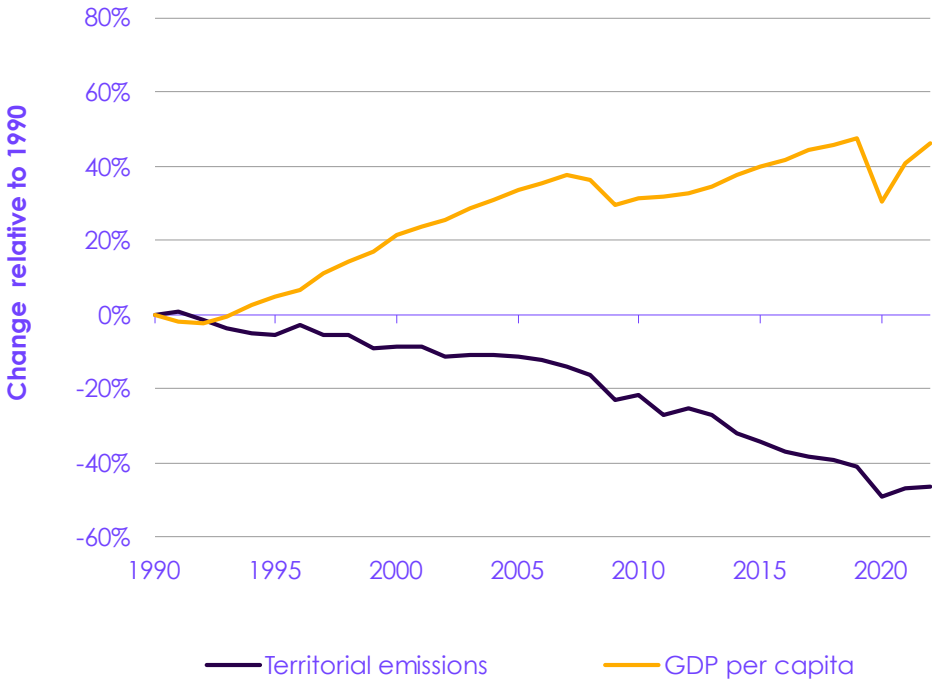
† Emissions are adjusted to account for year-on-year variations in temperature that lead to significant variations in actual emissions. The methodology is explained in our Monitoring Framework.

It is essential that an overachievement of the Third Carbon Budget is not banked as surplus emissions for the Fourth Carbon Budget.

It is essential that an overachievement of the Third Carbon Budget is not carried forward as surplus emissions for the Fourth Carbon Budget. An overachievement is not due to policy progress going ahead of schedule. Rolling over any surplus emissions would undermine the legal framework of the Climate Change Act and risk putting the UK off-track for Net Zero.

The UK's territorial emissions have been falling steadily since 1990 and in 2022 were 46% lower. During this period the UK's GDP per capita has risen by 46%.

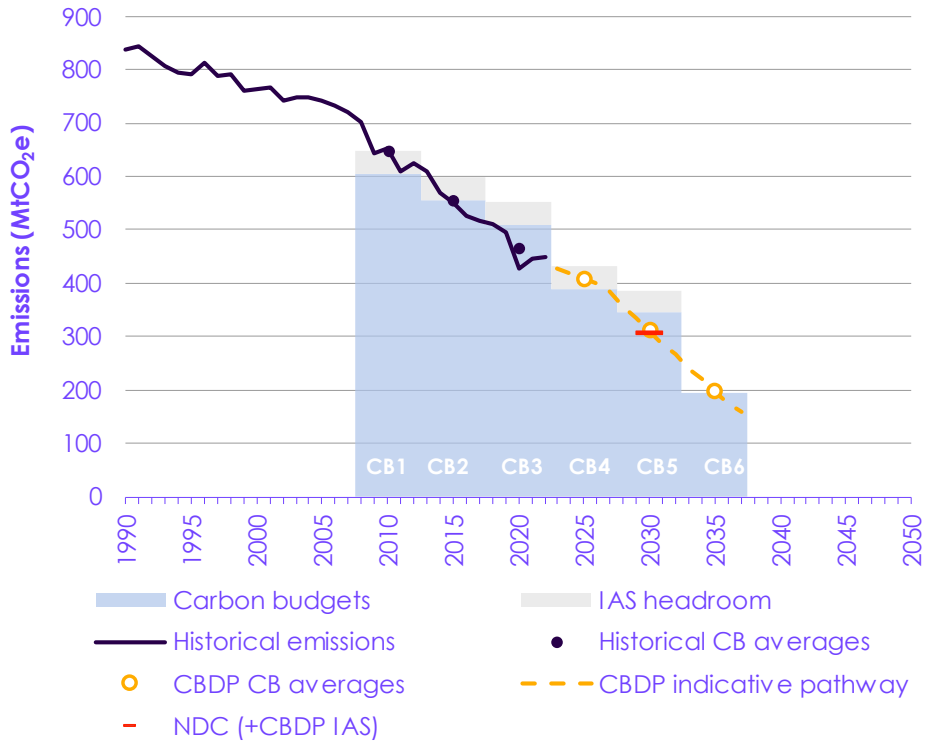
Figure 3.1 The UK's GDP and territorial emissions



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; ONS, *GDP and population data*; CCC analysis.
Notes: Emissions from international aviation and shipping are included.

The UK achieved its first two carbon budgets and is likely to have achieved its third. The 2030 NDC and Sixth Carbon Budget are significantly more challenging.

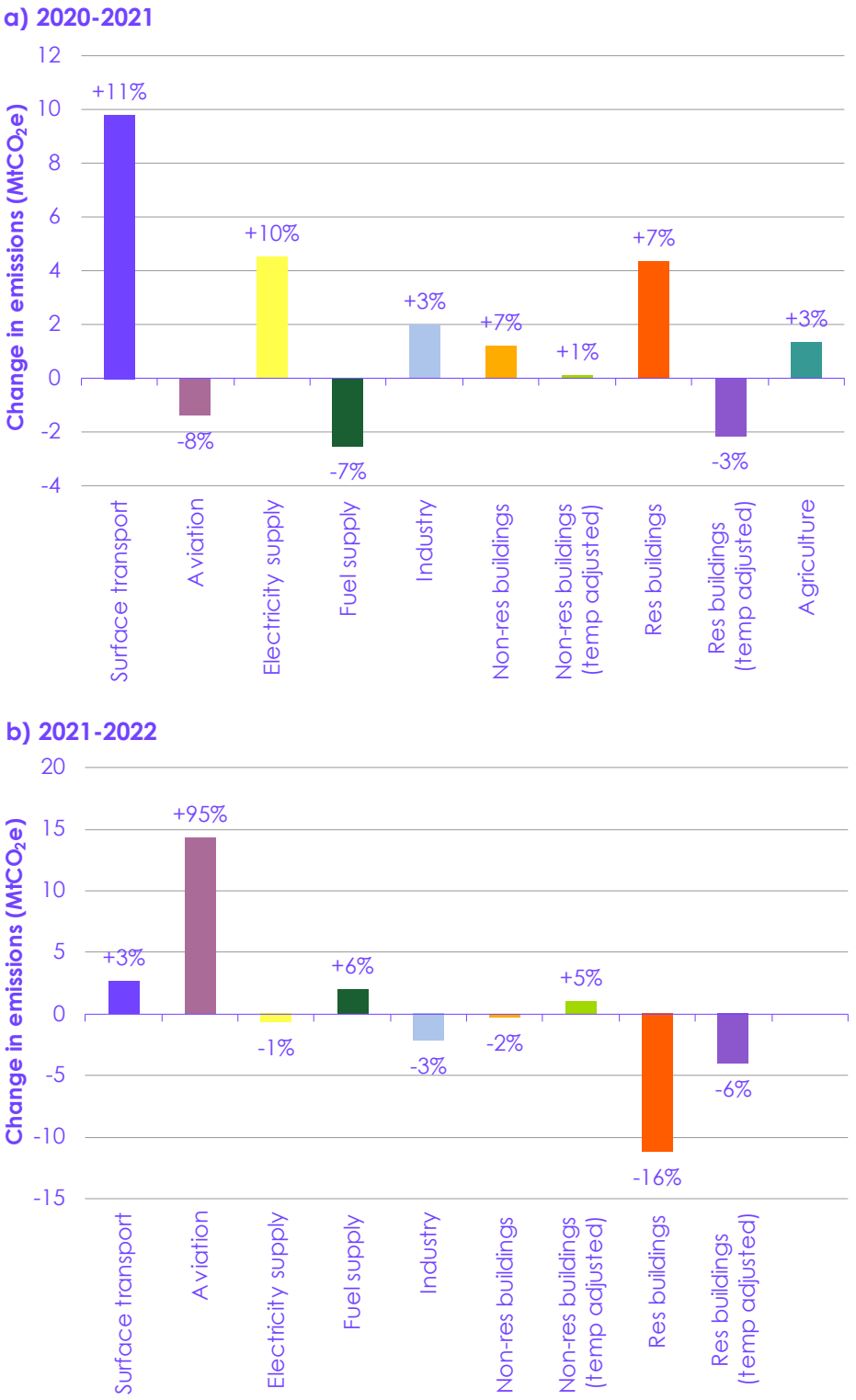
Figure 3.2 UK historical emissions, the Government's pathway and the UK's targets



Source: DESNZ (2023) *Carbon Budget Delivery Plan;* BEIS (2021) *Net Zero Strategy;* CCC (2020) *The Sixth Carbon Budget.*
Notes: (1) Emissions from international aviation and shipping (IAS) are included in historical emissions and the Carbon Budget Delivery Plan (CBDP) pathway and added to the NDC to allow for a direct comparison. (2) The CBDP projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (3) The annual pathway is an indication of emissions reduction. The UK does not have annual targets but the five-year carbon budgets and 2030 NDC must be achieved. (4) We have adjusted the Government's published CBDP pathway for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

Emissions increased in 2021, driven mainly by increases in surface transport and electricity supply. Emissions in 2022 increased slightly by 0.8% due to an almost doubling of aviation emissions balanced by a 16% decrease in emissions from residential buildings.

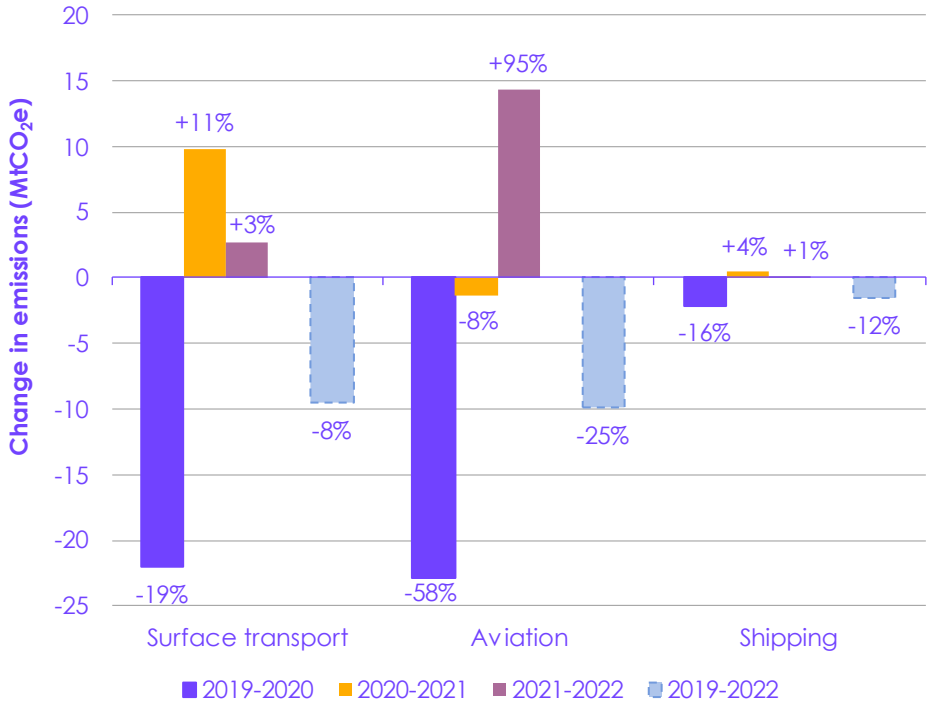
Figure 3.3 Change in UK emissions for key sectors (2020 to 2021 and 2021 to 2022)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; CCC analysis.
Notes: Provisional 2022 estimates are not made for non-CO_2 greenhouse gases, so the change in 2022 agriculture emissions is not shown.

Emissions in transport fell during the pandemic and have since increased, but remained below pre-pandemic levels in 2022.

Figure 3.4 Change in UK transport emissions (2019 to 2022)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; CCC analysis.

(b) Required pace of future emissions reductions

The rate of emissions reduction outside the electricity supply sector will need to accelerate quickly for the UK to meet its 2030 NDC and the Sixth Carbon Budget.

The rate of emissions reduction will need to accelerate quickly for the UK to meet its 2030 NDC and the Sixth Carbon Budget (Figure 3.5).

- Excluding emissions from aviation and shipping, which were significantly affected by the pandemic, emissions in 2022 were 408 $MtCO_2e$, having fallen by 110 $MtCO_2e$ in the eight years prior to this (since 2014). This corresponds to a reduction of 2.9% per year on average.*

- If we also exclude emissions from electricity supply, which have driven the bulk of the reductions over this period, emissions fell by only 36 $MtCO_2e$ to 360 $MtCO_2e$ over eight years, an average reduction of 1.2% per year. If the UK is to achieve its NDC, this will need to increase to 115 $MtCO_2e$ from 2022 to 2030 (an average annual reduction of 4.7%). The quantified plans in the CBDP projection leads to a reduction of 109 $MtCO_2e$ from 2022 to 2030, with the unquantified plans needing to make up the rest. The CBDP reduction corresponds to an average reduction of 4.4% per year, nearly four times the annual percentage reduction seen in recent years.

- Emissions reductions will need to accelerate in all sectors apart from electricity supply, where progress must be maintained (Figure 3.6).

  – Emissions reduction in the electricity supply sector over the last eight years has been driven by the phase-out of coal, growth in renewable

* Average annual percentage reductions here and elsewhere in the report refer to a compound reduction, which is the average of year-on-year percentage reductions.

generation and reducing demand. From now on the sector needs to switch to phasing out unabated gas generation, while also keeping pace with growing electricity demand.

– Emissions reduction in surface transport has been driven by falling car-kilometres following the pandemic. The rapid increase in electric vehicle sales has not yet resulted in major emissions savings, but these are expected to contribute a growing amount over the next few years.

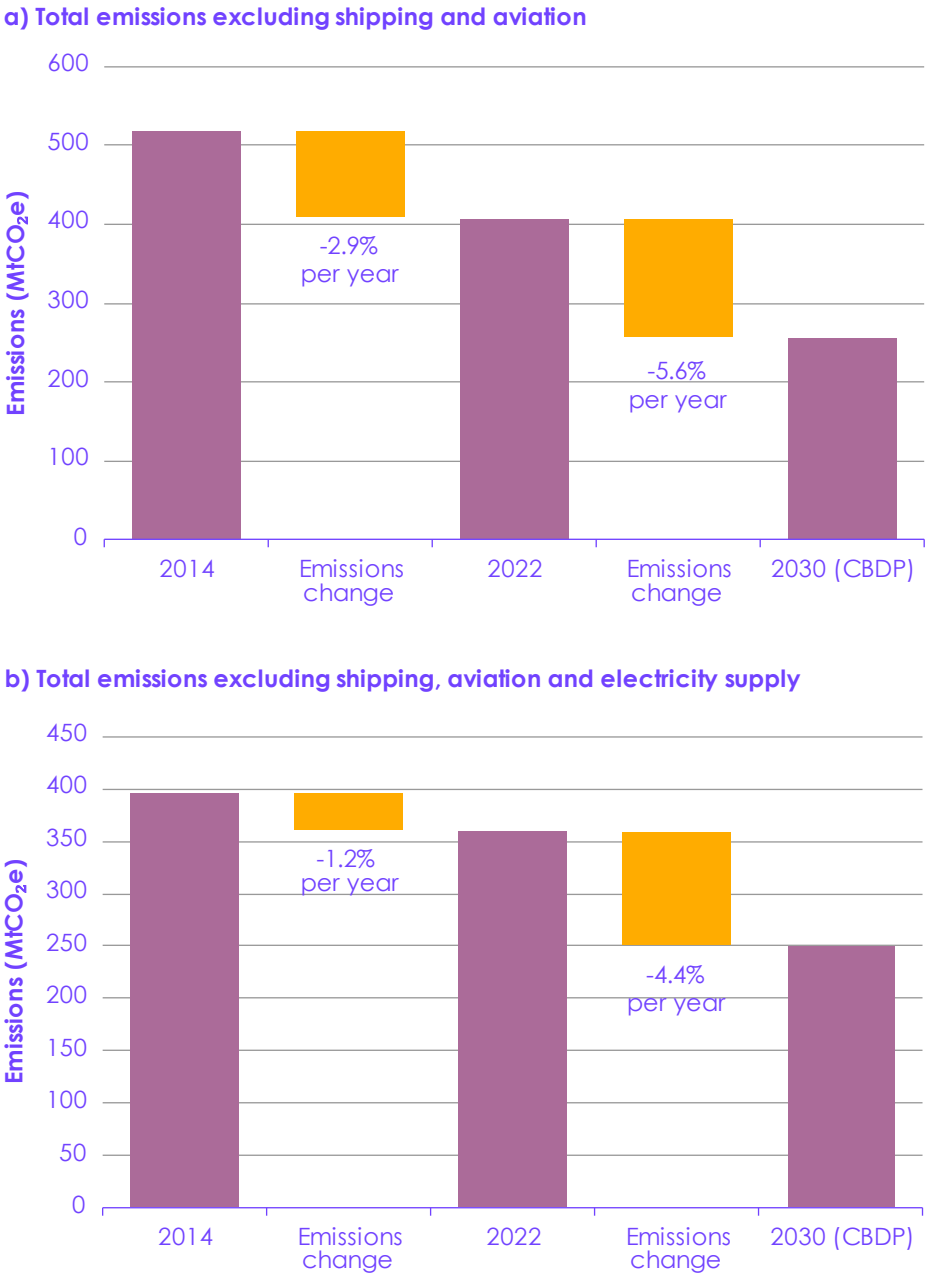
– While there has been some limited progress in the buildings, industry, fuel-supply and F-gases sectors, the rate of reduction needs to accelerate by a factor of two or three. Most of these sectors carry significant delivery risks.

There has been no progress in the agriculture, land use and waste sectors in the past eight years, with substantial reductions needed in the next eight years.

– There has been no progress in the agriculture, land use and waste sectors in the past eight years, with substantial reductions needed in the next eight years. The policies in these sectors carry significant delivery risk and, in some cases, plans are completely missing.

If the UK is to achieve its 2030 NDC, the rate of emissions reduction outside the electricity supply sector must almost quadruple.

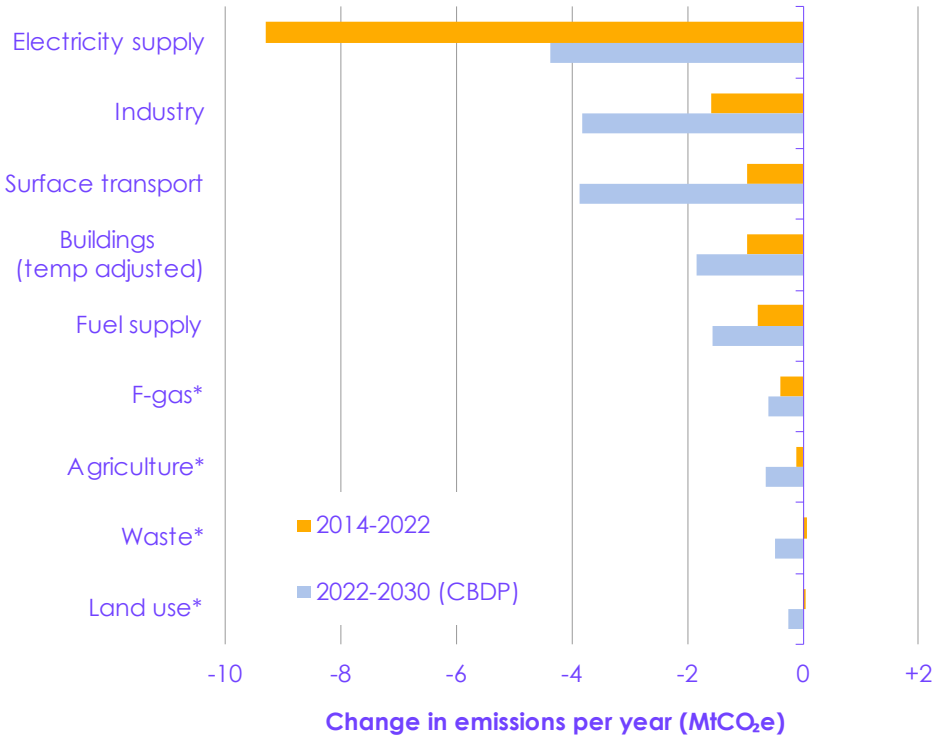
Figure 3.5 Change in UK emissions from 2014 to 2020 and required change from 2022 to 2030



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; DESNZ (2023) *Carbon Budget Delivery Plan.*
Notes: (1) The Carbon Budget Delivery Plan (CBDP) projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (2) We have adjusted the Government's published CBDP pathway for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

Emissions reduction in all sectors apart from electricity supply will need to accelerate. There has been no progress in the agriculture, land use and waste sectors in the past eight years.

Figure 3.6 Change in UK emissions per year by sector from 2014 to 2022 and 2022 to 2030



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; DESNZ (2023) *Carbon Budget Delivery Plan*.
Notes: (1) *Provisional 2022 estimates are not made for non-CO_2 greenhouse gases, so the change in 2022 land use, agriculture, waste and F-gas emissions are not shown and final 2021 emissions are used instead. (2) The Carbon Budget Delivery Plan (CBDP) projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (3) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. (4) We have adjusted the Government's published CBDP pathway for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

(c) UK methane emissions

The UK has no specific commitment to meet the Global Methane Pledge at a domestic level and action in reducing methane emissions needs to be stronger.

At COP26 in Glasgow, the UK signed up to the Global Methane Pledge: an international agreement to target a reduction of at least 30% in global methane emissions by 2030 compared to 2020 levels.[6] However, there is no UK-specific commitment to meet the Pledge at a domestic level and action in reducing methane emissions needs to be stronger (Chapter 2, recommendation R2022-229). The CBDP does not provide a breakdown by greenhouse gas of its emissions reduction pathway, so tracking progress towards the Pledge is difficult.

- Methane emissions come predominantly from agriculture and waste, with smaller contributions from fuel supply and land use (Figure 3.7).
- While methane emissions fell significantly from 2000 to 2015, driven by reductions in emissions from landfill waste and coal production in fuel supply, progress has stalled in recent years (Figure 3.7).
- In the six years from 2015 to 2021, methane emissions have fallen by an average of 0.9 $MtCO_2e$ (1.5%) per year. This will need to accelerate to 2.0 $MtCO_2e$ (4%) per year if the UK is to achieve a 30% reduction by 2030 (Figure 3.8).

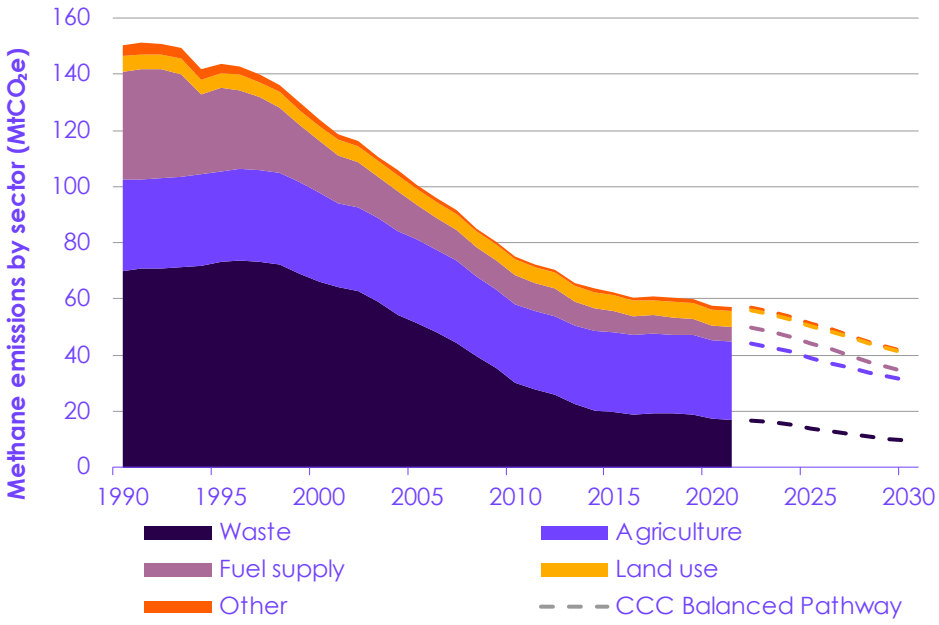
Reductions in methane emissions are driven by the waste, agriculture and fuel supply sectors all of which have significant delivery risks.

- In our Balanced Pathway,* methane emissions fall by around 30% compared to actual emissions in 2020 by 2030. This is driven by reductions in waste, agriculture and fuel supply. The Government's ambition in all these sectors is less than in our Balanced Pathway, and Government plans all have significant delivery risks. This is particularly the case in agriculture where some plans are completely insufficient with a heavy reliance on voluntary uptake of measures (Chapter 9). It is therefore unlikely that the UK would achieve a 30% reduction in emissions by 2030 with current plans.

- The UK Government needs to lay out clearly how it plans to achieve a 30% reduction and address the associated delivery risk (recommendation R2022-229).

While methane emissions fell significantly from 2000 to 2015, driven by reductions in emissions from landfill waste and coal production in fuel supply, progress has stalled in recent years.

Figure 3.7 UK methane emissions by sector

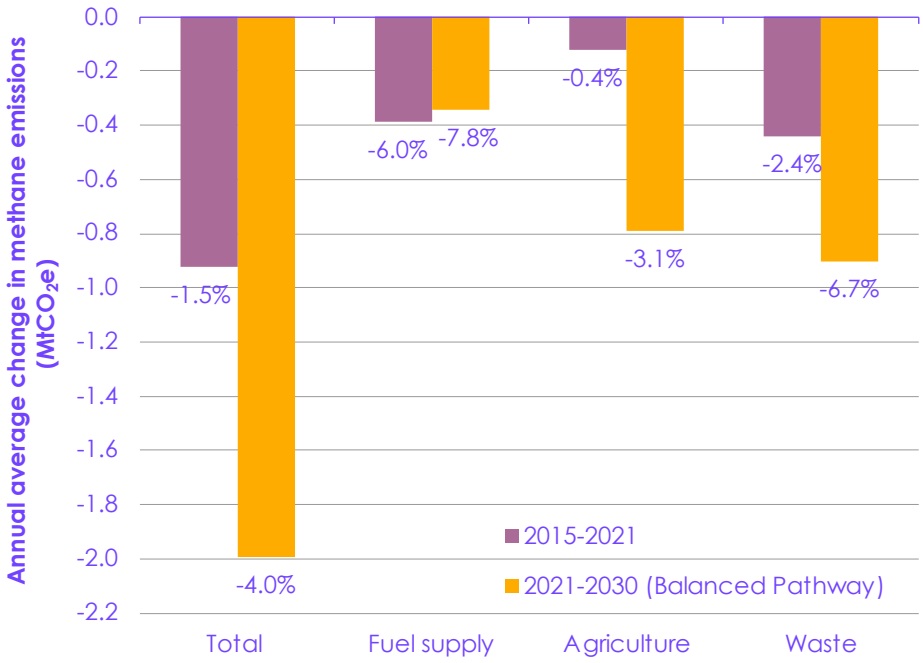


Source: BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; CCC (2020) *The Sixth Carbon Budget*; CCC analysis.
Notes: We have adjusted our pathway to account for changes in the UK's emissions inventory methodology.

* We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology.

Since 2021 methane emissions have fallen by an average 1.5% per year. This will need to increase to 4.0% if the UK is to achieve the 30% reduction by 2030.

Figure 3.8 Annual average change in methane emissions: historical (2015 to 2021) and required (2021 to 2030)



Source: BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; CCC (2020) *The Sixth Carbon Budget*; CCC analysis.
Notes: We have adjusted our pathway to account for changes in the UK's emissions inventory methodology.

(d) Emissions in Scotland, Wales and Northern Ireland

Like in England, emissions in Scotland, Wales and Northern Ireland fell during the pandemic in 2020 and rebounded in 2021.

As in England, emissions in Scotland, Wales and Northern Ireland fell in 2020 and rebounded in 2021 due in part to increases in surface transport emissions as pandemic restrictions eased. There were also increases in emissions from residential buildings due to colder than usual winter months, and from agriculture in line with those in England. Emissions from surface transport and aviation remain below pre-pandemic 2019 levels across the UK.

- **Scotland.** Emissions in Scotland were 41.6 $MtCO_2e$ in 2021, 2% higher than 2020 levels but remaining 10% below pre-pandemic (2019) levels and 49.2% below 1990 levels, 49.9% using the GHG account, which is used to assess targets (Figures 3.9 and 3.10). Scotland therefore did not meet its 2021 annual target of a 51.1% reduction compared to 1990 levels* (Figure 3.9).[7,8,9] Unlike the rest of the UK, emissions from industry and electricity supply (due to lower gas-fired generation) decreased in Scotland in 2021.

- **Wales.** In 2021 emissions in Wales were 36.3 $MtCO_2e$, 7% higher than the previous year but 6% below pre-pandemic (2019) levels and 35% below 1990 levels (Figures 3.9 and 3.10). Wales achieved its 2020 interim target and its First Carbon Budget (2016-2020), with emissions reduction over the First Carbon Budget period mainly driven by the electricity supply and industry sectors.[10] The 2021 rise in emissions was driven by the electricity supply, industry and surface transport sectors. In 2021, electricity supply

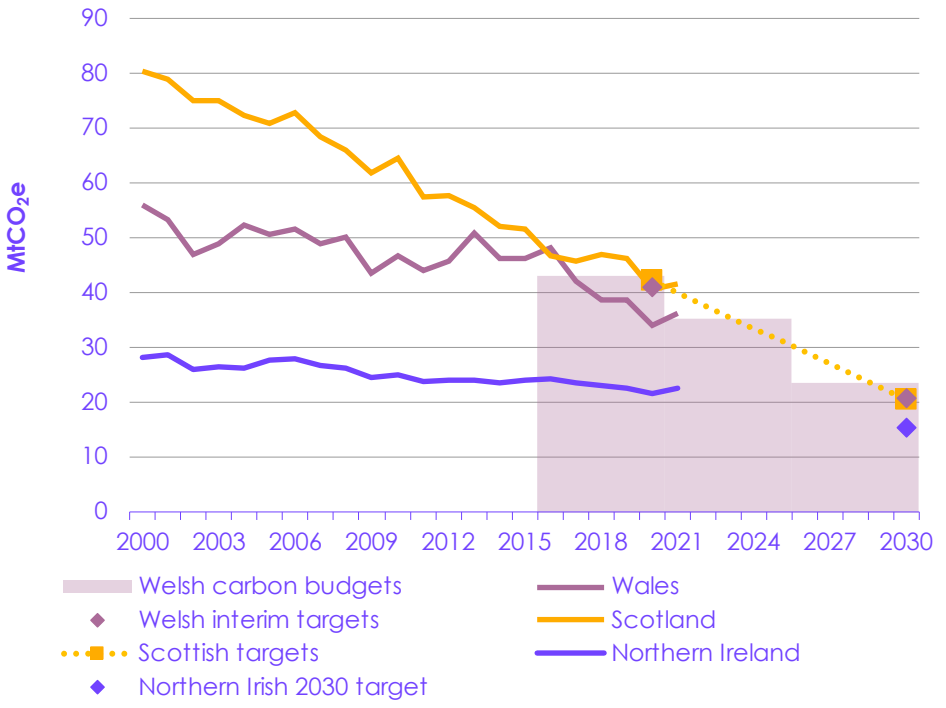
* This refers to the Scottish targets legislated in 2023 which were updated to ensure consistency with the latest change in international emissions reporting practices.

increased by more than the rest of the UK, with higher gas-fired generation (partly for export to England).

- **Northern Ireland.** Emissions in Northern Ireland were 22.7 $MtCO_2e$ in 2021, 5% higher than 2020 levels. This was 0.5% higher than pre-pandemic (2019) emissions and 23% lower than 1990 levels (Figures 3.9 and 3.10). The emissions increase in 2021 was driven by the surface transport, agriculture and electricity supply sectors.

In 2021 emissions in Scotland were almost half those in 1990 but Scotland missed its 2021 annual target. In Wales and Northern Ireland emissions reductions have been slower, although they sped up in Wales in the last five years.

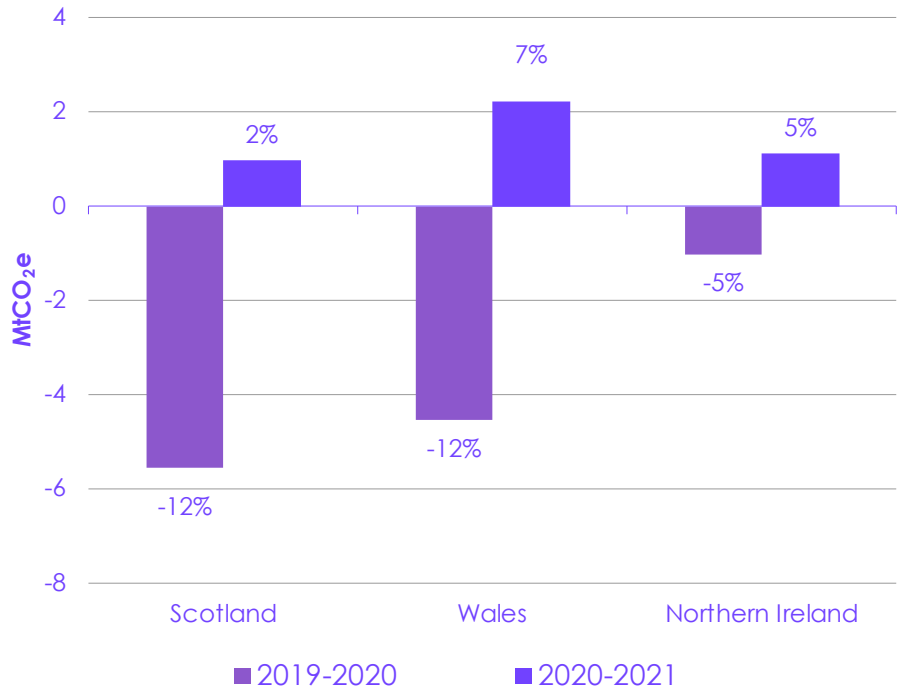
Figure 3.9 Emissions in Scotland, Wales and Northern Ireland compared to targets



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2021*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*
Notes: Scottish annual targets between 2020 and 2029 have been adjusted following the CCC's advice to align with the latest emissions estimation methodology. For example, the legislated 2020 target changed from a 56% reduction to 48.5% of baseline levels. This reflects the change in international emissions reporting practice. 2020 emissions were assessed by the Scottish Government against the old target of 56% (and using the old GHG inventory methodology). Historical emissions are shown using the 1990-2021 inventory. Targets in Scotland are assessed against the GHG account which reports slightly lower historical emissions in 2021, but the 2021 target was still missed.

Emissions in Scotland, Wales and Northern Ireland fell in 2020 and rebounded in 2021 with Northern Ireland's emissions back to pre-pandemic levels.

Figure 3.10 Change in emissions in Scotland, Wales and Northern Ireland, 2019-20 and 2020-21



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2021*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*

(e) UK consumption emissions

While we report emissions primarily on a territorial basis, as this is how the UK's targets are measured, it is also important to consider overseas emissions from UK consumption. Consumption-based estimates cover emissions that occur as a result of UK consumption of goods and services, wherever those emissions happen globally. UK consumption emissions are higher than its territorial emissions (Figure 3.11), because emissions associated with imports exceed those from exports.

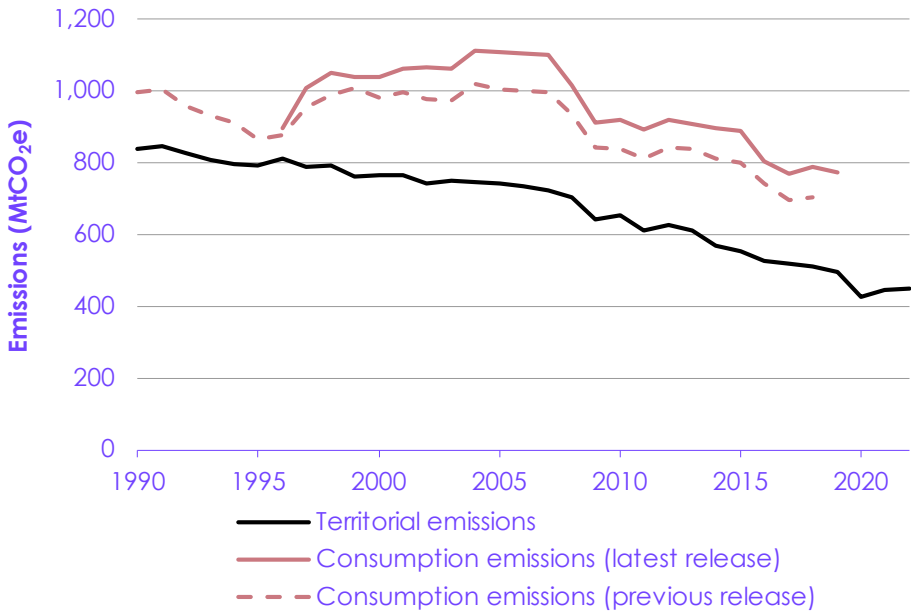
Consumption emissions decreased by 2% in 2019 and were 57% greater than territorial emissions in the same year.

- Consumption emissions were 774 $MtCO_2e$ in 2019 (the latest available year for which data are available), a decrease of 2% from 2018 and 57% greater than territorial emissions in 2019.
- Since 1996, the first year for which data are available, consumption emissions have fallen by 14% (122 $MtCO_2e$). This is a slower reduction compared to territorial emissions, which have declined by 39% (317 $MtCO_2e$) over the same period.

Since our last progress report, the Government's statistics on consumption emissions have been revised upwards by an average of 8% over the time period (Figure 3.11). This is driven by a large upwards revision on the estimated emissions from imports (of around a quarter). This revision is a result of updated source data on trade flows and reflects the large associated uncertainty on these estimates. The CCC has made recommendations to the Government on improving the quality of its consumption emissions statistics, and on policies to reduce the climate impact of UK imports (recommendations R2022-007, R2022-012, R2022-013, R2022-157).

Since 1996 consumption emissions have fallen by 14%. This is a slower reduction than in territorial emissions.

Figure 3.11 UK emissions on a consumption and territorial basis



Source: Defra (2022) *Carbon footprint for the UK and England to 2019.*
Notes: UK's consumption emissions estimates do not include emissions from land use.

2. Energy demand

Total energy demand on a final-use basis in the UK has been steadily falling since its peak in 2005.

Total energy demand on a final-use basis in the UK has been steadily falling since its peak in 2005. This has been driven by a combination of the decline of energy-intensive industries and increased efficiency of industrial processes, vehicles, and buildings. Recent years have seen significant changes in energy consumption patterns due to the pandemic and the energy crisis.

- **Overall electricity and gas demand.** At an economy-wide level, electricity demand fell to 273 TWh in 2022, a decrease of 4% compared to 2021, due to lower consumption in industry and residential buildings.[11] Gas demand fell by 7.5%, driven by a large reduction in residential buildings, as discussed below.

- **Heat demand in buildings.** Temperature-adjusted residential buildings emissions fell by 6% in 2022, significantly more than the annual average of 1% from 2010-2019. It is likely that this is due to the significant increase in gas prices in 2022. However, it is unclear whether these changes reflect short-term behavioural decisions or more permanent shifts in residential energy demand, and what the balance is between improvements in efficiency (e.g. reducing boiler flow temperatures) and people having colder homes due to the unaffordability. While these effects primarily affected gas demand, as gas provides the large majority of UK heating, they will also have affected electricity demand.

- **Energy demand from surface transport.** Changes in surface transport emissions between 2019 and 2022 have been driven by changes in car-kilometres during and following the pandemic, with only a marginal impact from the uptake of electric vehicles (Chapter 4, Figure 4.4). Prior to the pandemic, energy demand for surface transport had been fairly constant since 2010, with improvements in vehicle efficiencies offset by increases in total traffic and a trend towards larger, heavier vehicles.

The UK Government has committed to a 15% decrease in final energy demand by 2030 compared to 2021 levels for the industry and buildings sectors but greater ambition is feasible.

In the November 2022 fiscal statement, the UK Government committed to a 15% decrease in final energy demand by 2030 compared to 2021 levels for the industry and buildings sectors.[12] While the CCC welcomes an explicit target for energy demand, the CCC's Sixth Carbon Budget analysis and the Government's NZS demonstrated that significantly greater ambition is feasible. Since these pathways were developed, high fossil fuel prices have demonstrated the costs of the Government's ongoing failure to provide stronger incentives to reduce demand and thereby lessen the UK's import dependence and consequent exposure to volatile international markets.

- At an economy-wide level, the NZS pathway achieves a demand reduction of 23% from 2021-2030. However, the CBDP's ambition for demand reduction within the quantified plans will be lower due to changes in performance assumptions for plug-in hybrids, and the exclusion of policies on modal shift in transport from the quantified plans.

- It is unclear whether the CBDP would meet the Government's 15% target for buildings and industry, because a sectoral breakdown has not been published.

The UK's overall energy demand fell by 1%, a modest reduction compared with Germany's 5%.

The UK's overall energy demand fell by 1%, a modest reduction compared with Germany's 5%.[13,14] The greater reduction in energy demand in Germany may have been driven in part by more proactive public engagement; the German Government launched an information campaign on energy savings in June 2022, whereas the UK's equivalent did not launch until late December.[15,16] This highlights a missed opportunity from Government to protect consumers from the impact of volatile prices, while driving deeper reductions in emissions.

The CCC has made a number of recommendations in this area across multiple sectors including surface transport, buildings, and industry (including recommendations R2022-078, R2023-132, R2022-119, and R2023-170).

(a) The UK's Carbon Budget Delivery Plan (CBDP)

The CBDP provides a welcome increase in detail and transparency in the Government's plans for decarbonisation.

The CBDP provides a welcome increase in detail and transparency in the Government's plans for decarbonisation. It was published in response to a High Court ruling that the Government's 2021 NZS did not comply sufficiently with the Climate Change Act due to it lacking this detail. As a result of the ruling, the Government has had to provide a firmer public commitment to its plans, which has resulted in some changes in approach and ambition.

- The CBDP includes a set of quantified emissions savings with respect to projected baselines for most* of its policies and proposals, leading to sectoral emissions projections for each carbon budget.

These CBDP projections from quantified plans outperform the Fourth and Fifth Carbon Budgets but fall slightly short of the UK's 2030 NDC and the Sixth Carbon Budget.

- These projections outperform the Fourth and Fifth Carbon Budgets but fall slightly short of the UK's 2030 NDC (with around 4% of the required emissions reduction unquantified) and the Sixth Carbon Budget (with around 2% unquantified),† even before any consideration to the risk of delivering these reductions (Figure 3.12). The pathway from the 2021 NZS committed to an overall path for emissions that outperformed all the carbon budgets and the NDC, thus enabling some contingency (Figure 3.12). The Government categorised some plans and proposals as unquantified in the CBDP and takes the position that these will close these shortfalls.

The lower emissions reduction embodied in the quantified policies and plans compared to the Net Zero Strategy comes predominantly from surface transport.

- The smaller emissions reduction embodied in the quantified policies and plans compared to the NZS comes predominantly from surface transport (Figure 3.13). This is due to a more realistic estimate of emissions from plug-in hybrid cars and a decision to remove most of the estimated emissions savings from reducing car-kilometres, that had been included in the NZS pathway. Last year's High Court ruling has required the Government to disclose and give a firmer public commitment to its plans and the Government made a decision not to include an estimate of these emissions savings. Where possible the emissions savings from unquantified plans should be estimated, even if they cannot be attributed on a policy-by-policy basis (recommendation R2023-056).

- Emissions reduction is also smaller in the buildings and land use sectors (Figure 3.13). For land use the relative reduction in ambition is substantial compared to the NZS, but changes to emissions accounting methodologies have resulted in slightly lower emissions in the CBDP pathway (Chapter 9).

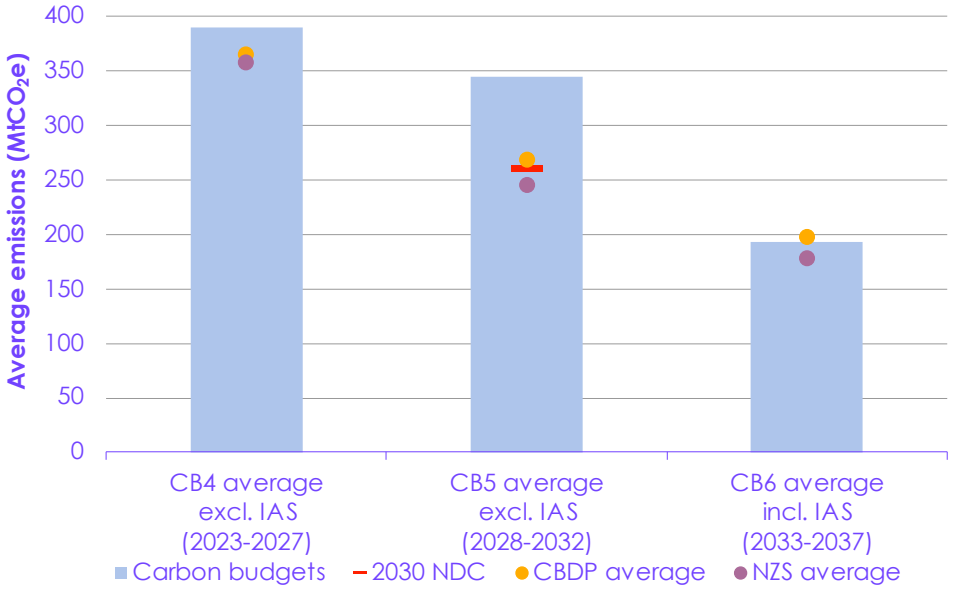
- This is slightly balanced by lower projected aviation emissions, due to updated projections for demand growth (Figure 3.13).[17]

* In the electricity supply sector, and for the contribution of emissions reduction from devolved administrations in the agriculture, land use, waste and F-gases sectors, there is no breakdown given.

† We have adjusted the CBDP land use baseline and pathway to account for changes in methodology between the 1990-2019 and 1990-2020 inventories, and removed some policies from the baseline so they can be assessed. Given these changes, the Government's pathway has a shortfall of around 4% to the NDC (as opposed to 8% published in the CBDP) and around 2% to the Sixth Carbon Budget (as opposed to 3% published in the CBDP).

The Carbon Budget Delivery Plan's quantified plans fall slightly short of the 2030 NDC and Sixth Carbon Budget, with the Government's position being that the unquantified plans will make up this shortfall.

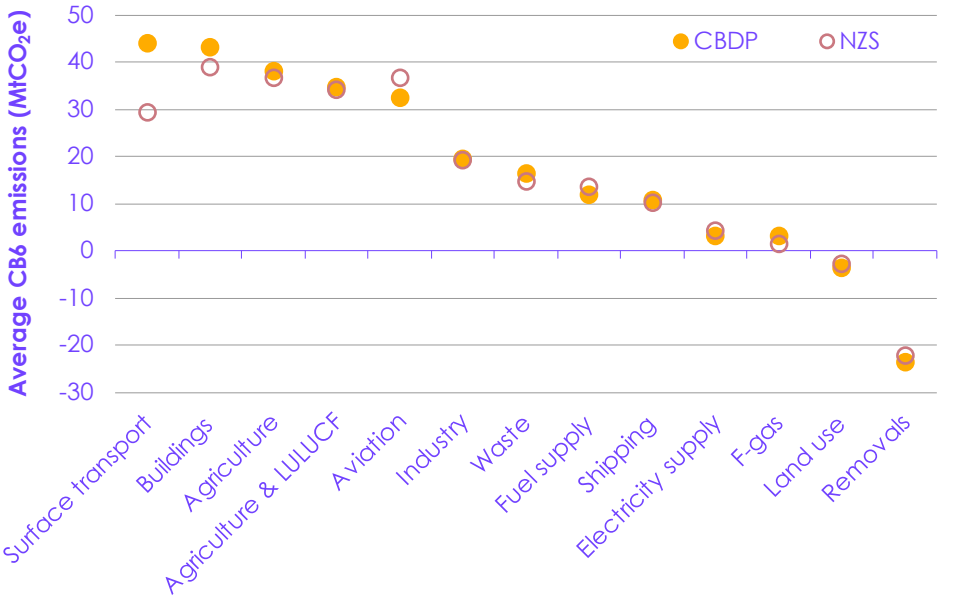
Figure 3.12 UK Government's projected emissions compared to the UK's targets



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC (2020) *The Sixth Carbon Budget*.
Notes: (1) The Carbon Budget Delivery Plan (CBDP) projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (2) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

Quantified plans in the surface transport sector are lower in the Carbon Budget Delivery Plan than the projections in the Net Zero Strategy.

Figure 3.13 Carbon Budget Delivery Plan projected emissions compared to the Net Zero Strategy



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*.
Notes: (1) The Carbon Budget Delivery Plan (CBDP) projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (2) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. (3) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

(b) Assessment of policies and plans

In this section we determine the risks to the UK achieving its targets by assessing the quantified policies and plans in the CBDP, determining if they are credible and on track according to the criteria outlined in Annex 1. The unquantified policies that act as enablers for the transition are included in our assessment. However, it has not been possible to include the unquantified policies and proposals that are expected to contribute additional emissions savings, due to the lack of clarity in what they are expected to achieve.

We focus on the short- and medium-term targets up to the end of the Sixth Carbon Budget period (2037) and including the 2030 NDC. It is vital that the UK meets its NDC, both in terms of honouring its international commitments (Chapter 2) and in ensuring it is on track to achieve the Sixth Carbon Budget and Net Zero.

Our confidence in the UK achieving its Fourth Carbon Budget has increased slightly this year, due to a combination of policy progress and the pandemic and fuel prices affecting demand.

- **The Fourth Carbon Budget (2023-2027).** Our confidence in the UK achieving its Fourth Carbon Budget has increased slightly this year, due to a combination of policy progress and the pandemic and fuel prices affecting demand (Figure 3.14). Sufficient plans over this period are predominantly from renewable electricity generation and the transition to electric vehicles (Figure 3.15).
  - With sales of electric cars continuing to grow in the last year, our confidence in this transition in the short term has increased.
  - Vehicle-kilometres are approximately 5% lower than 2019 levels, which appears to be a steady state following the reductions during, and partial rebound since, the pandemic. This leads to a lower level of baseline emissions over this period. Vehicle-kilometres are likely to resume growing at the rate seen prior to the pandemic unless the Government develops a coherent plan with clear milestones to empower the public to make low-carbon travel choices.
  - Some details have been released on some land and agricultural policies across the UK, with farmers starting to take up the Environmental Land Management scheme in England. This leads to an increased confidence in the short term.
  - The CBDP projects a significant reduction in baseline buildings emissions over the entire Fourth Carbon Budget period due to projected high gas prices. This reduction is very uncertain and could be considerably smaller than projected. The projected savings are indicated in Figure 3.14 compared to projected emissions from the NZS to demonstrate the level of uncertainty.

Our confidence in the UK meeting both the 2030 NDC and Sixth Carbon Budget has decreased in the past year.

- **The 2030 NDC and Sixth Carbon Budget (2033-2037).** Our confidence in the UK meeting both the 2030 NDC and Sixth Carbon Budget has decreased in the past year (Figures 3.14 and 3.16). This is driven by a combination of continued delays in action leading to increased delivery risk, the detail released in the CBDP enabling a more thorough assessment over the different time periods and the fact that emissions savings from certain policies were not quantified, most notably policies to empower the public to make low-carbon travel choices.

- While we would expect policies to be less developed for targets further away in time, the NDC is now only seven years away. Our assessment shows a concerning picture for emissions reduction by 2030 (Figure 3.14 and 3.16a):

  - **Credible plans exist for 25% of the required emissions reduction, with funding, enablers and timelines in place**. This comes predominantly from policies for the zero-emission vehicle transition and renewable electricity supply policies, although the proportion of emissions reduction from these policies judged to be covered by credible plans has decreased this year.

  - **There are some risks attached to 30% of the required emissions reduction,** where changes are needed to mitigate delivery risk. There is a much larger proportion from renewable energy generation than last year in this category, predominantly due to the continued absence of a delivery strategy for the sector and increased delivery risks around planning, consenting and access to network connections. The proportion from the zero-emission vehicle transition has also increased, largely due to the delay of the zero-emissions vehicle mandate with risks remaining for policies to address price disparity in car charging, zero-emission vans and HGVs. There are also some risks associated with decarbonising new homes, and policies for industrial CCS and hydrogen.

  - **There are significant risks attached to 23% of the required emissions reduction** where plans are either under development without a clear timeline for next steps or need further work to mitigate a significant delivery risk. These come predominantly from the market-based mechanism for low-carbon heat in homes, afforestation, conventional vehicle efficiencies, sustainable aviation fuels as well as the necessary infrastructure, CO_2 storage sites and funding mechanisms for around half of the Government's ambition for engineered removals.

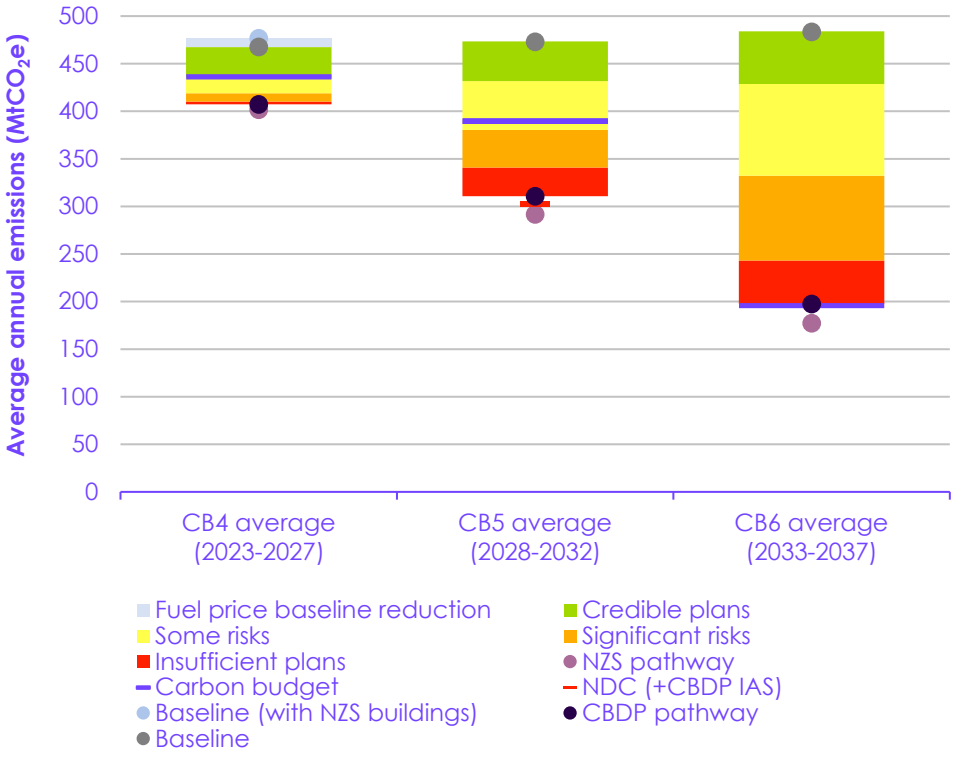
It is troubling that a larger proportion of required abatement is assessed as either completely missing or inadequate than last year.

  - **Plans are either completely missing or currently inadequate for 18% of the required emissions reduction.** It is troubling that this is a larger proportion than last year. Policies to drive the electrification of industry are missing, despite the CBDP making it clear that decarbonising the sector relies heavily on the electrification of the steel industry. Plans are also missing for agricultural productivity and peatland restoration in the long term. The CBDP clarified the dependence on a voluntary uptake and highlighted a lack of long-term funding to support changes in land use. There are also significant policy gaps for energy efficiency in non-fuel-poor homes and plans to accelerate vehicle fleet turn-over. Confidence in plans for the remaining half of the Government's ambition for engineered removals required to meet the NDC has reduced this year as continued delays to funding and guidance means there may now be insufficient time for new projects to begin operating by 2030.

  - **The remaining 4% of required emissions reduction is not covered by the quantified plans.** The CBDP lays out unquantified policies and plans that are supposed to make up this shortfall.

Plans are credible or have only some associated risk for no more than around half the required emissions reduction for the 2030 NDC.

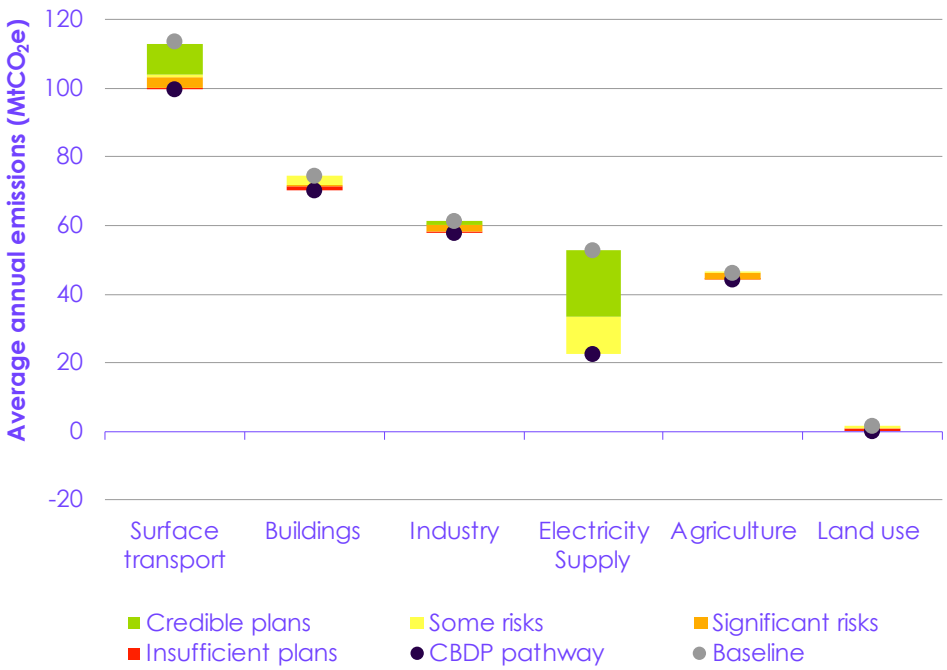
Figure 3.14 Assessment of policies and plans



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; DESNZ (2023) *Energy and emissions projections: 2021 to 2040*; BEIS (2021) *Net Zero Strategy*; CCC (2020) *The Sixth Carbon Budget*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, Tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The baseline is an adjustment to the Government's CBDP baseline, with the impact of some policies removed so that they can be assessed. Refer to each sector chapter for additional notes on our methodology. (3) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories. (4) For comparability, the CBDP's emissions pathway for international aviation and shipping (IAS) has been added to the target values for CB4, CB5 and the NDC. (5) The CBDP projections include only the quantified plans. Unquantified plans may lead to further emissions reductions.

Over the Fourth Carbon Budget period credible plans are mostly in the surface transport and electricity supply sectors.

Figure 3.15 Assessment of policies and plans for the Fourth Carbon Budget for key sectors



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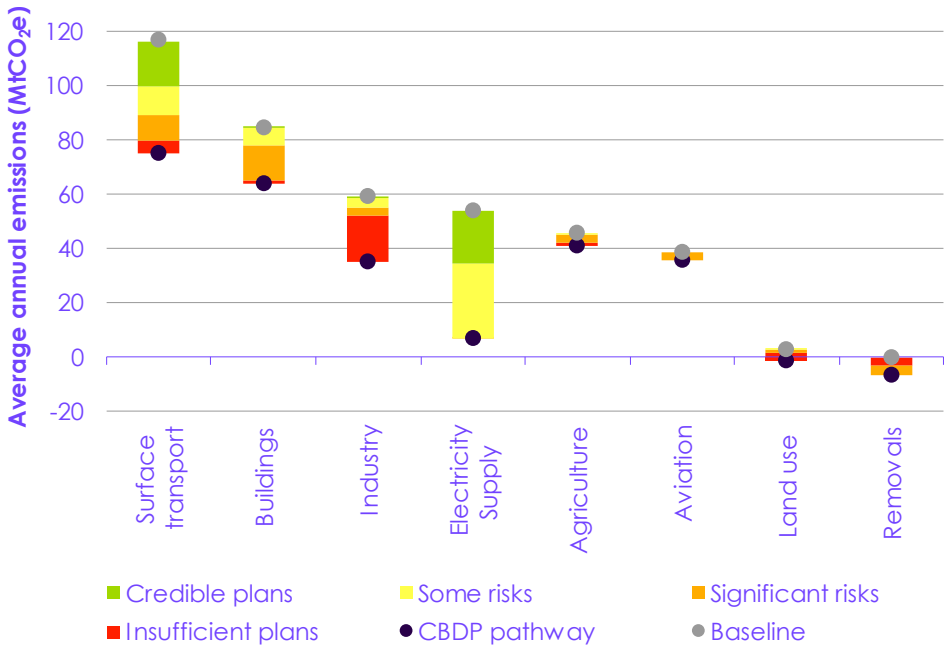
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The CBDP projections include only the quantified plans. Unquantified plans may lead to further emissions reductions (3) The baseline is an adjustment to the Government's CBDP baseline, with the impact of some policies removed so that they can be assessed. Refer to each sector chapter for additional notes on our methodology. (4) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

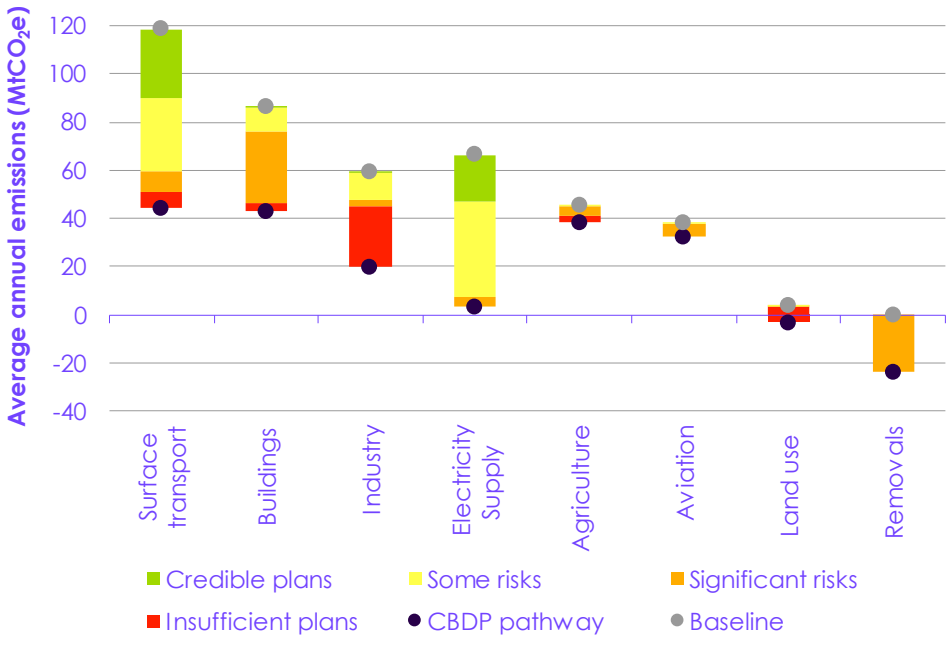
For the 2030 NDC and the Sixth Carbon Budget insufficient plans come predominantly from industry.

Figure 3.16 Assessment of policies and plans for the NDC and Sixth Carbon Budget for key sectors

a) Assessment for the 2030 NDC for key sectors



b) Sixth Carbon Budget (2033-2037)



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; DESNZ (2023) *Energy and emissions projections: 2021 to 2040*; BEIS (2021) *Net Zero Strategy*; CCC (2020) *The Sixth Carbon Budget*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The CBDP projections include only the quantified plans. Unquantified plans may lead to further emissions reductions. (3) The baseline is an adjustment to the Government's CBDP baseline, with the impact of some policies removed so that they can be assessed. Refer to each sector chapter for additional notes on our methodology. (4) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

4. Mitigation of delivery risk and contingency plans

Government must act now to develop a set of alternative policies and plans to mitigate delivery risk to meeting the 2030 NDC and Sixth Carbon Budget.

Our assessment of the policies and plans in the UK Government's CBDP have highlighted significant delivery risks and gaps in plans for around half the emissions reduction required to meet both the 2030 NDC and the UK's Sixth Carbon Budget (Figure 3.14). As well as strengthening existing policies and filling in gaps, the Government must act now to develop contingency plans, including a set of alternative policies to mitigate this delivery risk. If this is not done over the next year, there will be insufficient time to implement these alternative policies to cover shortfalls in current plans and policies (priority recommendation R2022-119).

The contingency plans should:

- Identify decarbonisation options beyond those in the CBDP and estimate the potential additional abatement that could be achieved on the required timescale. We discuss possible options below.
- Determine a timeline, considering how long it takes for the alternative policies to take effect. They should not be implemented as a last-minute emergency, but rather carefully planned to ensure they can be implemented in a sensible, cost-effective and fair way.

To better facilitate the development of contingency plans, the monitoring of progress towards Net Zero needs to be improved.

To facilitate the development of contingency plans, the monitoring of progress towards Net Zero needs to be improved:

- Indicators of progress should be tracked against pathways consistent with the required emissions reductions and presented more clearly to the public. Our Monitoring Framework contains many indicators that could be used for this purpose (recommendation R2023-058).
- Better governance structures are needed for monitoring this progress and coordinating the implementation of alternative options in sufficient time (recommendation R2023-151).
- In the annual public update on progress promised in the NZS (the Summary of Progress Against NZS Reporting Commitments in the powering up Britain Technical Annex), there was no comparison to required progress and no commentary on where things are off-track and how this will be addressed.[18]

We intend to develop our advice in this area, including quantifying uncertainties in emissions pathways in our work on advising the level of the Seventh Carbon Budget.

(a) Possible alternative policy options and their co-benefits

Alternative policy options will reduce delivery risk and bring significant co-benefits to the health of citizens.

The quantified policies and plans in the CBDP for 2030 are 5.5 $MtCO_2e$ short of meeting the NDC. We have also identified 30.3 $MtCO_2e$ of the remaining required abatement as a policy gap, with completely insufficient plans, and a further 39.4 $MtCO_2e$ of the plans and policies as having significant risks (Figure 3.14).

We have quantified potential emissions savings from the following alternative options, that could be considered to close this gap (Figure 3.17):

(i) Options included in the Government's unquantified policies and proposals

- **Modal shift in surface transport.** In the CBDP, only 2 $MtCO_2e$ emissions reduction is attributed to quantified policies that aim to reduce car-kilometres in 2030. In the Government's NZS this was significantly higher, with an additional 6 $MtCO_2e$ attributed to modal shift, similar to the assumptions in our Balanced Pathway. Modal shift brings co-benefits due to more active lifestyles and reductions in air pollution and congestion. While the Government does include some additional unquantified policies for empowering and incentivising the public to make green travel choices, their exclusion from quantified plans makes it impossible to judge the extent to which they are expected to contribute to emissions reduction, so we discuss them here as alternative options. On assessing these plans, we identify significant risks and some insufficient plans if the targeted level of abatement is assumed to be the same as that in the NZS.

(ii) Options we recommend for inclusion in the Government's main plans

- **Phasing out sales of hybrid cars.** If the Government were to ban the sale of plug-in hybrid cars as well as fossil-fuel cars by 2030 (recommendation R2023-141), with a corresponding reduction in hybrid sales prior to this, an extra emissions reduction of 2 $MtCO_2e$ in 2030 may be possible, with these emissions savings increasing further during the 2030s.

- **Limiting aviation growth.** The Government has no plans to limit growth in the aviation sector and relies heavily on nascent technologies (priority recommendation R2023-037). The Government's aviation pathway assumes a 70% increase in passengers by 2050 against 2018 levels, much higher than the 25% growth by 2050 in our Balanced Pathway. By 2030, the Government's pathway assumes an increase in passenger demand of 60% from 2022 actual demand levels,* while our Balanced Pathway assumes demand will be 40% higher than 2022 levels. Limiting the rebound in aviation demand to the level in the Balanced Pathway would provide an additional 5 $MtCO_2e$ of abatement.† While international aviation emissions are not included in the NDC, emissions reductions in this sector are needed to be on track for the Sixth Carbon Budget.

- **Diet change.** The Government has set out no plans to support the public to shift to a lower-carbon diet (recommendation R2022-036). A shift to low-

* Note that aviation emissions in 2022 were 25% below 2019 pre-pandemic levels.

† These calculations use the CCC's Sixth Carbon Budget Balanced Pathway assumptions on aviation fuel and efficiency changes.

carbon diets also brings co-benefits to the health of citizens. If meat and dairy consumption were reduced by 20% by 2030 as assumed in our Balanced Pathway, an additional emissions reduction of 5 $MtCO_2e$ could be possible. This option would also help with the reduction in methane emissions required by the Methane Pledge. This assumes low-carbon farming practices remain as they are today.

(iii) Additional options we recommend for consideration if progress is off track

- **Increased innovation in diet.** If changes in diet were to follow our Tailwinds scenario, which on top of the 20% reduction in meat and dairy by 2030 discussed above, has a significant contribution from lab-grown meat, an additional 2 $MtCO_2e$ of abatement could be achieved (on top of the 5 $MtCO_2e$ discussed above for diet change under the Balanced Pathway).

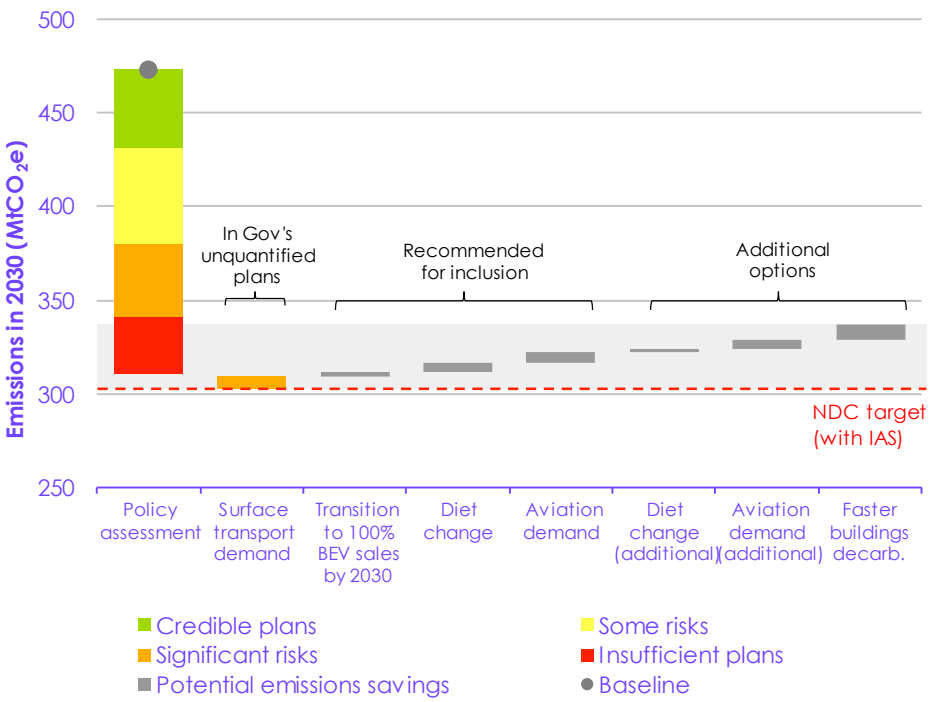
- **Lower aviation demand.** We have considered the potential savings that could be achieved by a 15% reduction in passenger numbers compared to 2018 levels by 2050, as modelled in our Tailwinds scenario. If the rebound in passenger demand from 2022 to 2030 were limited to a 21% increase, to reach the 2030 level of demand in Tailwinds, an additional 5 $MtCO_2e$ of abatement in 2030 would be possible (on top of the 5 $MtCO_2e$ from limiting aviation growth to that in the Balanced Pathway, discussed above).

- **Buildings.** Steps could be taken to speed up the decarbonisation of buildings. If emissions reduction followed our Tailwinds scenario for buildings, an extra 8 $MtCO_2e$ emissions reduction could be possible by 2030, driven by increased levels of behaviour change and energy efficiency in homes, and faster uptake of energy efficiency measures in non-residential buildings. There is further potential for emissions reduction from accelerated uptake of low-carbon heating (e.g. through retrofit of hybrid heat pump systems around existing boilers), but we have not quantified this potential.

Even with all these options included, there is insufficient additional abatement to make up the policy gaps we have identified. As well as developing additional plans, existing policies must be strengthened and risks must be reduced.

Developing contingency plans would significantly reduce delivery risk for the NDC, but current plans must also be strengthened.

Figure 3.17 Contingency options for 2030



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Notes: (1) The policy assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The baseline is an adjustment to the Government's CBDP baseline, with the impact of some policies removed so that they can be assessed. Refer to each sector chapter for additional notes on our methodology. (3) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories. (4) The CBDP projections include only the quantified plans. Unquantified plans may lead to further emissions reductions.

Endnotes

[1] Department for Energy Security and Net Zero (DESNZ) (2023) *Powering Up Britain,* https://www.gov.uk/government/publications/powering-up-britain.

[2] HM Government (2023) *Mobilising Green Investment – 2023 Green Finance Strategy,* https://www.gov.uk/government/publications/green-finance-strategy.

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105 $MtCO_2e$, 23% of UK emissions in 2022

Introduction and key messages

Surface transport remains the UK's highest-emitting sector, contributing 23% (105 $MtCO_2e$) of total UK emissions in 2022. The Government's Carbon Budget Delivery Plan (CBDP) indicates a reduction in surface transport emissions of 58% (61 $MtCO_2e$) by 2035, compared to provisional 2022 emissions.[1] However, the CBDP reduces the quantified level of ambition compared to the previous Net Zero Strategy, in which residual emissions from surface transport in 2035 were around 14 $MtCO_2e$ lower (see Chapter 3).[2] There were two key changes driving this:

- The CBDP acknowledged new evidence showing that the carbon savings from plug-in hybrid (PHEV) cars are around three to five times lower in the real world than previously assumed.[3] This means that the carbon savings accrued from the adoption of PHEVs are substantially smaller – by around 9 $MtCO_2e$/year – than in the Net Zero Strategy analysis. It is positive that this evidence has been incorporated into the modelling, and it emphasises the importance of prioritising battery-electric vehicles (BEV) over less efficient and less cost-effective PHEVs. The Government should use this evidence to justify either permitting only BEV sales or setting a very ambitious definition of 'significant zero-emission capability' when deciding what vehicles will be allowed to be sold in the period 2030-2035.

- Most policies that aim to support and incentivise the public to choose lower-carbon modes of transport have been removed from the quantified pathway – over 5 $MtCO_2e$/year of abatement that had been attributed to modal shift from cars to more sustainable modes of transport is no longer quantified. While these policies are still referenced in the Government's plan, making a choice not to quantify them signals a lack of commitment to modal shift. A pathway that is almost exclusively technology-dependent is likely to be less cost-effective, entails higher delivery risk (see Chapter 3) and risks missing out on opportunities to realise co-benefits to society.

This reduction in quantified ambition in surface transport results in an abatement shortfall which will need to be made up to meet legislated carbon budgets. The CBDP outlines a range of additional policy options – including those to reduce demand or encourage modal shift – that could deliver further savings but have not been quantified in the delivery pathway. It will be important for the Department for Transport (DfT) to continue to develop and implement these rather than relying on other sectors or speculative technological advances to address this shortfall.

Our key messages are:

- **Emissions.** Surface transport emissions increased by 3% in 2022 as travel demand continued to rebound from the COVID-19 pandemic. Emissions remain 8% below 2019 levels, primarily due to lower levels of car demand, which appear to represent a new 'steady state'.

- **Delayed policy progress.** Policy progress over the past year has been slower than expected, as various key documents and decisions have been delayed. This increases delivery risk across the sector, both by directly delaying deployment and by squeezing regulatory development timelines, reducing the ability for policies to push for greater ambition and leading key regulatory proposals to include more flexibility. The Government must now proceed with urgency to get plans in this key sector back on track.

- **Zero-emission vehicle markets.** The market share of electric cars continues to increase ahead of our Balanced Pathway assumptions, and most

manufacturers are now committed to offering electric options across their product ranges. Electric van uptake has been less strong, although the industry's market outlook remains positive.

- **Zero-emission vehicle policy.** Delivering the 2030 phase-out of new conventional car and van sales is vital to meeting the UK's decarbonisation pathway. The final consultation on the zero-emission vehicle (ZEV) mandate, which will require manufacturers to sell a rising proportion of ZEVs on the way to this, was published in March. This is an important policy which will ensure that electric vehicle (EV) sales scale up at the rate required, and the Government should focus on finalising its implementation and addressing the key enablers which will allow it to succeed.

  - Although the inclusion of various flexibilities for manufacturers will likely slightly weaken its practical impact, the ZEV mandate remains a credible delivery mechanism. The Government must now work at pace to ensure that it is implemented from 2024 as planned.

  - There is an opportunity to build on this progress to develop regulations and enabling policies to drive forward the market for zero-emission heavy goods vehicles (HGVs). The Government and industry have identified this as an area where there could be both emissions and economic benefits from the UK being a global first-mover. Swift action is vital to realise these.

- **Electric vehicle charging.** The UK's EV charging network has expanded by almost one-third over the past year, although provision remains inconsistent across the country and there are concerns around reliability and cost. The rate of chargepoint deployment will need to more than double in the coming year and beyond to ensure charging provision keeps pace with EV uptake. This is vital – if progress is insufficient, delayed or patchy, or if cost and reliability issues present barriers to use, it could undermine public confidence in the suitability of EVs and pose a serious risk to the achievement of the 2030 phase-out of new petrol and diesel vehicles.

- **Conventional and hybrid vehicles.** The Government's initial proposal for remaining sales of conventional and hybrid cars and vans to be subject to only flat emissions regulations risks missing an opportunity to incentivise manufacturers to reduce the size and weight of vehicles. Reducing vehicle sizes and weights could also be beneficial for EVs, where larger vehicles have higher embedded emissions and consume more electricity.

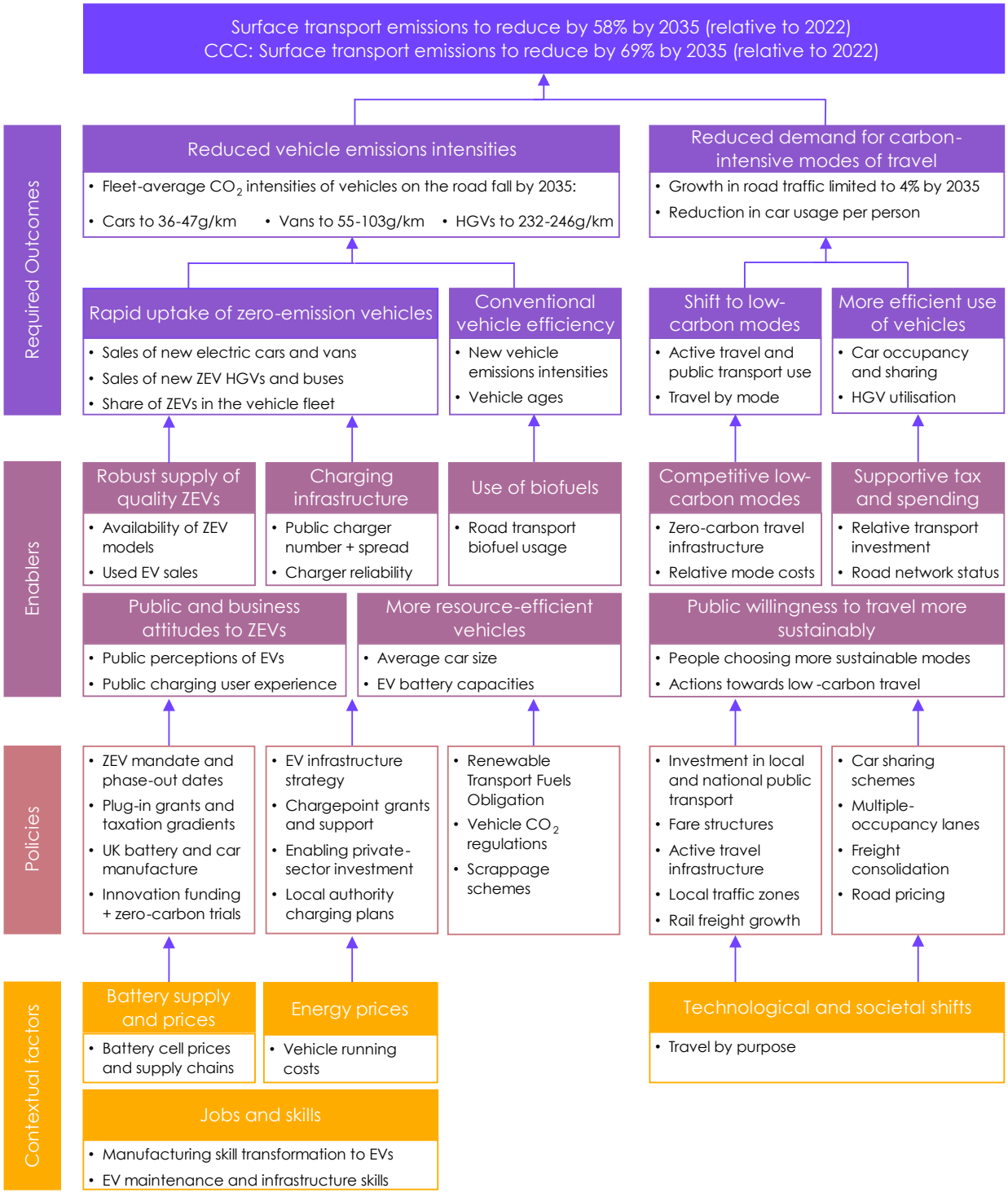
- **Limiting traffic growth.** The Government has made no progress on our recommendations on clarifying the role for car demand reduction and ensuring that key enablers (road-building decisions and taxation) are aligned to delivering this. While there have been some positive signs through the distribution of capability funding by Active Travel England, the introduction of the temporary £2 bus fare cap and the implementation of low-traffic neighbourhoods and low-emission zones by local authorities, these have been balanced by negative developments including delays to local transport plan guidance and cuts to the active travel budget.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 4.1 Monitoring map for surface transport



Source: CCC analysis.
Notes: The emissions reduction figures show the reductions required by 2035 in both the Government's Carbon Budget Delivery Plan and the CCC's Balanced Pathway. The vehicle intensity assumptions show the rough ranges in fleet-average CO_2-intensities that will be needed to meet these pathways, while the road traffic growth assumption is based on the increase in road traffic in the CCC's Balanced Pathway compared to current levels, before the impact of rebound effects.

The CCC's monitoring map for surface transport (Figure 4.1) sets out the policies, enablers and required outcomes for a successful transition. This report focuses on 11 key indicators, with additional indicators available in the supplementary material presented alongside this report. Our Monitoring Framework documents the indicators we track and our approach for assessing progress.

Surface transport emissions increased by 3% in 2022, but remain 8% below 2019 levels.

Emissions. As the surface transport sector continues its rebound following the pandemic, it is too early to say whether overall emissions are on track relative to the Government's pathway (Figure 4.2a). Surface transport remains the highest-emitting sector in the UK, contributing 23% of UK GHG emissions in 2022.

- Provisional estimates suggest that emissions were 105 $MtCO_2e$ in 2022, up 3% from 2021, but still 8% lower than pre-pandemic levels (Figure 4.3).

A reduction in car travel has been the main driver of the fall in surface transport emissions compared to 2019.

- Demand changes resulting from the pandemic have been the principal driver of the nearly 10 $MtCO_2e$ reduction observed in total car emissions from 2019 to 2022, while the impact of changes in powertrain technology remains small but is growing as uptake of EVs increases (Figure 4.4).
  - The decrease in car travel compared to before the pandemic (see road transport demand indicators below) has resulted in a 6 $MtCO_2e$ reduction in total car emissions. This is around one-third of the demand-side emissions reduction required in our Balanced Pathway by the early-2030s. Further action to maintain these trends and build upon them, for instance through effective modal shift, is necessary.
  - At the same time, despite a significant increase in EV sales (see uptake of zero-emission vehicles indicators below), the share of EVs in the overall car fleet remains small at around 2%, which has translated to a 1 $MtCO_2e$ reduction in total car emissions. These savings will grow as EV uptake accelerates.
- Emissions from road freight (vans and HGVs) have increased by 4% since 2019, largely due to rapid growth in van usage, which has been evident since the early-2000s but accelerated during the pandemic.
- In the decade prior to the pandemic, there was no significant reduction in emissions. This was due to upward trends in both vehicle size and kilometres driven, which offset modest improvements in the efficiency of new vehicles. The trend towards larger vehicles has continued over recent years.

Uptake of zero-emission vehicles is continuing to increase for cars and vans. However, the overall size of the new vehicle market has remained suppressed due to supply-chain issues following the pandemic. The Government will need to track not just EV sales but also the total volumes in the fleet to ensure that these scale up at the pace required to reduce emissions (Box 4.1).

Electric car sales continue to grow, making up 17% of all new cars sold in 2022. The used market is also growing but remains small.

- 17% of new car sales were BEVs in 2022 (Figure 4.2b), four percentage points ahead of the CCC's pathway. Availability is also increasing in the used car market, with EVs growing from 0.7% to 1% of sales in 2022. Public perceptions continue to be strong, with over half of drivers who are considering buying a new car intending to choose an electric or hybrid option, while almost all manufacturers are expanding their ranges of models. But continued disruption in the new-car market and the prioritisation of sports utility vehicles (SUVs) pose concerns.

  - The overall new-car market in 2022 remained 30% smaller than in 2019. Early 2023 data suggest that the market is beginning to recover, although this appears to be driven as much by hybrids as by fully electric vehicles.[4]

  - Recent analysis of the used car market found that the supply of used EVs available for purchase has risen by 270% and average prices have fallen by 15% in the past year.[5] Given that there are typically three to four times as many used car transactions as new car sales each year, it will be important for these trends to continue to widen access to the EV transition.

SUV sales are growing rapidly within the electric car market. This trend needs to be reversed to reduce embedded emissions and grid impacts and improve vehicle affordability.

  - SUV sales are growing rapidly within the electric car market, making up 44% of all new EVs in 2022 (Figure 4.5). This trend towards larger, heavier vehicles needs to be halted to lower the embedded emissions in vehicle production and reduce the demands on the electricity grid. Prioritising smaller vehicles would also benefit consumers by increasing the availability of cheaper EVs.

- Electric van sales (Figure 4.2c) are showing slower progress, with a market share of only 6% in 2022, and are significantly off track compared to the CCC's pathway. However, model availability is increasing and user research suggests that many van drivers are willing to make the switch.[6]

Enablers of EV uptake. While the fast uptake of EVs is promising, there are slower signs of progress for crucial enablers. In particular, public chargepoint deployment now needs to scale up more quickly.

The rate of deployment of public chargepoints needs to accelerate rapidly and must address the current uneven distribution of provision.

- Charging infrastructure deployment was approximately in line with the CCC's pathway* and the Government's target at the end of 2022 (Figure 4.2d). But these deployment trajectories require a rapid acceleration over the next year and beyond, which is not yet evident in data from the first quarter of 2023. This scale-up will be crucial to meet growing demand for charging, so it is too early to say whether this indicator is on track. Inconsistent provision, unreliability and cost also pose risks to user experience and must be addressed.

  - Charging infrastructure continues to be unevenly distributed across the UK (Figure 4.6). The bottom 20% of local authorities average just 20 public chargepoints per 100,000 population, compared to the national average of 55 and the top 20% at 133.[7] However, there are early signs of progress, with the charging networks in these bottom 20% authorities expanding by around 50% in 2022. This must be built upon to rebalance the existing regional inequality.

The average reliability of public chargepoints has improved, but is still a long way off the dependable service that is needed.

  - The proportion of chargepoints that are out-of-service has fallen from 7% to 5% this year, which is an improvement but still a long way off the dependable service that is needed.[8] Issues are most pronounced on the rapid network, with current average reliability of 92% substantially below the Government's 99% target.

  - Surveys of EV drivers highlight concerns about chargepoint reliability and pace of deployment.[9,10] Despite this, a majority find the

* Our CCC pathway for charging infrastructure deployment is based on modelling that was conducted on a five-yearly basis. Previously, the pathway was then based on a linear interpolation between these points. However, this year we have updated this to use an exponential interpolation approach instead, to better reflect the pace at which chargepoints will be needed as EVs become more widespread across the fleet.

experience of driving an EV more convenient than driving a conventional vehicle, for instance due to the ability for drivers with access to off-street or local on-street charging to recharge vehicles overnight or while visiting destinations, ready for use when required.

- Battery cell prices have seen a steady decline over recent years but increased in 2022 due to supply-chain disruptions, with the pandemic and the war in Ukraine seen as contributing factors. This indicator is slightly behind the CCC's pathway (Figure 4.2e).

Energy price rises have reduced the per-mile savings offered by electric vehicles, but these savings remain strong for drivers able to charge at home.

- Sharply rising electricity prices have reduced the per-mile cost savings offered by EVs compared to fossil-fuelled vehicles (Figure 4.7). Savings remain strong for drivers able to charge through their domestic electricity supply, but trends are more concerning for those reliant on public charging infrastructure.

- While public sentiment towards EVs is positive (see Chapter 15), addressing risks to this such as chargepoint availability and reliability, vehicle wait-times and availability of affordable new and used models across all size and use categories will be important to sustain this progress.

Conventional vehicle efficiency. Improvements in engine technologies (e.g. hybridisation) are being offset by trends towards larger vehicle sizes (particularly SUVs (Figure 4.5)), which has led to average new internal combustion engine (ICE) cars and vans becoming less efficient over recent years (Figures 4.2f-g). The CCC's pathway and the Government's assumed baseline both entail the carbon-intensity of the new non-ZEVs that continue to be sold falling gradually this decade, but current trends are moving in the wrong direction.

Road transport demand. Alongside the uptake of EVs, measures to limit growth in road traffic are also crucial for decarbonising transport, and bring wider co-benefits such as improved air quality.

Road transport demand seems to have recovered to a new steady state, around 5% below pre-pandemic levels.

- The number of kilometres driven by road vehicles was 21% higher in 2022* than in 2020 as travel restrictions were lifted following the pandemic (Figure 4.8), and seems to have reached a new steady state† which is around 5% below pre-pandemic levels. Studies have shown that rising fuel prices, increases in home-working and implementation of low-traffic neighbourhoods have all contributed to this reduction in overall demand.[11,12,13]

Without policy action to embed reductions in the need to travel by car or increase the appeal of more sustainable modes, pre-pandemic traffic growth trends are likely to resume.

- Measures to reduce car demand are largely absent from the Government's CBDP quantified delivery pathway, so we are not able to compare this against any clear pathway showing Government ambition, only the wide assumption ranges used in DfT's Transport Decarbonisation Plan. Compared to the CCC's pathway (Figure 4.2h), car demand is currently on track although there is a significant risk that this will fall off track if pre-pandemic traffic growth trends resume. As highlighted in our 2022 Progress Report, without policy action to embed a reduction in the need to travel by car or grow the availability and attractiveness of alternative lower-carbon modes, traffic is likely to increase beyond the CCC's pathway.

* This is based on provisional demand figures for the rolling 12-month period up to the end of Q3 2022 as final data for the whole of 2022 were not yet available at the time of writing.

† By this new steady state for road transport demand, we mean that the rebound in road vehicle-kilometres following the pandemic appears to have plateaued at a level around 5% below pre-pandemic levels. This is likely to resume growing at the rate it did before the pandemic unless policy interventions are introduced to limit traffic growth.

- Total kilometres driven by vans and HGVs (Figure 4.2i-j) now exceed pre-pandemic levels and are slightly off track relative to the CCC's pathway. This reflects significant shifts towards home-delivery over the past decade, which accelerated during the pandemic, and is concerning given the slower uptake of electric vans (Figure 4.2c).

Modal shift. Switching to lower-carbon modes of travel, including active travel, public transport and shared mobility, is one important means of reducing car demand. There has been little progress on this to date, and concerns remain around public transport service provision, reliability and cost.

- The demand recovery in public transport has been slower than on the roads, and usage remains around 80-90% of pre-pandemic levels (Figure 4.8). This presents an ongoing challenge to service operators, making it difficult to deliver the service improvements that will be needed to deliver meaningful levels of modal shift.

Concerns around public transport service provision and reliability are undermining the prospect of achieving meaningful modal shift.

- The share of passenger-kilometres travelled by public transport had been steadily rising until the mid-2010s, before declining slightly as service provision fell and prices rose and then falling sharply during the pandemic (Figure 4.2k). Concerns around service provision and reliability have been amplified by ongoing labour disputes, which means public transport may not present the appealing alternative to private car travel that is needed.

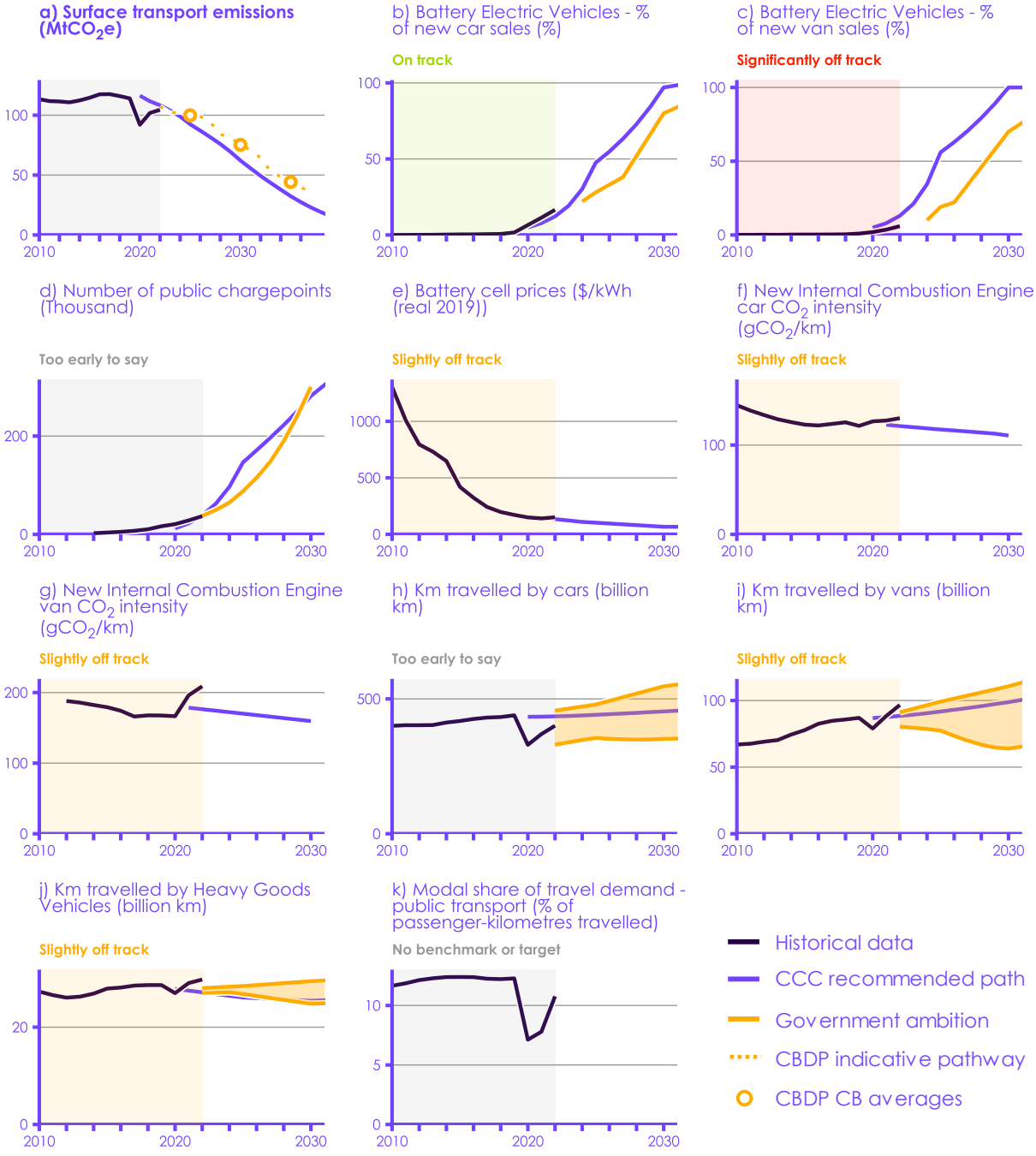
Since 2010, public transport fares have increased considerably faster than the cost of car travel.

- From 2010-2021, bus and rail prices increased by 80% and 43% respectively, significantly faster than inflation (Figure 4.9). By contrast, the cost of car travel rose by just 27%. Spikes in fuel prices and Government interventions to limit further growth in fares have reduced this gap during 2022 and early-2023, but the cost comparison between public transport and driving remains significantly less favourable than a decade ago.
  - This disparity in cost is largely due to the combined effect of repeated freezes and cuts to fuel duty and above-inflation increases in bus and rail fares over this period, and undermines efforts to encourage healthier and lower-carbon travel.
  - The pandemic appears to have exacerbated this situation, with bus fares rising particularly steeply as operators struggled with low ridership.
  - Initiatives including the £2 bus fare cap and limiting rail fare increases below the prevailing rate of inflation helped to reverse the long-term trend of increasing real-terms costs of public transport in 2022.

Increases in leisure participation in active travel during the pandemic could present an opportunity for promoting modal shift.

- Cycling kilometres fell in 2021, but remained 16% higher than pre-pandemic levels. Similar trends are apparent for walking. In both cases, participation for leisure purposes appears to have increased compared to before the pandemic.[14]
  - Primary research by WSP, commissioned by the CCC, found that walking is the most preferred alternative mode for drivers who might be willing to reduce their car use.[15]
  - Place-based approaches that combine interventions that aim to reduce car use with those that make active travel more appealing, coupled with effective public engagement, will be key to realising this opportunity.

Figure 4.2 Key indicators for surface transport

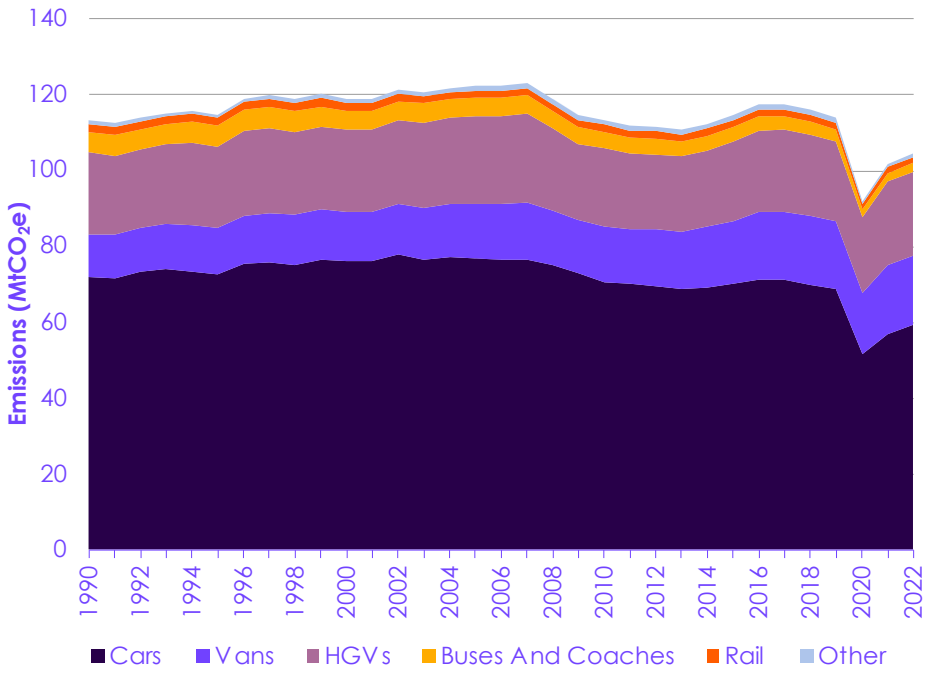


Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.

Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path and considering the wider contextual factors that may have a temporary impact (e.g. recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (3) In charts (b-c), data from the Society of Motor Manufacturers and Traders' (SMMT's) car and van registrations reports have been used for 2022, as DfT statistics for that year had not yet been published at the time of writing. Similarly, 2022 figures in charts (h-j) use the provisional demand figures for the rolling 12-month period up to the end of Q3 2022 as full-year totals had not yet been published. (4) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions. (5) The Government pathway in chart (d) shows the rate of infrastructure deployment that would be needed to keep pace with the projected share of EVs in the car and van fleet and meet the Government's minimum target of 300,000 public chargepoints by 2030. (6) In charts (h-j), vehicle-kilometres data for Great Britain has been scaled up based on the latest available comparison between demand in Great Britain and Northern Ireland (2014) to give whole-UK trends that can be compared with the CCC's Balanced Pathway. (7) In chart (k), National Travel Survey and Scottish Household Survey data have been used to convert DfT figures on car-kilometres into estimates of passenger-kilometres travelled by car, which have been compared with DfT and ORR statistics on public transport passenger-kilometres.

Surface transport emissions had been relatively flat since 1990 until the COVID-19 pandemic, when they fell steeply. They have since rebounded, but remain 8% below 2019 levels.

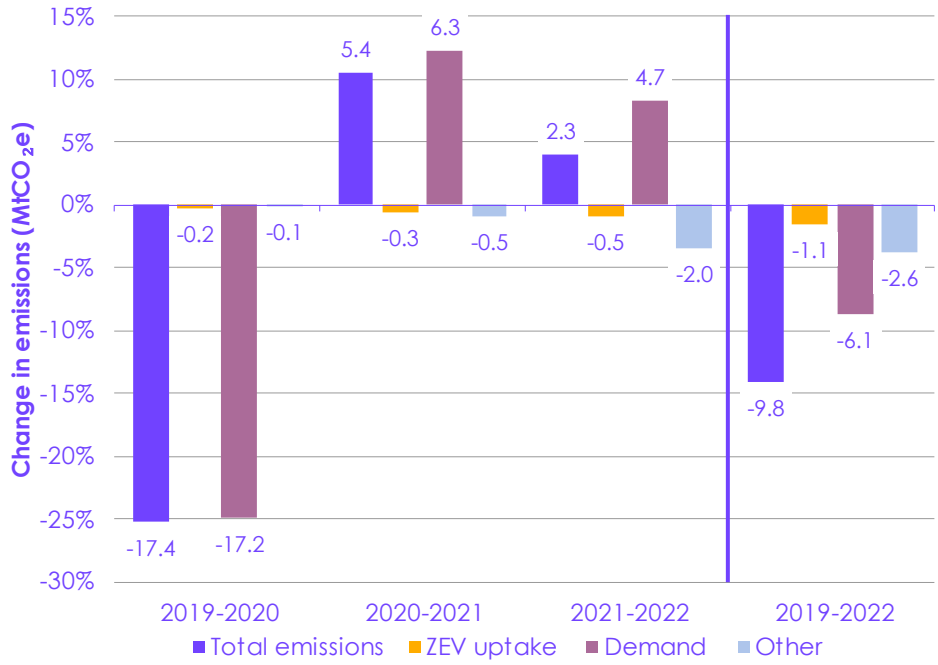
Figure 4.3 Surface transport emissions (1990-2022)



Source: DESNZ (2023) *Provisional UK Greenhouse Gas Emissions National Statistics 2022*; DESNZ (2023) *Final UK Greenhouse Gas Emissions National Statistics: 1990 to 2021*.

The emissions savings from the reduction in car-kilometres from 2019 to 2022 are more than five times as large as those due to the uptake of electric vehicles to date.

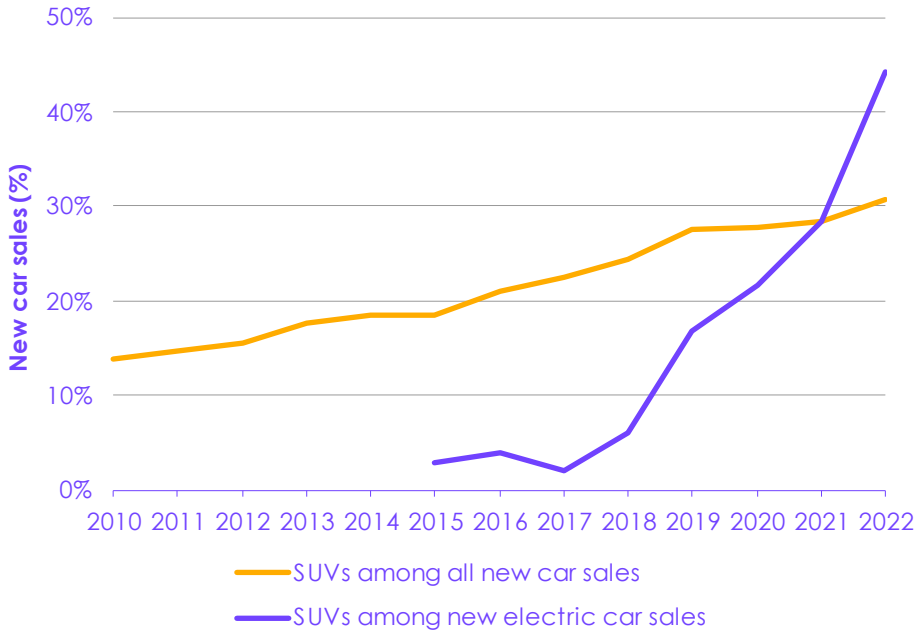
Figure 4.4 Separating the impact of car-kilometres and ZEV uptake on total car emissions



Source: DESNZ (2023) *Provisional UK Greenhouse Gas Emissions National Statistics: 1990 to 2022*; DfT (2022) *Road Traffic Statistics*; DfT (2022) *Vehicle Licensing Statistics*; CCC analysis.
Notes: Data labels indicate the absolute change in car emissions. The columns show the estimated impact of various factors on these emissions changes: 'ZEV uptake' refers to the ZEV share of the total car fleet; 'Demand' refers to the distance travelled by car; 'Other' includes conventional car efficiency, uptake of hybrids, use of biofuels, more fuel-efficient driving styles and reductions in low-speed driving due to reduced congestion. A large portion of the increase in 'Other' in 2022 is due to the introduction of E10 bioethanol blending in standard petrol from September 2021.

SUV sales are growing more quickly in the electric car market than among conventional vehicles.

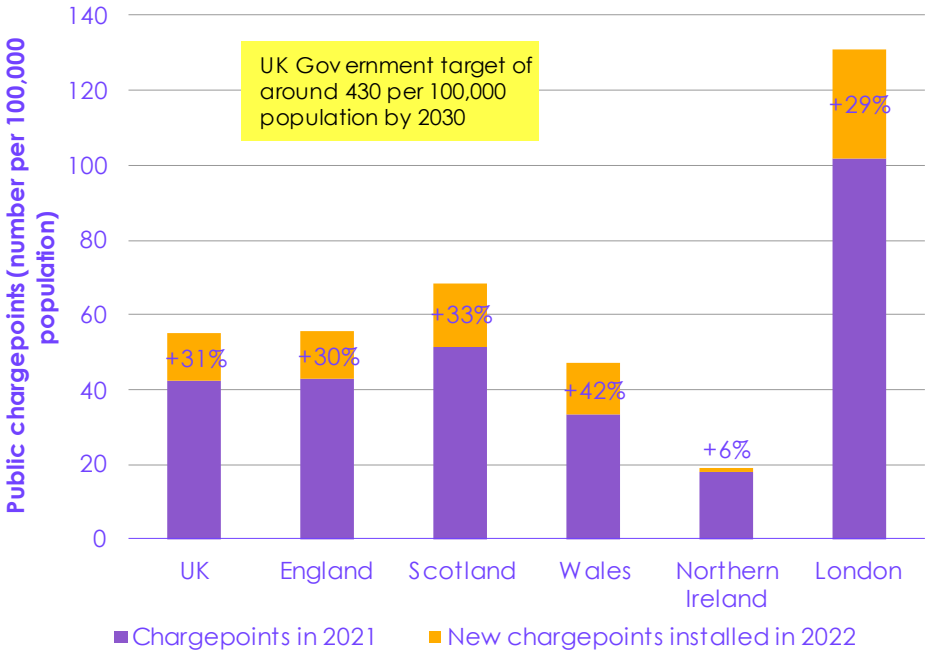
Figure 4.5 Sales of sports-utility vehicles (SUVs) as a proportion of all new car sales



Source: SMMT (2023) *Vehicle Segmentation 2007-2022* (data provided for CCC Monitoring Framework).
Notes: The two time series show the share of new car sales that are categorised as either 'Dual purpose' or 'Multi purpose vehicle' in SMMT's market segmentation, for all cars and for electric cars respectively.

Public charging infrastructure is distributed unevenly across the country. London is considerably ahead of most other areas.

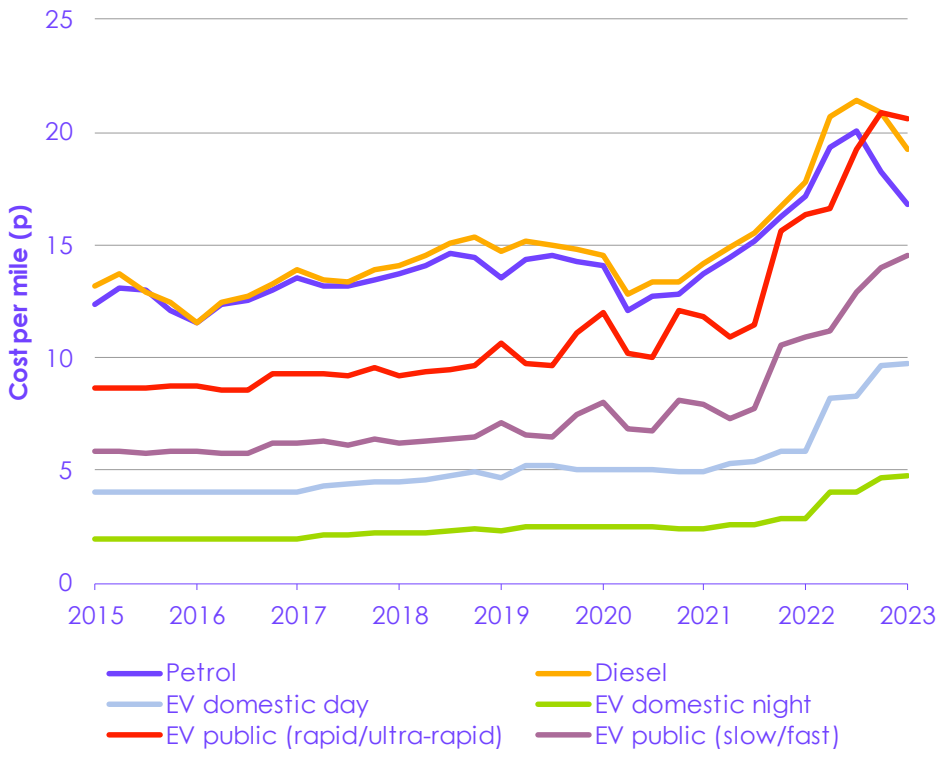
Figure 4.6 Regional variation in EV charging infrastructure



Source: DfT (2023) *Electric Vehicle Charging Device Statistics.*
Notes: Total column height indicates the number of chargepoints installed in each region per 100,000 population, with the orange sub-columns indicating the extent of network expansion in 2022. The UK Government target is calculated by dividing the minimum target of 300,000 public chargepoints in 2030 by the expected UK population.

Sharply rising electricity prices have increased the per-mile cost of driving an electric car. But costs remain lower than driving a petrol or diesel car.

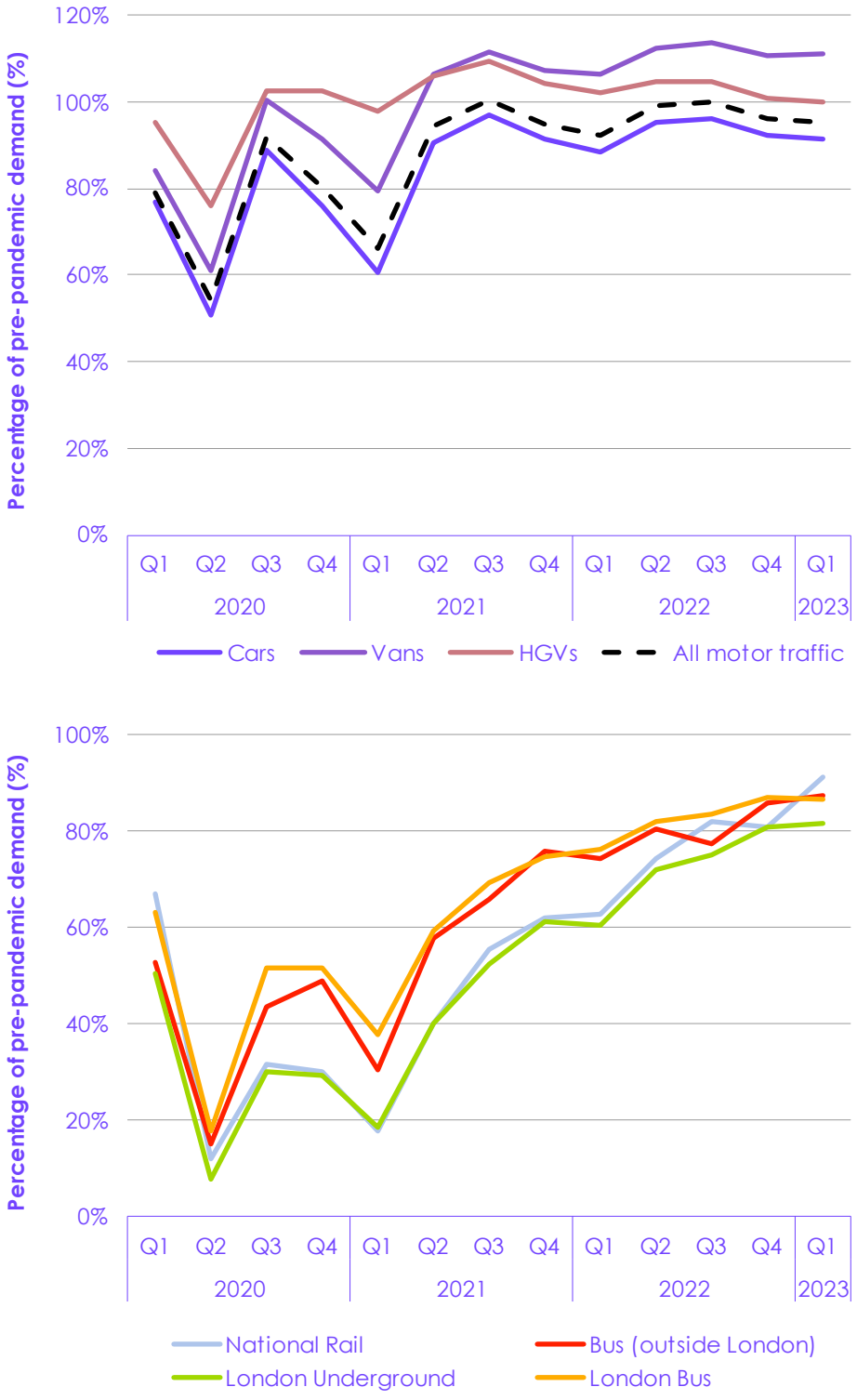
Figure 4.7 Changes in per-mile cost of driving, for a typical fossil-fuelled and electric car



Source: RAC Foundation (2023) *Charge Watch*; ZapMap (2023) *Charging Price Index*; DESNZ (2023) *Domestic Energy Price Indices;* DESNZ (2023) *Gas and Electricity Prices in the Non-Domestic Sector;* CCC analysis.
Notes: Costs are based on the RAC Foundation's assumed efficiency assumptions for a typical car – 8.8 miles/litre for petrol/diesel and 3.5 miles/kWh for an EV. Domestic charging prices are based on quarterly domestic electricity prices, while public charging costs are based on the ZapMap's current cost per mile, scaled by historical quarterly non-domestic electricity price data. All costs are shown in nominal terms. Separate time series are shown for slow/fast public chargers (up to 22 kW) and rapid/ultrarapid public chargers (25 kW upwards). 2023 domestic charging data shows the average for January to February 2023.

While road transport demand appears to have recovered to a new steady state, public transport recovery has been slower and usage remains around 10-20% lower than before the pandemic.

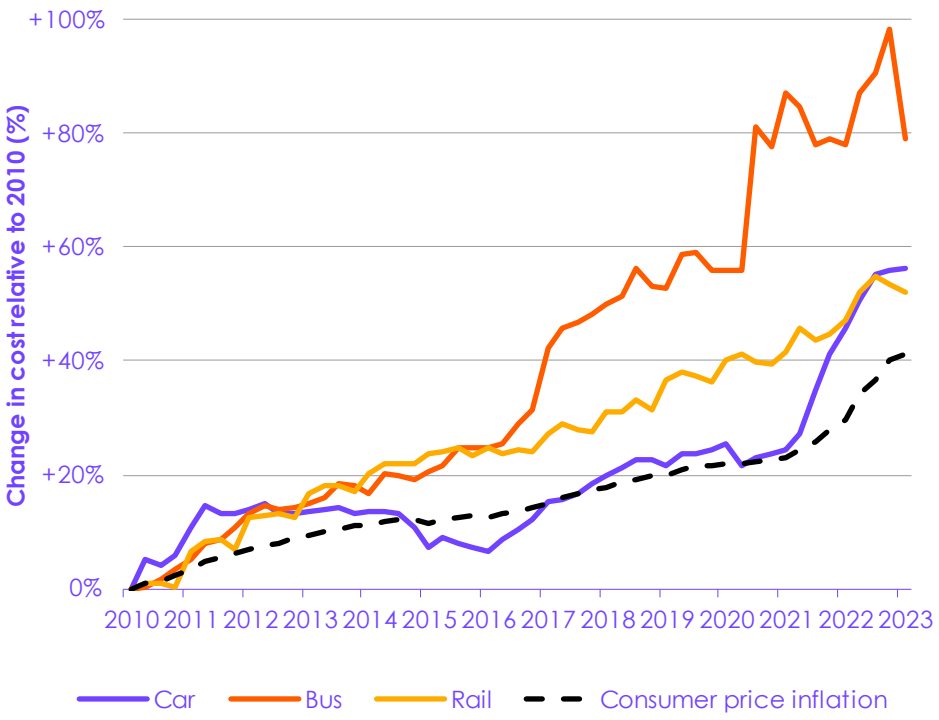
Figure 4.8 Transport demand since the COVID-19 pandemic



Source: DfT (2023) *Daily Domestic Transport Use by Mode.*
Notes: Daily demand has been averaged over each quarter. The data series began in March 2020 and was available up until the end of Q1 2023 at the time of writing. The first chart shows road transport demand, while the second shows public transport demand. In each chart, usage is shown as a percentage of the pre-pandemic baseline – these baselines vary by mode and are described in detail in DfT's accompanying methodology note.

Bus fares have increased much faster than inflation since 2010, while the cost of driving has generally remained roughly in line with inflation.

Figure 4.9 Relative cost of transport by mode



Source: ONS (2023) *Consumer Price Inflation Time Series*.
Notes: Costs are shown in nominal terms, based on ONS quarterly cost component indices. The time series show the change in these indices relative to Q1 2010.

A suppressed new-car market could slow the pace at which the overall fleet can transition to electric vehicles, even if market share targets are met.

Box 4.1
Impact of car market size on EV uptake

The market share of BEVs has been tracking ahead of our Balanced Pathway since it was first published in 2020, reflecting strong progress in both supply and demand. However, it is important to view this in the context of an overall new-car market that was suppressed by the pandemic and has remained restricted since as a result of global supply-chain issues (particularly semiconductor shortages). This means that the total number of BEVs entering the fleet over this period has been lower than was previously expected.

If these market challenges continue, then the market share targets set through the ZEV mandate will equate to fewer vehicles than had previously been expected, slowing the pace at which the overall fleet can transition to electric and potentially resulting in older, more-polluting vehicles remaining on the road for longer. This poses a risk to the delivery of the emissions pathways required.

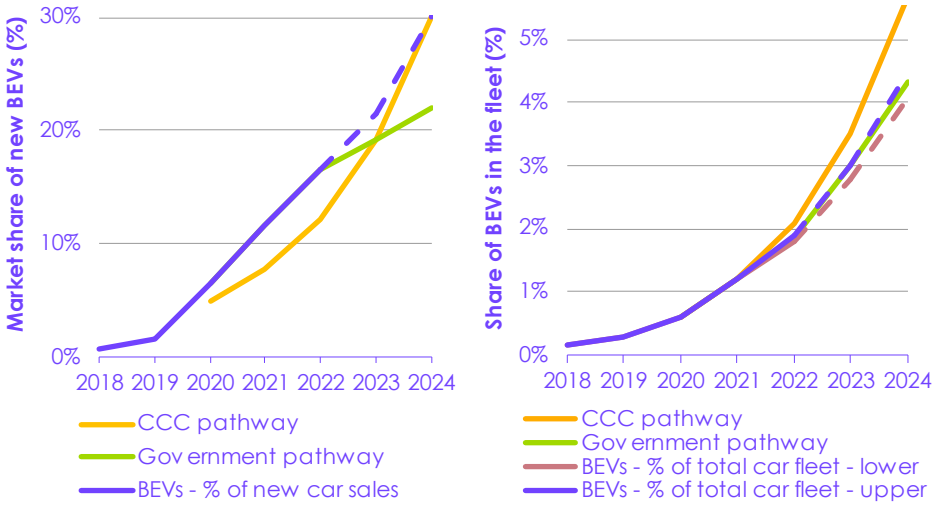
This discrepancy is illustrated in Figure B4.1, which shows that even if the BEV market share continues to outpace both the CCC's and the Government's projections to end-2024 (left-hand chart), this will only result in the share of BEVs in the overall fleet roughly meeting the Government pathway and falling behind our own (right-hand chart).

It is still early in the roll-out, so the shortfall in terms of number of BEVs and the emissions impact of this are relatively small. However, this will grow quickly if the market does not recover as expected. This emphasises the importance of tracking not just the share of BEV sales, but also the proportion in the fleet to understand whether the assumed emissions savings are likely to be delivered. If they are not, then the Government will need to consider contingency measures, including incentives to encourage vehicle supply to the UK, increases to the targets within the ZEV mandate or measures to reduce car-kilometres.

There could also be positives for emissions reduction arising from the reduced market size, depending on how potential purchasers' attitudes evolve in the coming years:

- The reduced market size and the fact that the BEV market share is ahead of our pathway also mean that total sales of new conventional vehicles over recent years have been considerably lower than expected. This could reflect some consumers delaying vehicle purchases until BEVs are more affordable or better meet their needs. If this is the case, then it could present a substantial opportunity for the size of the BEV market to increase as the market recovers.
- If improvements to more sustainable alternative modes of travel enable drivers to decide they do not need to own a car (or need only one car rather than two), then this could lead to lower overall levels of car ownership, reducing both the emissions from car use and also the emissions embedded in vehicle production.

Figure B4.1 Market share of new BEVs and share of total BEVs in the fleet



Source: DfT (2022) *Vehicle licensing statistics*; SMMT (2023) *UK new car and van forecast*; CCC analysis.
Notes: Projections for 2023 and 2024 (shown with dashed lines in the charts) are based on the CCC's Balanced Pathway for BEV market share and SMMT's forecasts for the size of the new car market. The range between the upper and lower scenarios for the share of BEVs in the fleet (right-hand chart) reflects uncertainty around the size of the overall car fleet in future years and the survival rates of existing vehicles. Government pathways (shown in green) are inferred based on a linear interpolation from the actual BEV market share in 2022 to the proposed 2024 ZEV mandate target.

Source: CCC analysis of DfT vehicle sales data and SMMT market size forecasts.

Delays to key policies have increased delivery risks within our policy assessment for surface transport.

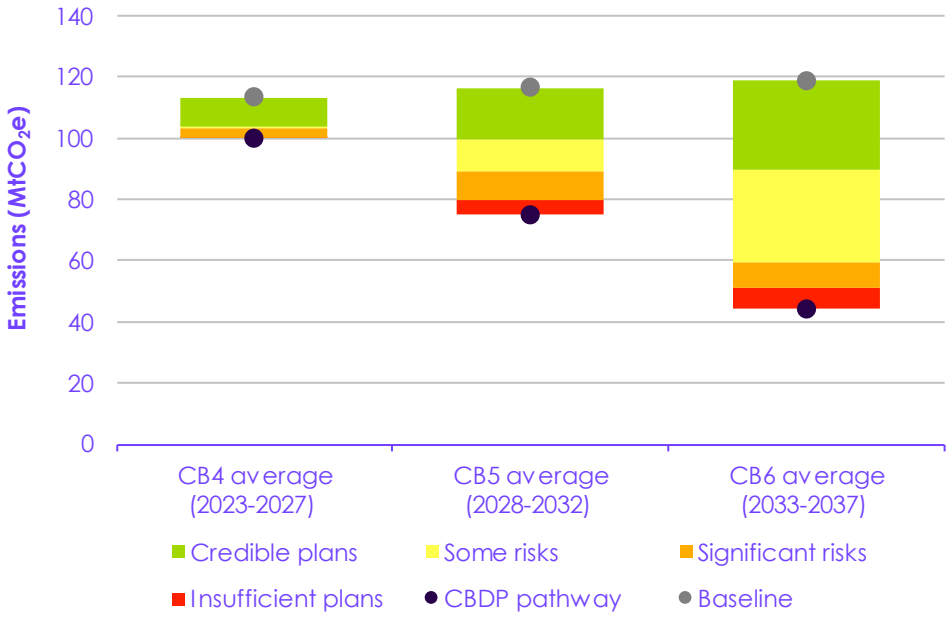
Policy progress in the surface transport sector over the past year has been slower than expected, with credible policies in place to meet only 38% of the required emissions reduction by the Sixth Carbon Budget period and delays to key policies increasing delivery risks (Figure 4.10, Table 4.1). Our assessment is based on the criteria outlined in Annex 1. Figure 4.10 is based on the revised quantified pathway presented in the Government's Carbon Budget Delivery Plan (CBDP), which is less ambitious than either the Net Zero Strategy or the CCC's Balanced Pathway. Further work is needed to develop coherent plans and measurable targets in areas of the sector that were not quantified in the CBDP – in particular measures to reduce car demand – to make up this shortfall. Table 4.1 provides a summary of recent progress and what still needs to be addressed, considering both the policy areas quantified within the CBDP and those that were omitted from that pathway. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 4.1.

It is important to ensure that changes to transport systems are resilient to climate impacts.

The policy assessment in this report focuses on measures to reduce emissions, but the transport system must also be well adapted to future climate impacts. In the CCC's recent report: Progress in adapting to climate change – 2023 Report to Parliament, we set out a number of recommendations in this area. These include designating transport sector regulators with climate resilience remits, integrating minimum climate resilience standards into regulatory cycles and ensuring that changes to transport systems, especially electrification of road and rail networks, are resilient to climate impacts.

Credible plans are in place to meet only 38% of the required emissions reduction by the Sixth Carbon Budget period.

Figure 4.10 Assessment of policies and plans for surface transport



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2023) *Energy and Emissions Projections: 2021 to 2040*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 and 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The baseline is an adjustment to the CBDP baseline, with the impact of various baseline policies in the Energy and Emissions Projections, including early-market EV uptake and conventional vehicle efficiency, removed from the baseline so that they can be assessed.

Table 4.1
Policy scorecard for surface transport

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome		Timeline for future policies		Overall assessment
Surface transport overall assessment	G	Y	O		Y		Y
Cars – zero-emission vehicles 54% of abatement over CB6 period	G	G – early market*	Y – early market	O – mass and late market	Y – early and mass market	O – late market	G – early market
		Y – mass market					Y – mass market
		O – late market					O – late market

Progress:

- The Government published its final consultation on implementing a zero-emission vehicle (ZEV) mandate in March 2023, following several months of delay.[16] Although the inclusion of various flexibilities has slightly weakened the mandate, it still represents a credible policy mechanism that should ensure sales of EVs scale up out to 2030.
  - The proposed targets will ensure that manufacturers are required to reach 80% of new car sales being ZEVs (likely almost all EVs) by 2030. This should be sufficient to deliver the abatement required in the Government's CBDP quantified pathway.
  - Despite its stated opposition to such flexibilities, DfT has included banking, borrowing and use of CO_2 credits alongside trading within the ZEV mandate. These flexibilities make it more likely that any overperformance will be compensated by underperformance elsewhere in the system, reducing the ability for the mandate to act as a delivery floor with aggregate performance tracking ahead of its targets. However, it is good that borrowing and CO_2 credit use will be restricted to the first three years of the mandate.
- The Autumn Statement 2022 confirmed the extension of favourable company car taxation rates for BEVs out to 2028 and announced that private purchases of BEVs will become liable for vehicle excise duty from 2025.[17] Analysis by Transport and Environment recently found that the UK's incentive landscape for company cars is comparatively strong, but that for private vehicles is already weaker than in many other European countries.[18]
- Following a pilot scheme which covered 19 local authorities, DfT has recently allocated almost £400 million of funding for the full implementation of the Local Electric Vehicle Infrastructure (LEVI) scheme.[19] This will support local authorities in England to develop and implement plans for charging infrastructure for residents without off-street parking.
  - Indicative funding allocations have been determined for all tier-one local authorities based on assessments of need and progress, a better approach than short-term competitive bidding processes.
  - It is welcome to see the LEVI scheme allocating not just capital funding, but also £38 million of resource funding intended to help build local authority capability. This is especially important for harnessing private sector investment.

* The technology adoption curve describes the typical uptake of a new innovation. It divides consumers into five groups – innovators, early adopters, early majority, late majority and laggards – each of whom have differing propensity to adopt the technology. Risks to the roll-out are likely to become more pronounced as it reaches the later groups, which we have reflected by ascribing separate assessments for the early, mass and late stages of the market. Early market adoption covers the most positive consumer groups and reflects the EV uptake that is expected to occur in the Government's baseline scenario due to policies introduced to date without further policy development.

- The On-Street Residential Chargepoint Scheme (ORCS) has also received an additional £15 million of funding for 2023/24.[20]
- DfT and Motability collaborated with the British Standards Institute to develop a new accessibility standard (PAS1899:2022) for EV chargepoints, which was published in October 2022 and aims to support development of an inclusive charging network in the UK.[21]

To be addressed:

- The ZEV mandate must be implemented from January 2024 as planned. Time is tight and the Government will need to work quickly to do this (priority recommendation R2022-272).
- DfT's cost-benefit analysis showed that faster uptake of EVs, in line with our Balanced Pathway, would deliver substantially higher net benefits than the trajectories in the ZEV mandate.[22] Moreover, the industry already expects the 2024 target to be met this year prior to policy implementation. Therefore, DfT must proactively monitor delivery and explore opportunities to boost adoption beyond these targets alongside the implementation of the mandate to drive the sector forward. This monitoring approach should also track the sizes and types of vehicles entering the market and consider how to address the growing trend towards heavier, more resource- and energy-intensive vehicles (recommendation R2023-140).
- Affordability is a key issue in ensuring that all drivers can access the benefits of switching to EVs. Establishing a robust used EV market, ensuring sufficient supply of smaller, more affordable EVs and potentially targeted incentives could all play a role in this regard (Box 4.2). Favourable company car tax rates have been effective at incentivising EV uptake among commercial fleets – these can be expected to feed an increase in supply to the second-hand car market, although there are concerns about the upfront cost surplus and current reluctance of some dealerships to stock used EVs.[23]
- The Government must also ensure that vehicle manufacturing and supply is able to meet the requirements of the ZEV mandate in a sustainable manner.
  - The incentives offered through the US Inflation Reduction Act and the market clarity provided by the EU's recent 2035 commitment will increase competition for both vehicle supply and manufacture. In response to this, the UK Government must consider how to ensure that the UK is able to access a sufficient supply of vehicles, including through creating a supportive landscape for domestic EV supply chains and gigafactories. It should also consider how these and other levers can be used to rebalance the UK's supply of EVs towards smaller, more affordable and more resource-efficient vehicles.
  - Responses to the first ZEV mandate consultation highlighted support for requiring ethical and sustainable supply chains as a condition within the mandate.[24] This was not taken forward in part due to the difficulty in defining what might count as ethical and sustainable. DfT should work with supportive stakeholders to agree a definition and investigate ways (e.g. certification) of requiring this (recommendation R2023-142).
  - The Government should also consult on regulations requiring EV batteries sold in the UK to be recyclable, to ensure that raw materials are used efficiently and embedded emissions are minimised (recommendation R2022-275).
- Ensuring widespread availability of reliable, affordable and easy-to-use public chargepoints will be fundamental to enabling mass-market uptake of EVs (recommendations R2022-277 and R2022-286).
  - DfT announced in 2022 that it intends to regulate to improve the consumer experience at public chargepoints, notably including a requirement for 99% reliability across the rapid network, mandating the consistent use of pence-per-kWh pricing and obliging a contactless payment option at all chargepoints above 8kW.[25] These regulations must now urgently be published and an appropriate enforcement regime implemented to share best practice and ensure compliance. DfT must also consider how it can improve reliability across the rest of the network (recommendations R2022-279 and R2023-144).
  - Public chargepoint operators were included within the Government's Energy Bill Relief Scheme, which helped insulate drivers from the full extent of non-domestic energy price increases.[26] However, the cost of public charging has still risen faster than that of home charging over the past year.[27] We continue to recommend that the Government should look for opportunities to reduce this disparity, including by reducing VAT on some public charging (recommendation R2022-301).

	– In the CCC's report Delivering a reliable decarbonised power system, we recommended that the Government should create a Minister-led infrastructure delivery group to ensure enabling initiatives for energy infrastructure build are taken forward at pace.[28] Through this group, the Government, Ofgem, distribution network operators and local government should work together to develop a more straightforward and streamlined process for delivering new and upgraded grid connections. This will be important for enabling the timely opening of rapid charging stations and electrifying van and HGV depots (recommendation R2023-143).
Vans – zero-emission vehicles 13% of abatement over CB6 period	G | Y | O | Y | Y **Progress:** • New van sales will (subject to the consultation process) be covered by a separate ZEV mandate, which will ensure that manufacturers are required to scale up EV sales in both the car and van markets and are not able to trade off overperformance in one to allow underperformance in the other.[16] • The final consultation proposes increasing uptake targets for vans, from 8% in 2024 and 52% in 2030 to 10% and 70% respectively, reducing the risk of manufacturers deprioritising development of vans or pushing hybrid technologies into this market. **To be addressed:** • Electric van sales to date have been insufficient. The Government must monitor whether this market is scaling up at the rate needed and consider whether further support – through incentives or regulation – is required (recommendation R2023-140). • The actions identified in the section above on zero-emission cars should all consider the implications on the van market in their implementation. In particular, infrastructure deployment plans must consider how to meet the charging needs of van drivers, which is a key concern that could hinder EV uptake.
HGVs – zero-emission vehicles 10% of abatement over CB6 period	Y | G | Y | Y | Y **Progress:** • The Government published the Future of Freight Plan in June 2022.[29] The plan set out a long-term vision for the sector, which included an ambition for achieving a Net Zero freight and logistics sector by 2050 and to support wider objectives around air quality and noise reduction. The plan also highlighted the need for certainty in future decarbonisation pathways and confidence the right infrastructure will be in place to accelerate the deployment of zero-emission technologies. Doing this could bring opportunities to the freight sector as a global first mover in decarbonisation. • As committed in the Future of Freight Plan, the Government established a Freight Energy Forum to build confidence in the transition by undertaking a review of regulatory barriers to implementing new infrastructure for the freight sector.[30] This will feed into Ofgem's regulatory review and any future planning and incentive reform opportunities. • DfT published draft regulations which will allow an increased weight limit for ZEVs and alternatively-fuelled vehicles.[31] This change means that these vehicle types will not be required to decrease their cargo weight to stay within weight limits, benefitting their commercial viability. • DfT and Innovate UK launched a £140 million Zero-Emission Road Freight demonstration competition, which ran between August and October 2022, to kick-start the deployment of battery-electric and hydrogen fuel cell HGVs, including by developing the required business models to scale up deployment and infrastructure.[32,33,34] The competition aims to fund up to five projects to each deploy at least 25 battery-electric or hydrogen HGVs onto UK roads by 2025. • A Hydrogen Transport Hub competition was launched in October 2022, with £20 million in funding for projects using hydrogen in transport in the Tees Valley.[35] The announcement included an additional £300,000 towards upskilling the local workforce. Winning bids were required to be ready to commence delivery of their projects by June 2023.

To be addressed:

- The Government has recognised the opportunities to the UK in being a first mover in this sector and increased its ambition in the CBDP, but the pace of policy development is not yet matching this. Although the Zero-Emission Road Freight demonstration competition closed more than six months ago, winning projects and next steps have not yet been announced. Alongside these trials, DfT should develop plans for how the transition to zero-emission HGVs will be enabled, including infrastructure plans and financial incentives for early movers (e.g. to support initial acquisition costs and depot charging installation costs) (recommendation R2023-146).
- The development for the ZEV mandate for cars and vans is tight and at risk of missing the Government's target start date. The Government should start the development of an appropriate regulatory mechanism for HGVs as soon as the cars and vans ZEV mandate has been legislated to provide early market certainty and avoid repeating these tight timescales (recommendation R2023-145).

Buses – zero-emission vehicles
2% of abatement over CB6 period

Y	G	Y	Y	Y

Progress:

- Additional funding for five further local transport authorities has increased the total allocation through DfT's Zero-Emission Buses Regional Areas scheme to almost £300 million for up to 1,400 zero-emission buses.[36] Many will be manufactured in Northern Ireland.
- The Government is delivering on its commitment in the National Bus Strategy to establish a Bus Centre of Excellence to share expertise to drive forward a decarbonised bus sector.[37,38]
- The UK's first autonomous electric bus service began running in Oxfordshire in March 2023.

To be addressed:

- The Government's response to the consultation on ending the sale of new non-ZEV buses is now overdue. This should be published, and a comprehensive policy package to deliver on it developed, to provided certainty to manufacturers and operators.

Conventional vehicles – efficiency, hybrids and biofuels
16% of abatement over CB6 period

O	O	R	O	O

Progress:

- DfT is consulting on proposed regulations to cover remaining sales of new non-ZEV cars and vans out to 2030.[16] The initial proposal is to require manufacturers to maintain average CO_2 emissions from the new non-ZEV vehicles that they sell at 2021 levels. This is limited in ambition and will deliver weaker emissions savings than had been assumed in the Transport Decarbonisation Plan.[39]
  - While this could still drive improvements where manufacturers switch their smaller vehicles over to ZEVs first, as they would then need to improve the intensities of the larger non-ZEVs to make up for this, it risks creating perverse incentives for manufacturers to delay transitioning small vehicle supply chains, restricting the availability of more affordable EVs.
  - Our calculations show that this policy of maintaining flat emissions intensities will result in the average emissions intensity across all non-ZEV cars on the road in 2030 being around 5% higher than in our Balanced Pathway. Given that non-ZEVs are expected to comprise three-quarters of the total car fleet at this point, this translates to around 3 $MtCO_2e$/year of abatement that will need to be made up elsewhere.
- London's Ultra-Low Emission Zone (ULEZ) is due to expand across all London boroughs from August.[40] This will prohibit the use of the most polluting vehicles, delivering emissions reductions and improved air quality. A scrappage scheme is available for owners of non-compliant vehicles, which can provide either a cash payment or annual public transport passes in return for vehicle scrappage.

To be addressed:

- DfT's alternative 'lightweighting' scenario within the non-ZEV regulatory consultation would require manufacturers to deliver intensity improvements in their non-ZEV sales each year by reversing the increase in size and weight of their vehicles. This would allow reductions in emissions from this portion of the market without requiring manufacturers to divert substantial

	research and development budget away from ZEV development. This scenario should be adopted within the final regulations (recommendation R2023-147). • A decision on how vehicle licensing regulations will apply during the period 2030-2035 has been deferred to later this year. The Government should use the evidence showing that real-world carbon savings from PHEVs are much lower than previously assumed and the expectation that PHEVs will be less cost-effective than BEVs by the late-2020s to justify either permitting only BEV sales or setting a very ambitious definition of 'significant zero-emission capability' (recommendation R2023-141).
Rail – efficiency and technology <1% of abatement over CB6 period	R | O | O | O | O **Progress:** • DfT and Innovate UK ran a First of a Kind innovation competition in 2022 focusing on technology ideas to decarbonise the railway, awarding £5 million total to 24 innovators.[41] • Great Western Railway will begin a trial of a fully battery-electric train on the branch line between West Ealing and Greenford later this year. • Electrification work has started on the Wigan-Bolton line, with completion due in 2024. Preliminary work has also begun on electrification of the Transpennine Route and the Midland Mainline, although completion timescales are less certain and longer-term. **To be addressed:** • The Government has not yet produced a plan for how its targets of removing diesel from passenger rail use by 2040 or achieving a Net Zero railway network by 2050 will be achieved. This is needed to ensure that funding commitments and network planning are appropriately directed and consistent with what will be required (recommendation R2022-283). • Only 2.2 km of track was electrified in 2021/22.[42] This is symptomatic of the current stop-start nature of network electrification, which is failing to deliver the infrastructure upgrades required. The plan should include establishing a rolling programme of electrification rather than planning and tendering each portion of track as a separate electrification project.
Passenger transport – reducing car travel No quantified abatement in the Government's delivery pathway	R | R | O | R | R **Progress:** • In December 2022, DfT published updated National Road Traffic Projections (NRTP), which set out eight scenarios for future traffic growth out to 2060.[43] These now include two decarbonisation scenarios (Vehicle-Led and Mode-Balanced Decarbonisation). These scenarios will be incorporated into transport appraisal through new scenario-based marginal external cost assumptions within transport appraisal guidance (WebTAG).[44] • DfT is consulting on a revised National Policy Statement on National Networks, which aims to better factor environmental objectives into infrastructure decisions.[45] This long-overdue update is welcome and its emphasis on the importance of schemes taking 'all reasonable steps' to reduce lifetime emissions and taking into account the potential direct and indirect impacts of climate change is positive. However, the draft statement needs to be clearer on the network's role in reducing traffic growth rather than simply meeting the demand projected in the Core NRTP scenario. • Local schemes such as 15-minute neighbourhoods and low-traffic neighbourhoods (LTNs), which have been supported by Government funding, may have contributed to maintaining some of the traffic reduction seen during the pandemic. – A recent study found that LTNs in London have led to large reductions in traffic, and this does not appear to have been displaced onto boundary roads.[13] – These schemes offer a wide range of co-benefits to local communities alongside emissions reductions. For example, 15-minute neighbourhoods provide key facilities and services locally, saving residents the time and hassle of having to drive to access these. LTNs reduce traffic flows on residential streets, providing a more appealing setting in which for locals to walk and cycle and improving air quality. – A survey of LTN residents found very high levels of support for Government action to realise these co-benefits (80-90%), with majorities of both residents (61%) and local business owners

(54%) supportive of the schemes that had been introduced in their areas.[46] A separate survey of the general public found majority (62%) support for making their local area into a 15-minute neighbourhood.[47]

- The Welsh Government accepted the recommendations of its independent Roads Review, which included cancelling 31 of 48 road projects reviewed (and reconsidering the merit of a further six) on environmental grounds and introducing stringent tests that will only permit new road projects if they will meaningfully contribute to modal shift, reducing emissions and adapting to the impacts of climate change.[48] This is a welcome step which should contribute to reducing traffic growth.

To be addressed:

- Measures to reduce car demand – whether through reducing the need to travel, modal shift or shared mobility – present an important opportunity to go beyond the Government's quantified pathways and reduce the risk of relying solely on rapid ZEV uptake. This can contribute to making up the shortfall on the UK's NDC and the Sixth Carbon Budget, but only if the development and implementation of a coherent set of policies begins urgently (priority recommendation R2022-119).
- To support local transport authorities in refreshing their local transport plans, DfT should issue guidance on what these should cover. In particular, this should include clear advice on how to plan for, calculate and deliver quantifiable carbon reduction. It is disappointing that this guidance, which was promised in the Transport Decarbonisation Plan, has not yet been published (recommendation R2023-149).[39]
- The strategic priority of Net Zero should mean that all scheme appraisals (including road-building decisions) must explicitly consider the NRTP decarbonisation scenarios and assess the emissions impacts that they will generate. Where these are detrimental, there should be a requirement to develop mitigating actions to reduce these impacts (Box 4.3).
- At a UK level, various road-building projects have recently been pushed back due to fiscal headwinds. The Government should launch a more strategic review (similar to the Welsh Roads Review) to assess whether these projects are consistent with its environmental goals (recommendation R2023-148).
- The Government must produce plans to address the long-term fiscal issues relating to the decarbonisation of transport (recommendation R2022-292).
  - In response to the Transport Committee's inquiry in January, the Chancellor confirmed that the Government currently has no plans to consider road pricing.[49] Without such plans, the consequent absence of central leadership risks an inconsistent mix of local schemes (e.g. clean-air zones, low-emission zones, zero-emission zones) and large fiscal shortfalls. Options for how to address this, potentially including a cross-party working group as proposed by the Campaign for Better Transport, should be considered.[50]
  - It should also consider the role of fuel duty, which was frozen at Budget 2023, extending last year's 5p cut despite fuel prices being 8% lower than when it was introduced.[51] Not undoing this reduction – which was billed at the time as being temporary – and choosing not to uprate duty in line with inflation is estimated to cost £4.8 billion in 2023/24 and amounts to a Government subsidy for driving.[52] This money could have been used to support more sustainable modes.

Passenger transport – increasing car occupancy and shared mobility 1% of abatement over CB6 period	O	O	O	R	O

Progress:

- The CBDP mentioned the possibility to reverse falling trends in car occupancy and bring the UK more in line with comparable countries, but there is no policy to deliver this yet.
- DfT published its evaluation of national e-scooter trials, which included a finding that the proportion of users reporting replacing car journeys with e-scooter use rose from 12% to 21% over the course of the trial.[53]
- The ZEV mandate consultation proposes to award additional credits for ZEVs that are sold for use in car clubs.[16] This should help expand the availability and use of shared EVs.

To be addressed:

- In producing local transport plan guidance for local authorities, DfT should set out the role that shared- and micro-mobility can play in increasing connectivity and reducing emissions. Clear policy and funding streams should be developed to enable this (recommendation R2023-149).
  - DfT should publish the Mobility as a Service Code of Conduct and develop funded policy building on this through which local authorities can deliver schemes to encourage greater use of car-, lift- and ride-sharing instead of single-occupancy private car travel.
  - The findings of the e-scooter trial evaluation should be used as the basis for developing policy for how they will be used as part of the future transport system.

Passenger transport – modal shift to active travel
<1% of abatement over CB6 period

G	O	O	Y	Y

Progress:

- The second Cycling and Walking Investment Strategy was published in July 2022.[54] It sets out the Government's ambition for making active travel a natural choice for most shorter urban trips by 2040, along with quantified interim targets and governance arrangements.
- Active Travel England announced a £200 million funding pot for local authorities to bid into for schemes aimed at improving local active travel infrastructure.[55] It is positive to see this accompanied by a separate £33 million capability fund aimed at developing local authority skills and conducting community engagement to develop effective schemes.[56]

To be addressed:

- In March 2023, the active travel budget received a substantial cut, with the £700 million allocated at Spending Review 2021, minus the £230 million already allocated, being reduced to just £100 million over the remainder of the period.[57] The Government must restore the previously agreed funding settlement (recommendation R2023-150).
  - Active Travel England's initial funding allocations appear well thought through and there are some promising signs of progress. The Government should be looking to build upon these to allocate all local authorities long-term funding to develop and implement active travel plans. The substantial funding cuts will undermine its ability to do this.
- DfT's local transport plan guidance should share best-practice on planning and delivering active travel schemes to help local authorities to make best use of this funding (recommendation R2023-149).

Passenger transport – modal shift to public transport
No quantified abatement in the Government's delivery pathway

O	Y	O	O	O

Progress:

- In January 2023, the Government introduced funding to enable bus operators outside London to cap fares at £2.[58] This has since been extended to October, delivering an average saving of 80p per journey. Recent research shows that this has led to 11% of respondents using the bus more, with many of these choosing it instead of car travel.[59]
- Rail fare increases for 2023 were capped in line with increases in average earnings, rather than the usual RPI.[60] This halved the increase that would normally have occurred.
- Budget 2023 committed to a second round of the City Region Sustainable Transport Settlements, totalling £8.8 billion over the period 2027/28-2032/33.[51] The objective of this investment – to improve public transport systems in city regions to match that in London – is a strong ambition and could help deliver modal shift, particularly if combined with measures to disincentivise car travel where viable alternatives are available.
- Construction of sections of HS2 has been delayed (Phase 2a from Birmingham to Crewe by two years and the section from Old Oak Common to Euston by four to ten years) due to fiscal headwinds. This adds to previous negative coverage around changes to the extent of its routes within Northern England.

To be addressed:

- The £2 bus fare cap has been successful in limiting inflation and encouraging modal shift. This should be made permanent and developed into a wider strategy to reduce the cost of public transport. This should aim to make public transport more affordable relative to higher-carbon

	modes, as well as making ticketing more joined up and straightforward (recommendation R2022-282). • It is important that public transport operators are incentivised to increase demand for their services and to improve both provision and reliability. – The Government should work with operators to understand how regulatory frameworks can best support these aims. – Ongoing labour disputes are causing disruption to rail services and risk undermining public confidence in the rail system.[61] It is important that these are resolved to help improve perceptions of the train as a reliable alternative to car travel. • DfT's local transport plan guidance should set out what actions local authorities can take to improve local public transport systems. This should include identifying areas where collaboration can be beneficial and maximising synergies with other Government objectives such as levelling up. The ambition to improve public transport in towns and cities to London's standard must be embedded within this guidance and supported by appropriate funding and powers (recommendation R2023-149).				
Freight transport – demand reduction and modal shift 2% of abatement over CB6 period	R	R	O	O	R
	Progress: • The 2022 Future of Freight Plan included an ambition to support and promote mode shift in freight.[29] The plan reiterates the Government's commitment to support rail freight and an intention to set out priorities for the sector in the forthcoming Rail Network Enhancements Pipeline. It also sets out an aim to facilitate the launch of new international rail freight routes by developing a bespoke inland customs clearance model for rail freight terminals. • The Great British Railways Transition Team (GBRTT), set up by the Government to bring about improvements across the rail system, is developing a range of target options in response to the Government's commitment to set a rail freight growth target. GBRTT published a Call for Evidence to understand how much freight demand could be met by rail, which closed in September 2022.[62] **To be addressed:** • Van traffic has increased more than any other vehicle type over the past twenty years and has risen even more quickly since the pandemic. The Government must explore options to address this, with particular focus on measures to facilitate schemes that reduce freight traffic in urban areas (recommendation R2022-290). – Continued growth at recent rates could make emissions reduction targets more difficult to meet and would also have implications for congestion and air quality, particularly in urban areas. We will continue to monitor van-kilometres as one of our indicators and consider the risks of continued growth in our future analysis. – The Transport Decarbonisation Plan pledged to explore the legalities and practicalities around traffic regulation and consolidation schemes that could reduce van and truck movements in urban areas, but this has not yet happened.[39] • Findings from the call for evidence on rail freight have not yet been taken forward to set a rail freight growth target and there are no policies in place to drive a shift from road to rail freight.				

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan, along with the adjustments we have applied to allow us to assess policies included in the baseline.

Box 4.2
International approaches to supporting EV uptake in low-income households

Global sales of EVs have been increasing rapidly, with the latest outlook from the International Energy Agency increasing its 2030 forecast for the EV share of new car sales worldwide to 35%.[63] Major policy packages including the US Inflation Reduction Act and the EU Fit for 55 initiative, along with the UK's 2030 phase-out commitments, have played a role in pushing this market forward.

As the proportion of EVs in the UK and worldwide grows, there will be increasing opportunities to learn from both regional and international comparisons to understand approaches to dealing with issues specific to the later stage of the EV transition, such as growing second-hand markets and ensuring EVs are accessible to low-income households. Several such examples already exist:

Second-hand markets for EVs.

- **Domestic.** Until 2022, Transport Scotland offered interest-free loans of up to £30,000 for purchases of used BEVs. Over £18 million was loaned to Scottish consumers and businesses between the scheme's launch in 2020 and its closure.
- **Netherlands.** The Dutch Government has introduced a grant scheme that provides €2,000 for purchasing or leasing a used BEV. The grant is only available for cars that are kept for at least three years, originally cost between €12,000 and €45,000 and that have a range of at least 120 km. This is part of a wider scheme that also provides grant incentives for the purchase of new BEVs.
- **France.** In 2020, the French Government introduced a policy that provides one-time grants of €1,000 for the purchase or lease of used BEV cars or vans for non-commercial purposes. Eligible vehicles must be at least two years old and kept by the grant recipient for at least two years. This an extension of a grant scheme that previously applied only to new vehicles.
- **Germany.** In Germany, used BEVs are eligible for the same purchase grants as new EVs, currently worth up to €6,750 for a vehicle worth up to €40,000.
- **United States.** The Inflation Reduction Act introduced a $4,000 tax deduction for purchasers of used BEVs worth up to $25,000.

Improving accessibility for low-income households.

- **Domestic.** Alongside the introduction of the ULEZ, London has launched a scrappage scheme offering residents in receipt of means-tested benefits cash grants of up to £2,000 to scrap non-ULEZ-compliant vehicles. Further savings are available if using this grant to buy a ULEZ-compliant replacement or various other sustainable transport alternatives through a partner retailer. Birmingham, Bristol and Scotland have also introduced similar means-tested scrappage schemes. The Scottish Government also funds ChargePlace Scotland, a network of free public chargepoints, which could be of particular benefit to households without private off-street parking.
- **France.** Larger grants are available towards BEV purchases for low-income households. In addition, the French Government has a policy that offers discounts on low-emission vehicles if an older and less efficient vehicle is traded in for scrappage. This policy offers the highest discounts when the older vehicle is traded in for an EV.
- **United States.** States including California, Oregon and Pennsylvania have grants for BEVs and PHEV sales to low-income residents. In California, low-income households can receive a rebate of $7,500 for purchasing a BEV.

Source: CCC research into a (non-exhaustive) range of international and domestic policies designed to support used EV markets or improve access to the EV transition for low-income households.

Box 4.3
Road transport demand projections and transport appraisal

In December 2022, DfT published its latest National Road Traffic Projections (NRTP) out to 2060.[64] The NRTP scenarios (there are eight in total) represent the expected traffic volumes in DfT's Common Analytical Scenarios, which are a collection of modelling scenarios that are intended to allow decision-makers to assess the impact of transport schemes against a variety of possible futures. These scenarios are therefore important in determining how the transport system evolves, and it is vital that appraisal guidance makes clear the importance of ensuring that decisions taken are compatible with the sector's pathway to Net Zero.

There is substantial variation in traffic levels across the NRTP scenarios, which reflects the uncertainty in how the sector will develop over 40 years (Table B4.1). The NRTP represent an improvement on their predecessor, DfT's Road Traffic Forecasts from 2018, both methodologically and through explicit inclusion of two decarbonisation scenarios (Mode-Balanced Decarbonisation and Vehicle-Led Decarbonisation) that reach close to zero tailpipe emissions by 2050. It is important that these scenarios are consistently used within appraisals of transport schemes to ensure that compatibility with the sector's decarbonisation pathway is an integral part of decision-making.

- The Core scenario is based on only 'firm and funded' policies and as such does not take account of the UK's legislated carbon budgets and Net Zero commitment.
  - DfT has made clear that it sees this scenario as representing a 'common analytical comparator' to enable comparisons to be made between scheme impacts, and the department's analytical leadership has suggested that wording should make clear that it should not be seen as a 'most likely' scenario.[65]
  - Indeed, the aim should be for all policy decisions and scheme approvals to move the system away from this counterfactual and towards a vision consistent with cost-effective decarbonisation.
- As well as using the Core scenario, DfT advises that scheme appraisals should also consider each scenario at least qualitatively and choose additional scenarios that are most in line with the scheme's strategic objectives for more detailed analysis.
- In light of the wider strategic importance of achieving Net Zero and the fact that transport is the UK's highest-emitting sector, it should be expected that all schemes that could impact on road transport demand should give detailed consideration to the decarbonisation scenarios. DfT should ensure this is clear in appraisal guidance.
  - The range of assumptions across the Mode-Balanced and Vehicle-Led Decarbonisation scenarios can be seen as reflecting uncertainty along the pathway to Net Zero.
  - Until the Government has developed a clearer vision for the quantified role of measures to reduce demand for private road transport in reaching Net Zero, the presumption should be that schemes that could impact on road transport demand should only progress if they would provide net societal benefit under both of these decarbonisation scenarios. Otherwise, there is a risk that decisions made today could lock in a dependency on higher-cost pathways and miss opportunities to realise co-benefits.
  - The similarity between traffic growth levels in the Mode-Balanced Decarbonisation scenario and our Balanced Pathway makes it likely that this will be the most cost-effective of the decarbonisation scenarios. Recent research from the RAC Foundation found that measures to reduce car demand can also significantly lower the delivery risk around the Sixth Carbon Budget.[66] Without this, meeting these goals would require rapid progress on both BEV sales and the departure of older fossil-fuelled vehicles from the fleet.
- To further embed the new NRTP scenarios within transport appraisal, DfT plans to include marginal external cost assumptions consistent with each of the eight scenarios in the next update of the WebTAG databook. This will allow transport modellers to use costs that are consistent with the traffic levels and expected

makeup of the vehicle fleet in each scenario, ensuring that cost-benefit appraisals more accurately reflect the impacts of schemes under each scenario.

Table B4.1
Changes in total car-kilometres in various CCC and NRTP scenarios relative to 2019

Source	Scenario	2030	2050
Sixth Carbon Budget (CCC)	Widespread engagement	-7%	-12%
	Balanced Pathway	+3%	+10%
	Headwinds	+7%	+27%
National Road Traffic Projections (DfT)	Behavioural Change	-8%	-9%
	Mode-Balanced Decarbonisation	+5%	+11%
	Core	+10%	+22%
	Vehicle-Led Decarbonisation	+11%	+27%

Source: DfT (2022) *National Road Traffic Projections*; CCC analysis.

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76 $MtCO_2e$, 17% of UK emissions in 2022

Introduction and key messages

Buildings remain the UK's second highest-emitting sector, accounting for 17% of total emissions. Territorial emissions from buildings peaked in 1996, and then fell by around 15% to 2008, when the Climate Change Act was passed. However, since 2010 progress has stalled, with no further substantive reductions in emissions. To reach Net Zero, the Government urgently needs to coordinate a shift in how the UK's 28 million homes and two million non-residential buildings use energy.

Our assessment of the Government's policy progress for buildings remains largely unchanged from last year. Progress remains broadly insufficient to ensure that the buildings sector reaches zero emissions by 2050.

The next ten years are the crucial period to decarbonise buildings, requiring a complete policy framework to be put in place, together with the necessary supply chains and supporting infrastructure, alongside public acceptance of the transition. Both our Sixth Carbon Budget pathways and the Government's Carbon Budget Delivery Plan reflect this reality.[1,2] However, a substantial amount of future abatement either lacks policies (most abatement from improvements to energy efficiency) or depends on policies which carry significant risks (most abatement from low-carbon heat).

Our assessment has also identified systemic uncertainty around the future roles of electrification and hydrogen, particularly for heat in buildings. The Government will take a strategic decision on this by 2026, in line with CCC advice.[3] However, progress is slow and there is a risk that the UK loses the opportunity for progress while the Government considers the issue for a further three years. This uncertainty is also holding back investment in the infrastructure to produce, store and transport electricity and hydrogen. This chapter includes our updated analysis of the issues and the options available to the Government. We present new advice about how the Government can drive progress by taking a strategic approach to decisions about heat in buildings.

Our key messages are:

- **Indicators and policy progress.** The Government clearly stated its ambition to transform the way we heat buildings at scale in its Heat and Buildings Strategy (HABS).[4] The Government continues to deliver thousands of measures through targeted schemes. However, the required scale of delivery to meet the Fifth and Sixth Carbon Budgets represents a step change from the current level. The Government continues to avoid big, impactful decisions and action.
  - **Indicators.** Most indicators are off track. While overall emissions appear to be on track, this is likely to be temporary as a result of recent high gas prices and mild weather. There is a concern that the number of trained retrofit assessors and heat pump installers are off track.
  - **Policy progress.** Since the HABS, the Government has continued to consult on key policy proposals, allocated further new funding and taken steps to legislate for some of the necessary powers in the forthcoming Energy Bill. It has made progress by publishing proposals for the Clean Heat Market Mechanism and has provided longer-term certainty for programmes such as the Energy Company Obligation (ECO) and the Boiler Upgrade Scheme (BUS).

  - **Urgency.** The UK needs significant new policies and programmes to underpin the delivery of low-carbon heat and energy efficiency. The current pace of Government decision-making will not deliver this. There are major upcoming rule changes, such as implementing the Future Homes Standard and the ban on off-gas grid boiler replacements. These are critical steps to Net Zero and must not be delayed.

- **Key details missing.** The Government has laid out broad ambitions for the buildings sector, but the details of the policies that will achieve these are largely missing. This information gap creates barriers, making it hard for households and businesses to take key decisions, such as how and when to retrofit buildings, or decisions about investments in skills and supply chains.

  - **Ongoing uncertainty about heat is stalling progress – heat pumps and heat networks should be being installed at pace now**. The Government has not yet set a clear direction on the future technology mix for low-carbon heat. It has said that it will take a 'strategic decision' on the role of hydrogen for heat by 2026, but this is a long way off.[4] Progress both on buildings decarbonisation and energy supply infrastructure are needed now, rather than waiting a further three years for more complete information – pace should be prioritised over perfection. Heat pumps and heat networks are no-regret options in many cases; industry needs encouragement to invest and roll them out at pace.

  - **Non-residential buildings need attention.** There is a large and increasingly concerning policy gap relating to non-residential buildings. We note some progress in public buildings, but a stable, long-term funding approach is urgently needed. There are no convincing plans to decarbonise commercial buildings. These properties get some benefits from schemes for residential decarbonisation (either directly or indirectly). However, this is not enough to drive improvements across the non-residential sector.

  - **Affordability remains a concern.** The long-run benefits of Net Zero buildings are increasingly clear. Buildings will be cheaper to run and healthier to live and work in. But the up-front capital costs needed to decarbonise the UK's building stock remain high, and the Government has not made much progress on answers for the question of 'who pays?' for the Net Zero transition in this sector.

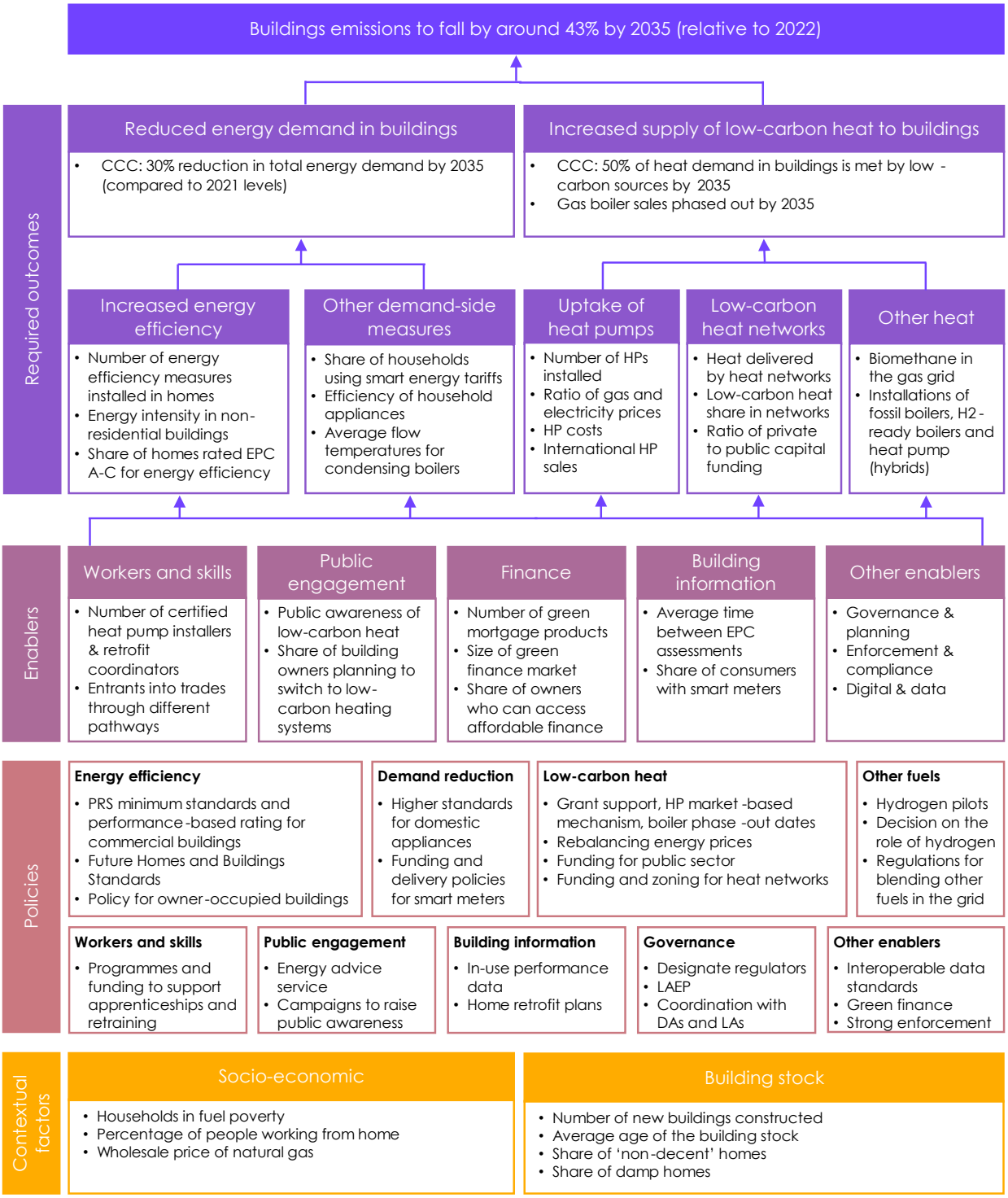
- **Policy gaps and uncertainty.** The Government has not resolved key questions on the direction of policy for energy efficiency and low-carbon heat. The respective roles for hydrogen and electrification in building-scale heat remain unresolved, causing uncertainty.

  - **Some options are already clear.** There are low- and no-regrets actions which the Government should pursue now regardless of any future decision on hydrogen. This includes electrification of heating in all new buildings and existing properties off the gas grid, using a mixture of heat pumps and heat networks.

In the rest of this chapter, we discuss progress in three sections:

1. Emissions and indicators of progress
2. Policy assessment
3. Long-term strategic choices on heat decarbonisation

Figure 5.1 Monitoring map for buildings



Source: CCC analysis.
Notes: Temperature adjustment of buildings emissions is explained in our Monitoring Framework.

The CCC's monitoring map for buildings (Figure 5.1) sets out the policies, enablers and required outcomes for a successful transition. This report focuses on 11 key indicators, with more indicators available in the supplementary materials. Our Monitoring Framework documents the indicators we track and our approach for assessing progress.

Overall, the indicators and emissions trends for the buildings sector are not on track to meet the Government's targets.

Buildings emissions fell 13% in 2022. However, it is unclear how much of this is driven by energy efficiency improvements, underheating or working pattern behaviour.

Territorial emissions. 2022 emissions estimates suggest that buildings emissions are in line with the Government's pathway (Figure 5.2a). However, forward-looking indicators suggest that this trend will not continue without further policy intervention.

- Buildings emissions fell 13% in 2022 to 76 $MtCO_2e$. Emissions for residential buildings fell by 16%, but emissions for non-residential buildings only fell by 2% (Figure 5.2a and Figure 5.3).

- However, the winter months in 2022 were particularly mild. After temperature-adjusting the emissions data, the 2022 fall was only 6% in residential buildings, with a rise of 5% in non-residential buildings.* The fall in residential emissions has likely been driven by a behavioural response to the record-high gas prices. It is unclear how this reflects the balance between improvements in efficiency (e.g. reducing boiler flow temperatures) and people underheating their homes in response to the much higher prices.

Overall energy demand. It is likely to be too early to say whether overall energy demand indicators are on track (Figure 5.2b, 5.2c and 5.2f) compared to the CCC's recommended pathway.

- Changes in non-residential buildings emissions may be an example of a post-pandemic behavioural change in working patterns.

- It is likely that the energy crisis is having an impact on demand for many residential and non-residential buildings, although it may also have stimulated some lasting improvements to energy efficiency.

New schemes, such as the Home Upgrade Grant (HUG) and Local Authority Delivery (LAD) have not delivered many measures. With ECO4 off to a slow start, the totals continue to lag behind our pathway expectations.

Fuel-poor homes and social housing. The number of Government-backed retrofits for fuel-poor households and residents of social housing has been insufficient for some years. The Government has introduced new schemes, such as the Home Upgrade Grant (HUG) and Local Authority Delivery (LAD), but these have yet to deliver many measures. In addition, the newest round of the Energy Company Obligation (ECO4) has started slowly and the totals continue to lag behind our pathway expectations (Figure 5.2g).

- HUG and LAD now account for 19% of all the fabric efficiency measures being installed in fuel-poor homes (Figure 5.5a).[5] While ECO has been the main programme over the past decade, each new round of ECO has delivered less than the one before (Figure 5.6).

- The number of fabric measures installed in fuel poor homes needs to rise to meet our pathway expectations (Figure 5.2g).

* The CCC baseline starting point included a temperature-adjustment to historical emissions based on an averaged 1981-2010 temperature rather than more recent trends, which leads to an overestimate of projected emissions.

  - HUG and LAD are now well established. Alongside ECO4, they provided 79,000 measures in fuel poor and social housing in 2022. There are plans to install fabric energy efficiency faster in homes in the coming years to 2025 (Figure 5.7).

- These programmes also offer heating installations. A long-standing issue with ECO was the fact that it focused on installing new and replacement fossil gas boilers over low-carbon alternatives. With HUG and LAD, the focus has shifted. Under these schemes, total installations of fossil boilers fell to a new low of 31,300 in 2022, as installations of low-carbon heating measures rose to 3,300, or 8% of all heat measures. The trend is heading in the right direction, but still falls short of our pathway (Figure 5.5b).

  - As the number of fossil boilers installed through ECO fell, the scheme delivered 1,400 heat pump installations in 2022. This is a significant increase from its previous single-year total of 250 in 2021.

  - HUG and LAD have delivered 2,000 heat pump installations in 2022.

Heat pump installations rose in 2022, but the total number is still well-below our pathway.

Low-carbon heat. Heat pump installations rose in 2022, but the total number is still well-below our pathway (Figure 5.2h).[5] Our pathway predates the recent high gas prices. As such, it does not reflect price increases as an incentive for homeowners to install heat pumps nor the greater strategic imperative for policy to shift energy use rapidly away from imported fossil fuels with volatile prices.

- The UK installed 72,000 new heat pumps in 2022, 69,000 of which were installed in homes (approximately 40,000 retrofits and 29,000 in new homes). Our Balanced pathway projected 130,000 installations in 2022, rising to 145,000 in 2023.

- The average cost of installing a heat pump in a home fell by 1.9% in 2022. This followed sharp rises in 2020 (10.3%) and 2021 (19.2%)(Figure 5.2i).

  - While unit costs for the heat pumps themselves fell by 6.7% in 2022, the cost of system components rose by 4.9%. The labour costs for installation only rose by 0.7%, although these had increased by 13.7% in 2020 and 17.8% in 2021.

  - These rising costs track the overall pattern of inflation for materials and labour in the construction sector. It is too early to say whether the Government's market-based approach is affecting any of these costs.

  - The Government is 'firmly committed to making the UK one of the largest markets in the world for heat pumps'.[6] However, in comparison to neighbouring countries, the UK ranked 21st out of 21 for per-capita installations of heat pumps in 2022 and was only 11th out of 21 for total volume of installations (Figure 5.4).

- The ratio of consumer electricity to gas prices fell sharply in 2022. In 2021, the consumer price of electricity was 5.59 times that of gas. It is now down to 3.74 (Figure 5.2e).

  - The ratio fell sharply because the Government transferred all the policy levies from energy bills to general taxation on a temporary basis.

– Previously, consumers were paying around £41.75 in policy costs per MWh of electricity consumed, but only £1.93 per MWh of gas consumed.* Even after allowing for the fact that the UK's homes use around four times as much gas as electricity (on an equivalent energy basis), the costs of levies were still disproportionately associated with electricity bills.[7]

– It is now essential that this improvement in relative prices is made permanent, in the rebalancing of electricity and gas prices to which the Government has committed to implement by March 2024.

Overall energy demand will drift further off track without faster deployment of energy efficiency measures in homes.

Energy efficiency. Overall energy demand will drift further off track without faster deployment of energy efficiency measures in homes.

- The energy crisis provided a clear incentive to insulate buildings, but progress in the owner-occupied and private rented sectors remains slow. New research shows that a combination of stop-start funding, labour and material costs and regulation costs present barriers to the growth of supply chains for buildings-level energy efficiency measures. Other barriers include access to finance for measures.[8]

The number of fabric measures installed needs to rise to meet our pathway expectations.

Public and commercial buildings. The number of fabric measures installed needs to rise to meet our pathway expectations.

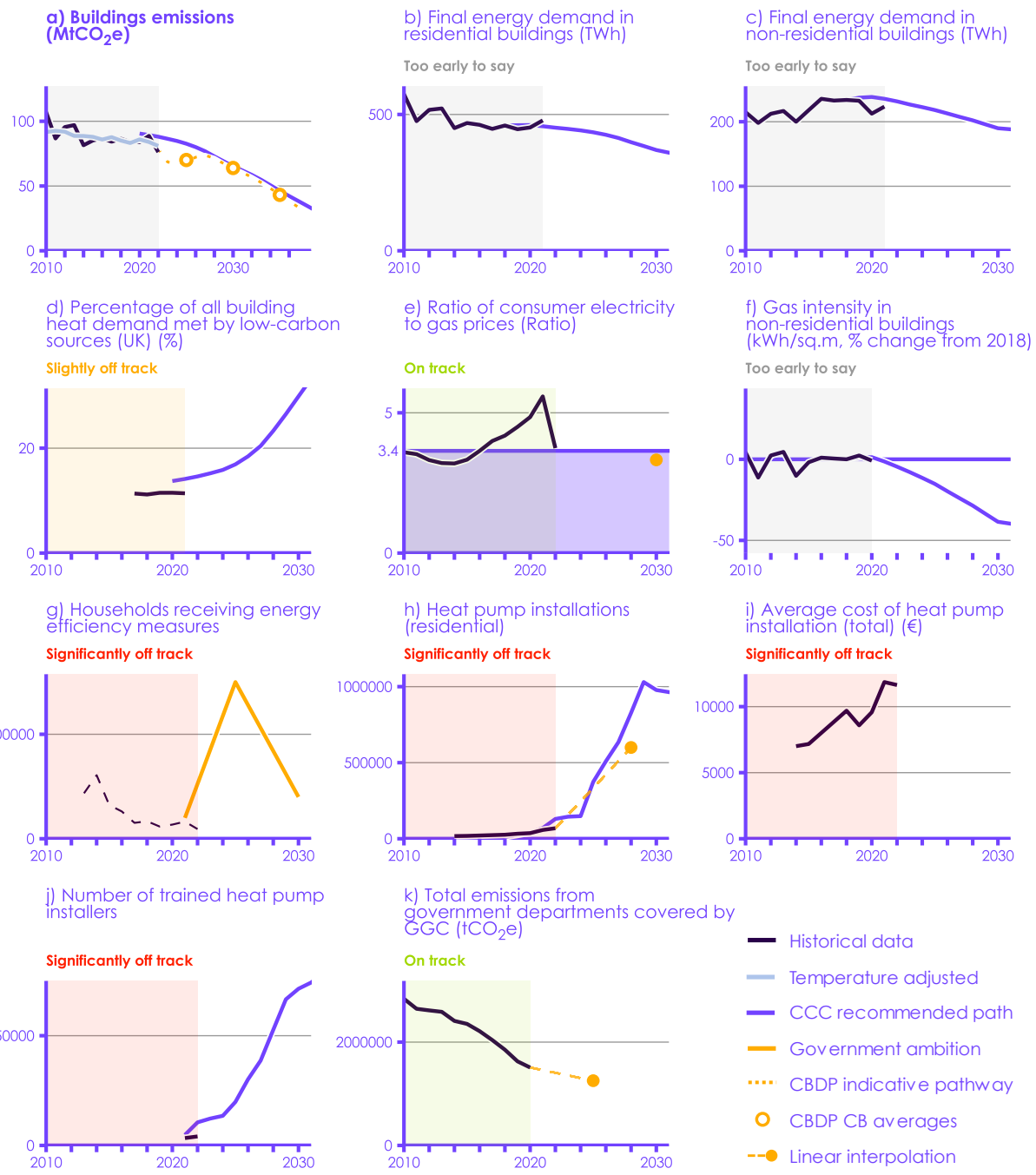
- There was a slight improvement in gas intensity across retail and offices during 2020, driven particularly by reduced intensity in retail (Figure 5.2f). This is likely to be largely due to the pandemic. More pronounced reductions were evident in leisure and hospitality sub-sectors.

- Emissions from government departments also fell in 2020, putting them well on track for the 2025 Greening Government Commitment targets. Public sector emission performance is also likely to have been strongly influenced by the pandemic.

Workers and skills. The UK will need a skilled workforce to deploy low-carbon heat and retrofit homes at the required rate. The number of trained heat-pump installers is significantly off track compared to the CCC's recommendation (Figure 5.2j). This suggests that supply chains and workforce upskilling are not scaling up at the rates which will be required to meet both the Government's deployment targets and CCC's recommended pathway.

* The fixed policy costs per consumer are roughly equivalent, at £10.30 per consumer for electricity and £10.75 per consumer for gas.

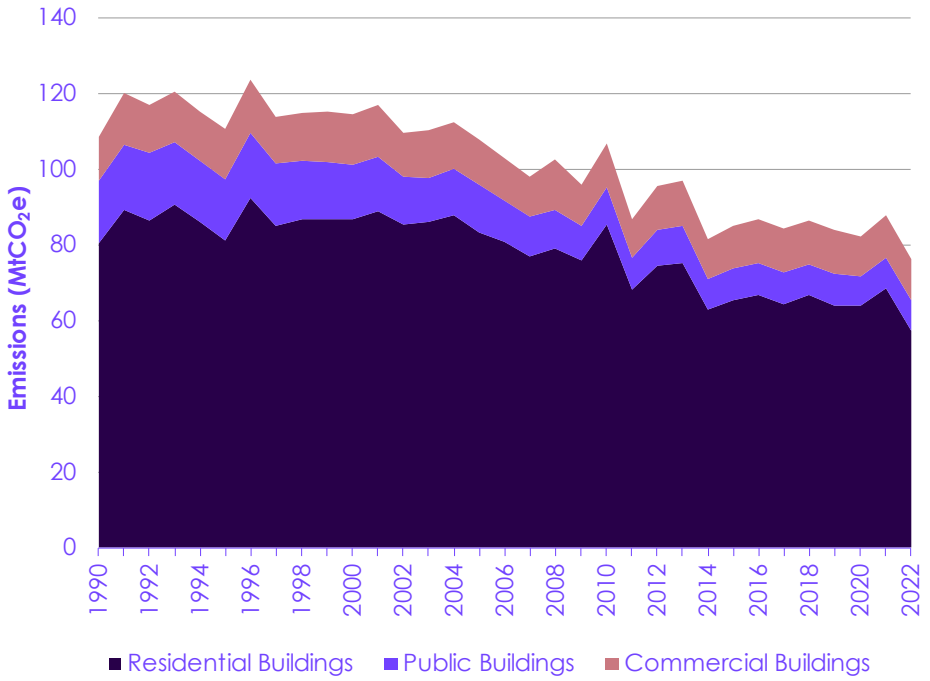
Figure 5.2 Key indicators for buildings



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path and considering the wider contextual factors that may have a temporary impact (e.g. recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) Dashed lines indicate the linear rate of change that would be required to meet the target, whereas solid lines show modelled pathways. (3) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions. (4) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (5) Temperature-adjustment of buildings emissions is explained in our Monitoring Framework. (6) In chart e), the CCC recommended pathway shows the price ratio required to incentivise heat pumps over gas boilers needs to be below 3.4, representing a range of average heat pump Seasonal Performance Factor (SPFs)). (7) Historical data in chart g) include Government funded programs only; the lack of data for owner-occupied homes is a priority data gap listed in our Monitoring Framework.

Between 2014 and 2022, buildings emissions have been broadly flat, having fallen in the previous decades. The latest year's emission reduction is likely to be due to mild weather as well as other behavioural effects.

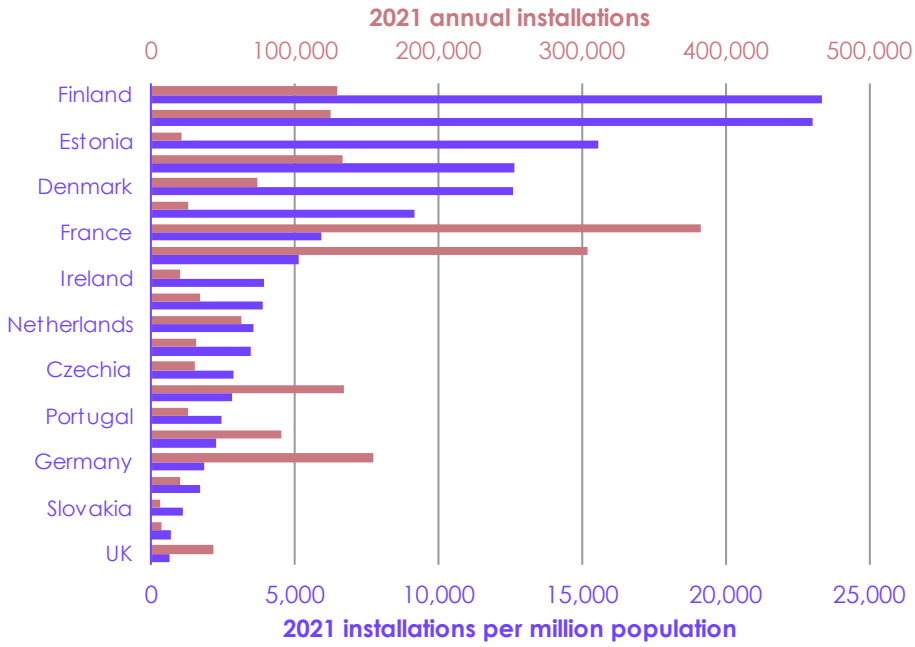
Figure 5.3 Buildings emissions (1990-2022)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*.

The UK ranked 21st out of 21 European countries for per capita installations of heat pumps in 2022. It ranked only 11th of 21 for total volume of installations.

Figure 5.4 Heat pump markets in Europe (2021)



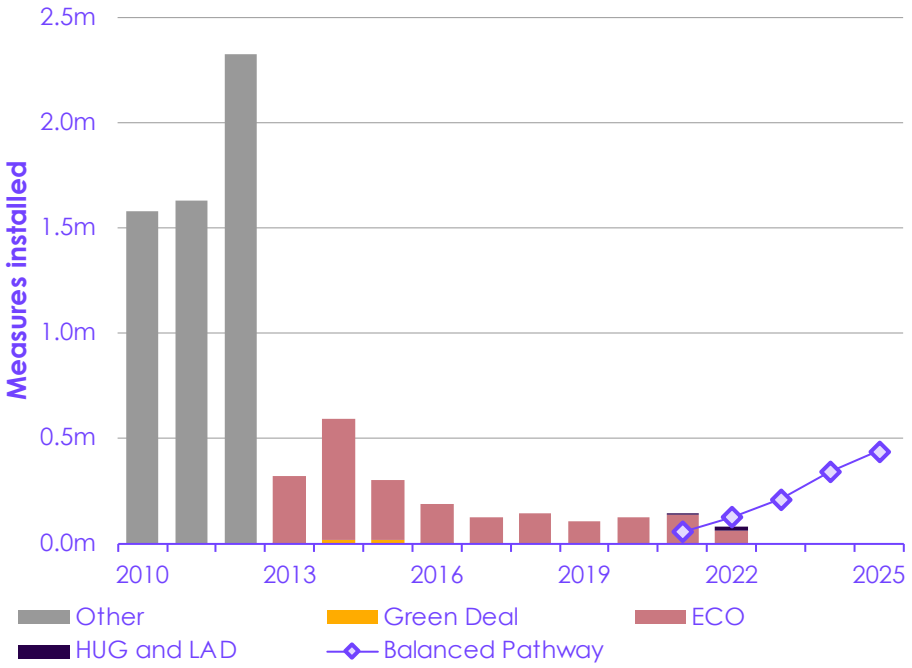
Source: EHPA (2023) *European Heat Pump Market and Statistics: Report 2022*; UN (2023) *2022 Revision of World Population Prospects*.
Notes: Installation numbers are for 2021, population estimates are from 2022.

The number of Government-funded fabric measures installed through the Home Upgrade Grant (HUG), Local Authority Delivery Schemes (LAD) and ECO 4 need to rise to meet our pathway expectations.

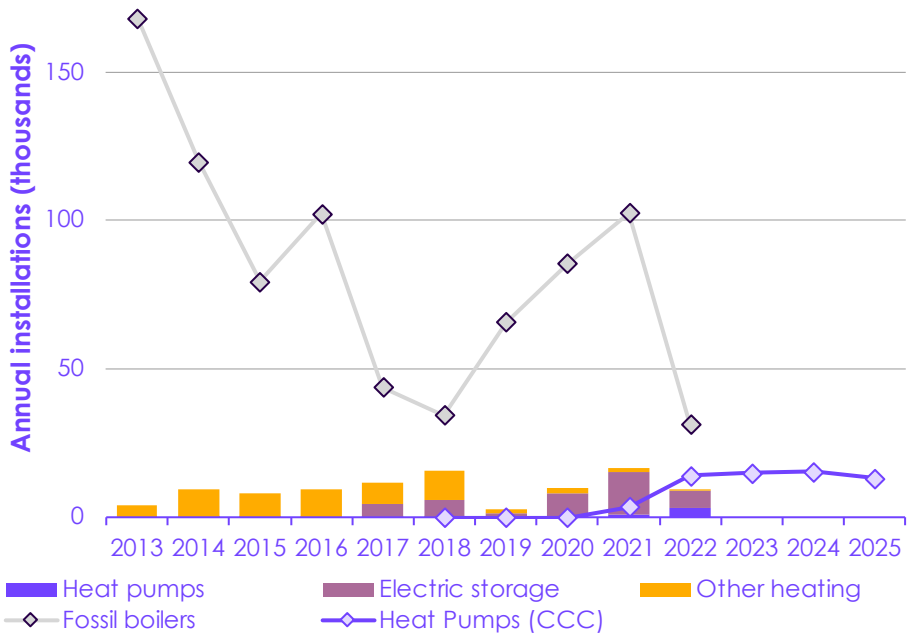
There were more heat pumps and fewer fossil boilers installed in 2022 than in previous years.

Figure 5.5 Government-funded measures for fuel-poor homes

a) Fabric efficiency measures



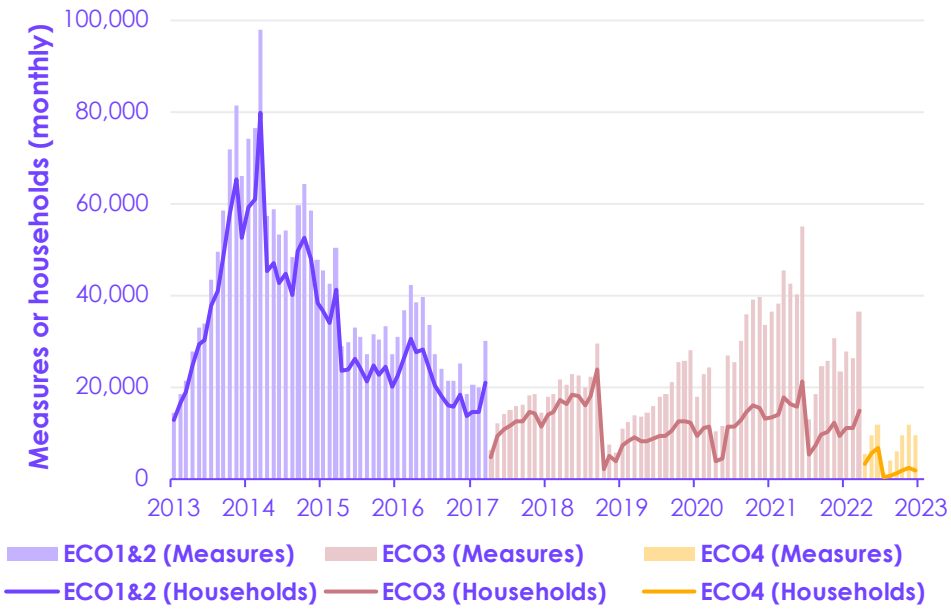
b) Heat measures



Source: DESNZ (2023) *Household Energy Efficiency Statistics*; DESNZ (2023) *Green Homes Grant and Home Upgrade Grant statistics; Historical DECC data*; CCC (2020) *Sixth Carbon Budget*.
Notes: Fabric measures include: cavity wall and solid wall insulation (internal and external), loft and roof insulation, and floor insulation. Heat pumps include: individual and communal Air Source Heat Pumps (ASHPs) and Ground Source Heat Pumps (GSHPs), and individual hybrid systems. Other heating includes electric resistive, connections to heat networks, solar thermal and biomass boilers.

The Energy Company Obligation (ECO) has been the main programme for delivering energy efficiency over the past decade – each new round of ECO has delivered less than the one before.

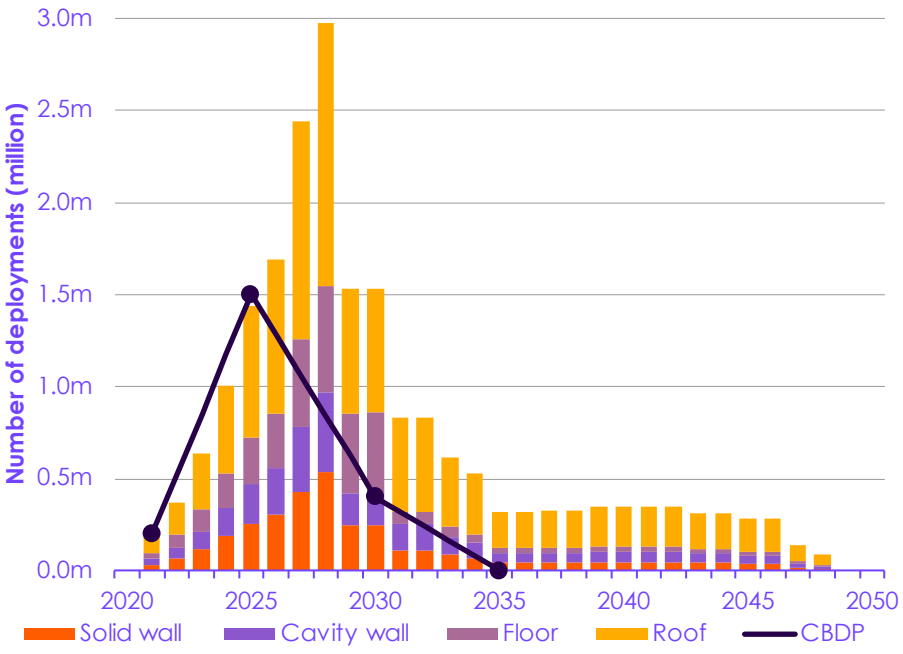
Figure 5.6 Measures delivered through four rounds of the Energy Company Obligation (ECO)



Source: DESNZ (2023) *Household Energy Efficiency Statistics.*

In the latest Carbon Budget Delivery Plan, there are plans to install 1.5 million fabric energy efficiency measures in buildings in 2025.

Figure 5.7 Number of energy efficiency measures required under 6CB and CBDP pathways



Source: CCC (2020) *The Sixth Carbon Budget*; DESNZ (2023) *Carbon Budget Delivery Plan.*
Notes: We have only compared the Government's deployment assumptions to the deployment assumptions for the four main categories of fabric efficiency in our Balanced Pathway. 'Behavioural' and 'Other' measures would add an additional 3.7 million measures in 2025 and 3.3 million in 2030.

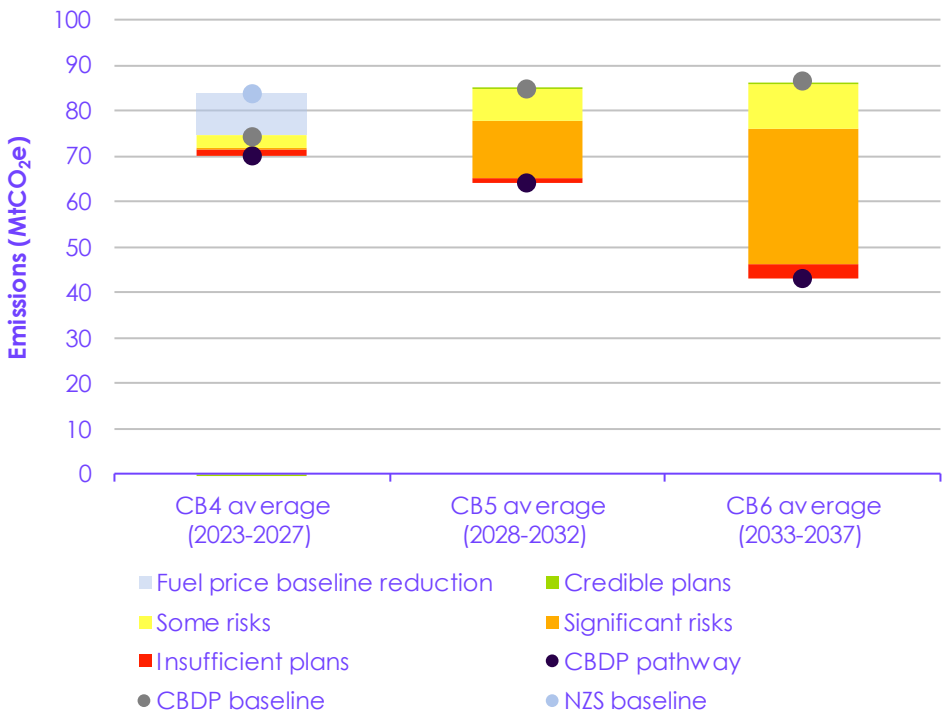
Policy progress in the buildings sector is not on track, with 77% of the required emissions reduction by the Sixth Carbon Budget period judged to be either at significant risk or with insufficient plans (Figure 5.8, Table 5.2). Our assessment is based on the criteria outlined in Annex 1.

Table 5.2 shows a summary of recent progress and policy that still needs to be addressed. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 5.2.

The policy assessment in this report focuses on measures to reduce emissions, but buildings must also be well-adapted to future climate impacts. In the CCC's recent report: Progress in adapting to climate change – 2023 Report to Parliament, we set out a number of recommendations in this area.

77% of the required emissions reduction by the Sixth Carbon Budget period is judged to be either at significant risk or with insufficient plans.

Figure 5.8 Assessment of policies and plans for buildings



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The shaded blue shows the difference between the CBDP and Net Zero Strategy baselines for buildings over the Fourth Carbon Budget period. There is a significant reduction in the CBDP baseline due to projected high gas prices. This reduction is very uncertain and could be considerably less than projected.

(a) Comparisons with the 2021 Net Zero Strategy

The latest Carbon Budget Delivery Plan demonstrates an increased focus on heat pump delivery by 2035.

The Carbon Budget Delivery Plan (CBDP) presents an expanded view of how the Government expects to reach Net Zero, building on the Net Zero Strategy (NZS), and reflects how the Government's ambition and priorities have evolved in the past 18 months.[2,9] The context within which these policies are being developed has changed. The twin crises of energy prices and cost of living have shifted the economics of building energy use and retrofits in many ways.[10] The latest CBDP plans will increase focus on heat pump delivery by 2035. This is reflected in the deployment assumptions which underpin the Government's new pathway for buildings (Table 5.1).

Table 5.1
Deployment assumptions in the Net Zero Strategy (2021) and the Carbon Budget Delivery Plan (2023)

Deployment assumptions in 2035 (unless otherwise noted)		Net Zero Strategy (NZS)	Carbon Budget Delivery Plan (CBDP)	Change (CBDP vs NZS)
Cumulative heat pumps installed in homes	Million installations	6.9 – 11.3	7.1 – 11.5	0.2 million **more** heat pumps by 2035 (but 0.4 – 0.5 million **fewer** by 2030)
Cumulative homes converted to 100% hydrogen for heat	Million homes	0 – 4.0	0 – 4.0	Unchanged
Homes treated annually by new residential energy efficiency measures	Million homes	0.5 (2025) 0.5 (2035)	1.5 (2025) 0 (2035)	1 million **more** homes treated in 2025, 0.5 million **fewer** in 2035
Low-carbon fuels consumption as a percentage of total fuel consumption in commercial buildings (excluding heat networks)	%	78-81%	73%	5-8 percentage points **less** heat supplied by low-carbon sources
Annual heat supplied via heat networks	TWh	29	35	6 TWh **more** heat supplied via heat networks
Annual biomethane injected into the grid	TWh	12	13	1 TWh **more** biomethane in the gas grid

Sources: BEIS (2021) *Net Zero Strategy: Build Back Greener;* DESNZ (2023) *Carbon Budget Delivery Plan;* DESNZ (2023) *Net Zero Growth Plan and Carbon Budget Delivery Plan: analysis methodology.*
Notes: Illustrative characteristics in 2050 were included in the Net Zero Strategy (Table 5, p319) but were not included in the Carbon Budget Delivery Plan.

Table 5.2
Policy scorecard for buildings

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Buildings overall assessment	○	○	○	○	○
Low-carbon heat in non-fuel-poor homes 40% of abatement over CB6 period	○	○	○	○	○

Progress:

- The Government has extended the Boiler Upgrade Scheme (BUS) to 2028.[6] This programme provides grants that could deliver around 180,000 heat pump installations over the period to 2028, predominantly in homes.
  - The scheme (launched in May 2022) had a slow start – its online application portal wasn't online until November 2022.[11,12] BUS is only on track to deliver 13,500 installations in 22/23, 45% of its potential.[13]
  - Air-source heat pumps (ASHPs) account for around 96% of the verified installations to date. BUS grants cover around 39% of the average cost of an ASHP.* Inflation may erode the value of this over time, weakening the grant as an incentive for homeowners.
- The Government has committed to implementing the Clean Heat Market Mechanism in 2024 and has published a new consultation on this policy.[14]
- As part of its response to the energy price crisis, the Government moved all the policy costs off energy bills and onto general taxation.
  - If this change reverts to the previous policy (before the invasion of Ukraine), then electricity will once again be disfavoured. The Government has committed to outline a clear approach to gas vs. electricity 'rebalancing' by the end of 2023/24.[6]
  - The Energy Bill includes provisions for the Secretary of State to introduce a new levy on consumer energy bills to support the development of a hydrogen economy.[15,16]
- A Net Zero investment roadmap for heat pumps will be published shortly, according to the 2023 Green Finance Strategy.[17] The Electrification of Heat Demonstration Project has shown that heat pumps are viable in most property types, supporting the case for widespread electrification of heat.[18] Around 88% of the properties eligible for the project were deemed technically suitable for heat pumps.†,[19] We expect up to 74% of homes will receive heat pumps by 2050.
- The Government continues to explore the potential of hydrogen as a fuel for heat in buildings. Hydrogen for heat features to some degree in all but one of our pathways to Net Zero, although with a relatively small role in most.
  - The Government is moving forwards with legislation which will enable neighbourhood and village-scale trials of hydrogen for heat in 2024 and 2025.[20] The neighbourhood-scale trial in Fife is running two years behind schedule and is now on track to start in 2024.[21]
  - The village trials are at risk. In Whitby, relationships between the project and the local community have deteriorated.[22] Residents there will be polled on whether to participate.[23] Cadent has proposed to build an entirely new gas distribution network for residents who wish to opt out.[24,25]

* The grant covers 24% of the median installation cost of a Ground Source Heat Pump, 33% for a biomass boiler, or 39% for a Shared Ground Loop GSHP.

† Properties in the project were selected based on suitability for low-temperature heat pumps.

– The Government has launched a consultation to develop policies for hydrogen-ready boilers.[26] We have previously advised that there would be a 'no-regrets' option for decarbonisation, although other replacements for gas boilers are becoming available, such as compact hybrid heat pumps. There is further advice in the final section of this chapter.

To be addressed:

- The details of the Clean Heat Market Mechanism need to be resolved as soon as possible, and the enabling legislation (Energy Security Bill) needs to be passed promptly (recommendation R2023-178). The impact of the policy needs to be monitored carefully. Alternative plans should be developed in case progress proves insufficient, along with options for future policies (recommendation R2023-181).
- Uptake of BUS has been lower than expected. The Government needs to improve public awareness of this offer and speed up the administration of the scheme (recommendation R2023-180).
- The Government needs to clarify its position on hybrid heat pumps and the role they will play within the clean heat market.* See Section 3 (Long-term strategic choices on heat decarbonisation).
- Supporting regulation needs to be in place for hydrogen-ready boilers. Any policy must preclude their installation in new buildings from 2025. This should complement policies which would ban new connections to the gas grid for all buildings (priority recommendation R2023-190).
- The Government needs to establish a clear position on the future of energy bill levies (recommendation R2022-063). It must ensure that the allocation of new (hydrogen) and existing levies do not continue to favour gas over electricity. It also needs to accelerate work on the review of electricity market arrangements (REMA).
- The Government needs to proactively and effectively engage with the village-scale hydrogen trials. A lack of Government visibility and engagement is undermining public confidence and increasing the risks of project failure (recommendation R2023-184).

Heat networks 8% of abatement over CB6 period	Y	G – until 2028 O – from 2029	Y	O	Y – until 2028 O – from 2029

Progress:

- The Government has extended funding for heat networks through the Green Heat Network Fund (GHNF) and the Heat Network Efficiency Scheme until 2028.[6] This will provide much-needed certainty for the sector.
- The Heat Network Efficiency Scheme (HNES) provides funding to public, private and third sector applicants in England and Wales to support improvements to existing heat networks.
- There are now stronger regulatory frameworks and the Energy Bill will empower Ofgem to regulate heat network zoning by 2025 (recommendation R2022-079).[27,28]

To be addressed:

- New projects funded through GHNF will need to use low-carbon sources but there are not yet clear policies to prohibit the creation of new high-carbon networks which do not draw on public funds (recommendation R2022-081).
- Pass legislation that provides the Government with powers to make regulations to implement heat network zoning in England (recommendation R2022-079).

* Three of our five pathways project between 3.4 million and 11 million hybrid air source heat pumps in homes by 2050.

New homes 6% of abatement over CB6 period	O – until 2024 Y – from 2025	G	O	Y	O – until 2024 Y – from 2025

Progress:

- Improvements arising from the recent uplift to Part L (conservation of fuel and power) of the Building Regulations. The uplift in June 2022 ensures that new homes produce lower CO_2 emissions compared to those built to previous standards.

To be addressed:

- The Government needs to launch its consultation on the 2025 Future Homes Standard (FHS). It must complete this to ensure that new buildings are resilient to climate change impacts, with ultra-high energy efficiency standards and low-carbon heating (recommendation R2022-092).
- The Government has not yet committed to end connections to the gas grid for new homes. There is also a risk the heat pump market does not grow fast enough to deliver around 200,000 heat pumps in new builds annually from 2025 (priority recommendation R2023-190).

Energy efficiency in non-fuel-poor homes 8% of abatement over CB6 period	R	R	O	O	R

Progress:

- The Government has introduced a target to reduce demand by 15% (relative to 2021 levels) by 2030 for the first time this year (this covers both the buildings and industry sector, see Chapter 6).[29] However, there is no clear plan to deliver this. The Energy Efficiency Taskforce was announced in November 2022 and the group was established in March 2023.[30] The taskforce will examine the barriers to reducing energy use and help the Government meet its 15% target.
- The Government has increased its near-term ambition for the deployment of energy efficiency measures in homes. It is taking other new steps to reduce household energy waste.
  - The Carbon Budget Delivery Plan (CBDP) projects that 1.5 million homes will be 'treated by new domestic energy efficiency measures' annually by 2025, falling to 0.4 million by 2030. The equivalent deployment numbers in the NZS were 0.5 million in 2025 and 1 million by 2030. See Section 1 (indicators of progress).
  - This increased ambition for major fabric efficiency measures in homes tracks our Balanced Pathway to 2025 before falling off. In our pathway, we expect households to continue adding efficiency measures at an increasing rate until at least 2028.
- The Government has introduced the Great British Insulation Scheme (GBIS) – a new programme for residential efficiency.[31]
  - It will focus on fabric efficiency measures. Installations will need to comply with TrustMark and PAS2035 specifications, which will increase costs by around £950 per household.[32]
  - The Government expects that GBI will deliver 376,000 measures between 2023 and 2026. Around 315,000 of these will be fabric efficiency measures (cavity walls, loft, and underfloor insulation).[33] These would account for around 8% of the corresponding fabric efficiency measures projected for 2023-26 in our Balanced Pathway.[1]
  - Because GBI uses the same model as ECO a portion of the headline funding figure will be taken up by administration and search costs. For ECO the administration costs are currently around £500 million per year.[34]

To be addressed:

- Energy efficiency in non-fuel-poor homes is the most significant policy gap in the buildings sector (recommendation R2022-065).
- There has been no response to consultations on minimum standards for the Private Rented Sector (PRS) (EPC band C for residential). The Heat and Buildings Strategy originally promised a response by the end of 2021 for residential buildings, but this has not happened.
- The Government's response to the energy price crisis focused on support for consumer energy bills with no matching investments to reduce energy waste.[35]

	– The Government's approach transferred much of the financial risk associated with high energy bills onto the Treasury.[10] These schemes provided transient but important benefits. – However, the UK's buildings are no more resilient to volatile energy prices now than before the crisis and pre-existing vulnerabilities that the crisis exposed remain. By contrast, other nations responded with significant investments in permanent measures to improve energy efficiency.[36] • The Government has still not published a response to the mortgage lenders EPC disclosure consultation. This has been outstanding for over two years now (recommendation R2023-189).[37]				
Fuel-poor homes 5% of abatement over CB6 period	Y	Y	Y	Y	Y
	Progress: The Government expanded funding to local authorities through the second wave of the Homes Upgrade Grant (HUG and the second wave of the Social Housing Decarbonisation Fund (SHDF) (recommendation R2022-078): • The second round of funding for HUG awarded £584 million, a substantial increase over the first-round funding of £218 million.[38,39] This means that the Government has allocated the bulk of the £950 million it announced in 2021 as part of the Heat and Buildings Strategy. • Wave 2.1 of the SHDF has allocated £778 million of funding for the period 2022/23 to 2024/25. **To be addressed:** There are a range of targeting and delivery concerns, in particular related to the Energy Company Obligation (ECO): • ECO4 is delivering a low number of measures compared to its predecessors (recommendation R2023-185). • There are no current plans to tighten regulation of social rented sector minimum standards of energy efficiency (recommendation R2022-074). • An end date for gas boiler installations in ECO should be set. • A clear date for phasing out new and replacement fossil fuel heating systems for off-gas-grid properties is needed (priority recommendation R2022-072).				
Residential product standards and appliance efficiency 7% of abatement over CB6 period	G	G	Y	G	G
	Progress: The Government has a robust and evolving framework for product standards (Energy-related Product Policy Framework). This uses appliance efficiency standards to deliver the objective of reducing energy consumption from all properties.[40] • The Government is currently consulting on improved efficiency standards for lighting products.[41] • The Government has proposals for new Ecodesign regulations for appliances. These would raise the minimum energy performance standards of residential and non-residential cooking appliances, and small-mid size space heating appliances. • The Government projects that improvements to the labelling of energy consumption on products (including lifetime costs) could save 0.4 $MtCO_2e$ annually during the Fourth, Fifth and Sixth Carbon Budget periods.[2] **To be addressed:** • The CBDP highlights that extending efficiency standards to more products (such as cooking equipment and garden machinery) could reduce carbon emissions. The cost and consumer and business impacts of this will need to be considered (recommendation R2023-186).				
Commercial buildings low-carbon heat 9% of abatement over CB6 period	O	Y	Y	O	O
	Progress: The Government has not introduced any new dedicated policies or programmes for low-carbon heat in commercial buildings. • Some of the policy developments in residential low-carbon heat are also relevant for small commercial properties. However, these policies are not necessarily well-targeted and only apply to a small share of the stock. Progress (in particular for SMEs) depends on the				

Government successfully developing its Clean Heat Market Mechanism across the residential stock.

- The Clean Heat Market Mechanism may help some smaller commercial buildings. Heat pump installations will qualify under this policy if they have maximum installed capacity of 45kWth from a single heat pump (or 70kWth in total). Buildings with higher heat demand (the vast majority of total non-residential heat demand) and those using air-based space heating (13% of non-residential heat demand)* will not be covered.
- Some SMEs can access grants for heat pumps through the Boiler Upgrade Scheme (BUS). This has been extended to 2028 and covers installations under 45kWth. However, many commercial properties will not meet the eligibility criteria (which cover most existing homes). To date only 0.4% of installations through the scheme have been in non-domestic properties.[13]
- Commercial properties use more electricity (relative to gas) than residential properties. Consequently, the Government needs to outline a clear approach to rebalance the relative costs of gas vs. electricity for consumers by the end of 2023.

To be addressed:

- An announcement on phasing out gas grid connections to new buildings is overdue. Any policy for hydrogen-ready boilers must not create a loophole which would permit further installations of fossil boilers (priority recommendation R2023-190).
- Prohibit fossil fuel boiler replacements in off-gas grid buildings from 2024 for large non-residential buildings (priority recommendation R2022-072).
- There is no confirmed date for consultation on the technical requirements for the Future Buildings Standard (FBS) 2025 (recommendation R2022-094).
- The Government should set out an approach to drive uptake of and market capacity for larger heat pumps for commercial buildings.

Public Buildings
11% of abatement over CB6 period

Y	O	Y	O	O

Progress: The Government has awarded £1.1 billion to 302 projects through Phases 3a and 3b of the Public Sector Decarbonisation Scheme.[42,43] It has also provided additional funding to public sector organisations to help manage the cost of energy bills and reduce energy waste from their properties.

- Phase 3 of the Public Sector Decarbonisation Scheme will provide £1.425 billion of grant funding over the financial years 2022/23 to 2024/25. This brings total funding under this scheme to £2.5 billion from 2020/21 to 2024/25 (recommendation R2022-066).
- Eligible schools and colleges received an allocation from £447 million of capital funding for energy efficiency upgrades in 2022/23 – part of an additional £500 million of capital funding for schools and further education.

To be addressed:

- Committed funding for the public sector up to 2024/25 comprises around 80% of what we estimate is needed to meet the Government's ambitious emissions reduction pathway for public sector buildings.
- There is no policy commitment beyond 2024/25 and a significant ramp up in investment will be required to meet carbon budgets and the Government's ambition to reduce public sector emissions by 75% (from a 2017 baseline) by 2037.
- Organisational capability and structure can limit the effectiveness of converting funding into actual emission savings.

Commercial buildings energy efficiency
3% of abatement over CB6 period

O	O	O	O	O

Progress: There has been some support and advice for small businesses and strengthening of the Energy Savings Opportunity Scheme (ESOS).

* Share of unabated non-residential heat demand that uses a dry heating system, as assumed in our Sixth Carbon Budget analysis.

- The Government has announced its intention to strengthen the ESOS during either Phase 3 (2019-2023) or Phase 4 (2023-2027).[44] This will include improving the quality and standardisation of audits and introducing public disclosure to increase uptake of recommendations.
- The Government intends to launch a digital energy advice service for small businesses this year to give impartial, trusted advice on improving non-residential energy efficiency. The Government will also be piloting a new audit and grant scheme this year, enabling small businesses to implement energy efficiency measures.

To be addressed: There are significant policies areas still awaiting action:

- The Government's response to its consultation on the implementation and trajectory of the EPC B target in the private rented sector regulations is long overdue (the consultation closed in 2021). Delay has created uncertainty for the market and has made potential interim milestones tighter (recommendation R2023-187).
- The Government has not established meaningful policies or programmes to support the delivery of energy efficiency measures and low-carbon heat in owner-occupied commercial buildings (recommendation R2022-075).
- Action has stalled on introducing a performance-based policy framework in large commercial and industrial buildings. The Government's consultation closed 2021 and it is yet to publish a response (recommendation R2022-076).

Enablers

Y	O	G	O	O

Progress:

- The Green Home Finance Accelerator provides up to £20 million to support green financing products, including solar PV.
- The Government has taken steps to help consumers access information and advice about how buildings – especially homes – use energy and what they can do about it. The Government's new energy advice service launched in late 2022.
- The Heat Pump Accelerator Investment Competition opened to UK businesses, providing grant funding of up to £15 million per project for major investments in the manufacture of heat pumps and strategically important components.
- The Heat Training Grant will provide up to £500 grant payments to support trainees in England undertaking short training courses relevant to heat pumps and/or heat networks.

To be addressed:

- Supply chains are not scaling up at the rate required to meet the Government's deployment targets (recommendation R2022-082).
- There is a major skills gap for low-carbon heat and energy. The Government needs to develop further plans to ensure that the supply of labour does not constrain supply chain growth (recommendation R2022-070).
- The Government has made little progress on policies which would increase access to finance for retrofits for either households or businesses (recommendation R2022-107).
- Affordability remains a significant barrier to progress in reducing emissions from buildings. Policies around financial levers need development to help consumers with prohibitive up-front capital costs (recommendation R2022-107).
- Energy Performance Certificates (EPC) are the main form of information about building energy use which is available to consumers. However, EPC ratings are poorly aligned with Net Zero and are in urgent need of reform (recommendation R2023-183).[45]
- The UK lacks a clear and consistent process for delivering credible, coordinated energy planning across local, regional and national levels (see also the Governance section of Chapter 15). The Government needs to set standards for energy planning and establish a clear governance framework which enables planning by empowering organisations at the local, regional and national level (priority recommendation R2023-176).
- The electricity distribution network needs to be in place to support heat pump deployment (see Chapter 7).

	• The Government should continue to ensure that the Government's energy advice service and funding schemes (such as the Boiler Upgrade Scheme and Great British Insulation Scheme) are adequately publicised to ensure widespread take-up (recommendations R2023-179 and R2023-180).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan.

Waiting until 2026 to set a clear direction on the respective roles of hydrogen and electrification will lead to three more years of lost progress in buildings and hinder infrastructure development more widely.

The Government has said that it will take a 'strategic decision' on the respective roles of hydrogen and electrification for heat in buildings by 2026.[2,9] The UK needs a clear direction on heat in buildings, with the imperative to make rapid reductions in our dependence on fossil gas and major progress this decade towards zero emissions from the sector by 2050. It would be inefficient and expensive for the UK to fully pursue multiple options nationwide, so the Government needs to decide their relative roles. While doing so it must press on with other actions to decarbonise buildings.

In 2016 we advised that the Government needed to take strategic decisions on heat by "2025 at the latest".[46] This date approaches, and in our assessment there has not been enough progress on the decisions needed to enable progress on buildings decarbonisation.*,[47]

The lack of a strategic direction is creating systemic uncertainty. This is hindering the growth of supply chains for low-carbon heat and limiting progress on energy supply infrastructure. Waiting until 2026 to set a clear direction will lead to three more years of lost progress in buildings, and hinder infrastructure development more widely.

This section is an addition to our core assessment of progress in building; it includes new analysis and an updated position. The Committee's view is that the absence of strategic decisions on electrification and the use of hydrogen for heat is creating systemic issues that need addressing now. While heat in buildings is the core concern, it is also affecting progress in the energy supply sectors, and on enablers such as finance and skills.

We have assessed the options for heat in buildings and the uncertainty caused by the absence of strategic decisions. From this, and building on our past advice, we have set out a series of no- and low-regret options for low-carbon heat, alongside routes to narrow the options where uncertainty remains. The Government should pursue these now, while continuing to develop the evidence base on the merits and uncertainties associated with different types of heat.

(a) The costs of indecision regarding low-carbon heat

The costs of indecision are weak supply chain growth and delayed infrastructure investment.

The lack of strategic decisions about the future direction of low-carbon heat has created considerable uncertainty. The UK is now at an impasse in the buildings sector, with knock-on effects for the power and fuel supply sectors amongst others.

(i) Supply chains for electrified heat are weak and growing slowly

There will be a major role for electrical heat in every plausible eventuality; there is no 100% hydrogen scenario for the UK. But supply chains for electrical heat are not developing at the required pace (and supply chains for hydrogen heat cannot even begin).

* The Government's Hydrogen Champion recommended that it "provide early clarity on the nature of this decision"

Installations of heat pumps across the UK must rise nine-fold in six years, from 69,000 per year in 2022 to 600,000 in 2028.[1] The UK is not currently on track to hit this target.

- The slow development of heat pump supply chains is reflected in our indicators (Figure 5.2). The workforce of engineers and related trades is growing slowly, the installed cost of heat pumps is rising rather than falling, UK manufacturing capacity has not grown significantly, consumers continue to have limited options for green finance, and imports of key components are not growing.

- The Government has not sent clear signals about its intentions for low-carbon heat; nor has it done much to engage the public about this issue. Messaging about hydrogen-ready boilers and blending may be adding to consumers' confusion; especially where the consumers receiving these messages are unlikely to ever have a hydrogen supply.[48]

- There is clearly demand for heat pumps – most of the UK's (small) cohort of qualified engineers are currently oversubscribed. But the fact that supply chain growth is weak suggests that there is a wider lack of confidence in the Government's ability to help these markets scale up. It is also unclear how large these markets will be in the future. As a result, manufacturers, installers, importers and others are holding back on major decisions relating to investment.

(ii) Delivering a decarbonised energy system is made harder

It appears implausible for the UK to meet all its hydrogen demand by 2035 just using domestic non-fossil production.

Our report Delivering a reliable decarbonised power system set out how GB could achieve a decarbonised electricity system, and deliver the required hydrogen supply, by 2035; and how supplies could be expanded as use of these vectors grows to 2050.[49] We concluded that it appears implausible for the UK to meet all its hydrogen demand by 2035 just using domestic non-fossil production. One limitation here is the likely rate at which the UK can build new renewable generation capacity – even with the highly ambitious plans set out in the Energy Security Strategy.[50] Another limitation will be electrolyser build rates.

Planning the energy system is made more challenging because the range of demand for hydrogen for heat in 2050 is projected to be anywhere between zero and either 182 TWh (CCC, 2020), or 210 TWh (BEIS, 2021).* Uncertainty about the future role of hydrogen in buildings appears to be preventing decisions on hydrogen storage and transmission infrastructure, despite the fact that this will be needed for other purposes. Delaying decisions on this infrastructure by a further three years until 2026 will delay the necessary progress in the electricity sector and elsewhere.

We recommended that the Government should identify a set of no- and low-regret investments that can proceed now (regardless of decisions in 2026) and fast-track the business models to deliver them. The Government will need to take strategic decisions on the use of hydrogen in buildings to facilitate any progress beyond this.

- Government plans for a rapid expansion of zero-carbon generation should be supported by the deployment of a portfolio of flexibility options to manage a renewables-heavy power system, developing hydrogen production and storage infrastructure, and continuing to upgrade the

* These projected ranges for hydrogen in buildings in 2050 are greater than the comparable ranges for the power, industry and transport sectors combined.

electricity transmission and distribution grids. In order to maximise the resulting benefits on emissions and energy security, zero-carbon electricity must be prioritised where it provides most value in economic and decarbonisation terms: displacing unabated fossil generation and meeting increasing demands from electric vehicles and heat pumps (Figure 5.9).

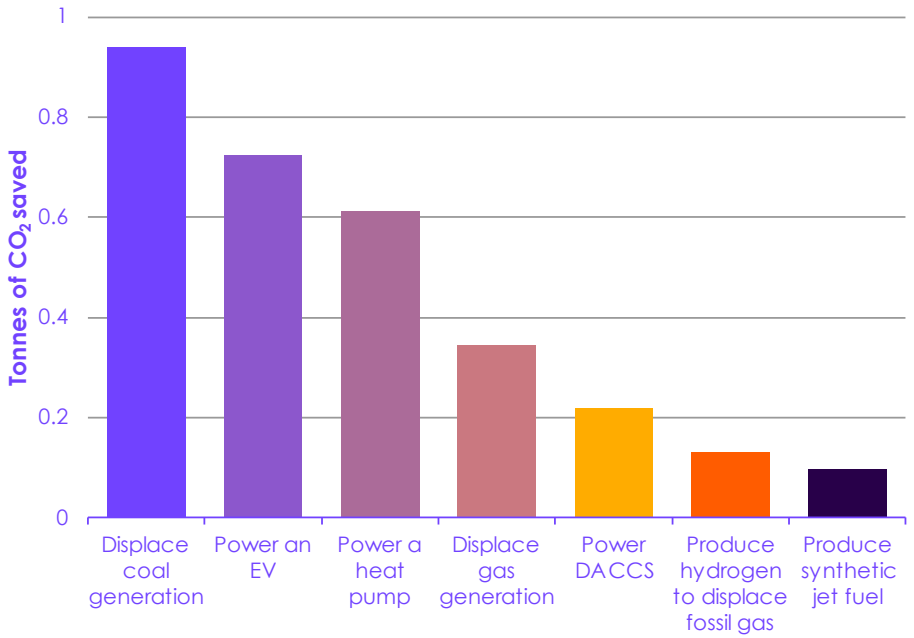
- Even by 2050, hydrogen availability remains a key risk for scenarios with higher levels of hydrogen use. The viability of using hydrogen at-scale in buildings depends on the availability of hydrogen with sufficiently low lifecycle emissions. In particular, whether it could be sourced at the necessary scale without risking security of supply or excessive exposure to volatile fossil fuel markets. This implies that the Government needs to focus hydrogen use on those areas in which electrification is not feasible in order to ensure that the hydrogen supply challenge is manageable.

- Even without the use of hydrogen in the buildings sector – and limiting its use in other sectors to where it's essential for Net Zero – meeting the demand for hydrogen across the UK's energy system is likely to require a substantial contribution from imported energy at least until the early 2040s. These imports could be fossil gas to produce 'blue' hydrogen with carbon capture and storage (CCS) and / or importing renewable energy for 'green' hydrogen. Given the uncertainty about potential future international trade in green hydrogen, the default expectation remains that the gap would mostly be filled with blue hydrogen.

It is also important to maximise the value of any low-carbon hydrogen supplies that we do have – this means focusing its use on applications where it provides most value (i.e. where electrification is not feasible). Where full electrification of a building is not feasible, using hydrogen boilers in a hybrid system, alongside a heat pump, would require much less hydrogen, while still providing value to the energy system at peak times.[3]

Zero-carbon electricity must be prioritised where it provides most value in economic and decarbonisation terms: displacing unabated fossil generation and meeting increasing demands from electric vehicles and heat pumps.

Figure 5.9 Emissions saved with 1 MWh of zero-carbon electricity in different applications



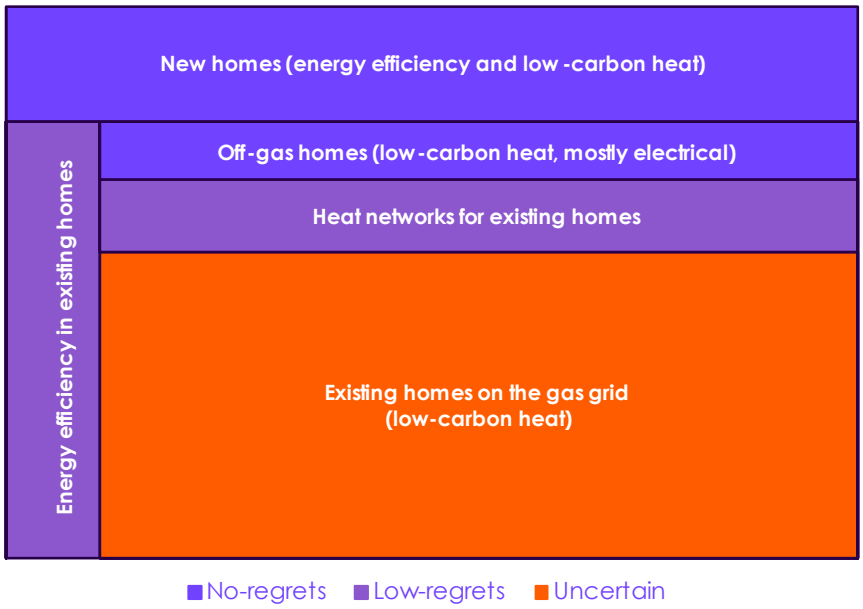
Source: CCC (2020) *Sixth Carbon Budget.*

(b) Assessing the options for low-carbon heat in buildings

For many buildings the most appropriate way to decarbonise heat is already evident and will not be affected by the outcome of the Government's upcoming strategic decision. In these properties, pressing ahead with the clear choice for low-carbon heat represents either a no- or low-regrets option (Figure 5.10).

Pressing ahead with the clear choice for low-carbon heat is likely a no- or low-regrets option for new homes, off-gas homes, as is energy efficiency in existing homes.

Figure 5.10 Strategic options to decarbonise homes



Source: CCC (2020) *Sixth Carbon Budget*.
Notes: The sizes of the blocks are equal to the potential abatement from the related measures in 2050 ($MtCO_2e$), based on the Balanced pathway from the Sixth Carbon Budget. In this scenario heat networks are assumed to be fully electrified (although they could conceivably use hydrogen, waste heat, or other forms of energy). New build homes on heat networks are included with existing homes under 'low-regrets'.

The Government needs to make strategic decisions about the remaining properties. These choices will account for a large proportion of the abatement from homes in 2050. There is some scope to go faster here: for instance, local and devolved governments could proactively decide to use local/national plans to direct the electrification of areas in advance of a strategic decision.

As well as technology choices there is a set of supporting actions that should be taken, including engagement to bolster public understanding of and support for the transition, and analysis to build the evidence base for the strategic decision.

No-regrets actions. There are desirable and necessary actions which the Government can (and should) take now.

Electrifying heat in new buildings and properties off the gas grid are no-regrets actions that will help accelerate the transition to low-carbon heat.

- **Electrical heat in new buildings.** New buildings have high standards of fabric efficiency and can be optimised for electrical heat from the outset (whether using heat pumps, heat networks or smart resistive / storage heating in homes with smaller heat demands). They provide an excellent opportunity for building supply chains and consumer confidence. Heating these buildings using low-carbon hydrogen would be a poor use of limited resources (Figure 5.9).

- **Electrical heat in off-gas properties.** These properties do not have the option to use hydrogen for heat, and (along with all new buildings) should not be connected to the gas grid in the future.* The only potential limitation on electrification for these properties is the capacity of the electricity grid. It is likely that electricity distribution networks will need to be upgraded to meet demand; but not all rural areas (where a higher proportion of properties are off-gas) will have electricity grid upgrades immediately. Hybrid heat pumps with a biofuel boiler could offer a solution in these circumstances.

The Government is already committed to reduce energy waste from fuel poor homes and social housing through schemes such as ECO, HUG, and SHDF.

- **Energy efficiency in fuel-poor homes and social housing.** The Government has committed to retrofit fuel-poor and social homes. Reducing energy waste from these homes will reduce energy bills, thereby alleviating fuel poverty and improving the health and wellbeing of occupants.

Low-regrets actions. In other areas, there are more options to decarbonise heat, but it is both feasible and desirable for the Government to press ahead with known solutions. In some cases, the scale of action on these will depend to an extent on other strategic choices that the Government makes.

Heat networks are a proven technology. The Government should increase support for the locations where district or communal heating will be the best option.

- **Low-carbon heat networks.** The Government should increase support for the (mostly known) locations where district or communal heating will be the best option for low-carbon heat. These networks could use either electrical or waste heat; with potential scope for a limited role for hydrogen in the longer term.† The overall viability of these projects will not be significantly affected by any strategic decisions on heat.

- **Energy efficiency in other existing buildings.** Actions which reduce energy waste from buildings will not inhibit the Government's strategic decisions and may simplify them.

  – Efficiency measures can enable electrical heat and reduce energy demand and consumer energy bills regardless of the heating system used. They also provide co-benefits such as increased comfort and better health and wellbeing for occupants.

  – Policies that deliver efficiency measures have limited downsides – the main one is opportunity cost. Advances in low-carbon heat (such as high-temperature heat pumps and hybrids) have reduced the value-for-money, or outright necessity of fabric efficiency measures in some settings. But in others there is still clear value in insulation.

Common barriers that will limit or prevent the adoption of these options at scale are logistical, regulator and policy challenges.

There are some common barriers that will limit or prevent the adoption of these options at scale. These barriers vary in how much they might hinder progress and the extent to which they have already been addressed.

- **Logistical and regulatory challenges**. Ensuring that the technologies are safe, reliable and produce minimal emissions; managing and delivering the transition; funding and financing the costs of new infrastructure and upgrades to existing infrastructure; and managing the development and

* There are some properties not connected to the electricity grid, predominantly in remote rural areas and islands. This is estimated to be less than 0.1% of the UK housing stock. These properties largely rely on diesel generators or renewable microgeneration to produce electricity.

† Waste heat could come from industrial processes, power generation, transport services, wastewater or other sources.

growth of markets and supply chains for low-carbon heat; managing public awareness and the acceptability of low-carbon heat.

- **Policy barriers.** Developing and regulating new business models; ensuring that the planning system supports the deployment of low-carbon heat; and ensuring that any strategic decision on heat aligns with the wider energy security and energy priority needs of other sectors across the UK.

(c) Ways forward on decisions for low-carbon heat

(i) Required characteristics of strategic decisions on heat

Rather than focusing on technologies or scenarios, the Government should consider a range of strategic approaches to heat decarbonisation. The Government can then make progress by narrowing the decision space by expediting the no- and low-regret options we have outlined.

The Government can make progress on strategic decisions before 2026 – it can narrow its decision space by expediting the no- and low-regrets options we outlined above. The remaining decisions will mostly affect existing buildings which fall outside the no- and low-regret categories (i.e. those connected to the gas grid but not connected to heat networks). These buildings could (in principle) use either electricity or hydrogen to produce low-carbon heat.

The Government's strategic decisions about the respective roles of hydrogen and electrification should not be treated as a one-off choice that will determine every aspect of heating out to 2050. Rather, it is important for the Government to see its strategic decisions as a series of choices between different deployment strategies, rather than choices about technology A or B.

The scale of this transition underscores how important it is for the Government to find an approach that enables steady progress at the necessary pace. Doing so will allow the Government to work its way towards the most appropriate solutions for these buildings; minimising the remaining uncertainty ahead of the strategic decision which needs to be taken by (but ideally before) 2026.

Rather than focusing on technologies or scenarios, the Government should consider a range of strategic approaches to heat decarbonisation and find ways to narrow these down. An ideal strategy will meet the following criteria:

1. Provide confidence that the UK can make substantial progress on reducing building emissions by 2030, and reach zero emissions by 2050.

2. Give medium-term clarity for infrastructure and supply-chain development.

3. Form the basis of a fair, deliverable transition that builds and sustains public consent while delivering ever-greater progress.

4. Fit within a strategic approach to reduce the UK's dependence on energy imports and to deliver progress towards the 2040 net exporter target.

This is the start of a long transition and the choices before Government will evolve as markets and sentiments change within the UK and globally. The Government will need to learn as it goes and allow its approach to evolve as conditions change. As it does this, it must ensure that the direction of policies and the timing of decisions are always clear to consumers, businesses and other arms of Government.

All the technology options carry uncertainties. However, uncertainties about the costs, performance and / or roles of technologies should be identified, together with ways to resolve these. In some cases, uncertainty will only be resolved over time or with policy action (e.g. technologies that can only be assessed through real-world attempts at implementation).

Public attitudes are also a key variable, and these will evolve in response to the choices made by Government as well as circumstances outside the Government's control. The Government must sustain public confidence and should treat this as a first-order risk that they must manage as part of their strategic approach.

(ii) Required characteristics for low-carbon heating solutions

Any strategic decisions about building-scale heat will need to assess the characteristics and uncertainties of the technology options.

Any strategic decisions about building-scale heat will need to assess the characteristics of the technology options and address the key uncertainties about them. This includes the respective whole-system costs of different choices. Previous modelling for the CCC does not provide a clear guide to the least-cost solution.[51]

- Use of hydrogen at scale for buildings is likely to entail a significant role for 'blue' hydrogen produced from imported fossil gas with CCS.[49] The costs of this depend heavily on the future price of fossil gas, which cannot be projected accurately on the relevant timescale. Should fossil gas prices remain significantly elevated on a long-term basis, this will adversely affect the costs of hydrogen pathways.

- It is difficult to model the impacts of heat decarbonisation pathways on electricity distribution networks, as data availability is poor on the level of capacity at a local level.

- There are also general uncertainties around technology costs. Since the 2018 modelling for the CCC, costs of renewables have fallen significantly, lowering the costs of systems reliant on zero-carbon electricity.

The CCC considers that the key criteria include: safety, reliability, emissions, affordability, energy security, infrastructure and system requirements, deliverability and readiness, public acceptability and the future of markets.

In our 2018 hydrogen review we advised that it is important for Government to make decisions based on other characteristics, given the relatively close assessment of the system costs of different options.[3] That position remains appropriate.

The Committee considers that the key criteria for making these decisions are:

- **Safety, reliability and public acceptability.** These are fundamental criteria. All low-carbon heating systems must (as a minimum) be safe and reliable. Changing buildings (and homes in particular) requires public trust and consent. Any system which cannot satisfy these criteria must be discounted before any further strategic assessments.

- **Emissions from use and time to deliver abatement.** Low-carbon heating systems should produce close to zero greenhouse gas emissions across their lifecycle. The time taken to deploy an option at scale matters – earlier deployment will minimise additional emissions from fossil fuel combustion.

- **Affordability.** All households and businesses should have options for low-carbon heat where both the initial capital and the ongoing energy costs are affordable and stable.

- **Energy security and energy priority.** The UK needs a secure supply of energy with stable, affordable prices. Strategic choices about heat must support the case for the whole-system decarbonisation and ensure that the UK's limited energy resources are used in the most efficient and effective ways.

- **Infrastructure and system requirements.** Strategic choices on heat should seek to minimise the total cost of providing a secure, reliable supply of low-

carbon energy. This requires appropriate levels of investment in the enabling infrastructure.

- **Deliverability and readiness.** Every low-carbon heating technology needs a clearly-defined delivery model which maximises efficiencies and minimises disruption. The 'readiness' of different options also matters; getting to Net Zero by 2050 will require increasingly rapid delivery of measures.

- **The future of markets.** Consumers cannot be expected to change heating technologies multiple times. The markets for low-carbon heat – and the energy that supports them – need to be stable and resilient to future policy changes or economic shocks at both a local and national level for decades to come. They need to operate at a sufficient scale to ensure ongoing innovation and competition.

Box 5.1 provides a preliminary assessment of the key characteristics of relevance for heat pumps, hydrogen boilers and hybrid heat pump systems. The latter consists of a heat pump that does most of the heating, supplemented by a boiler when necessary (e.g. on the coldest days). Hybrid systems can be installed immediately, retrofitted around existing fossil boilers, cutting emissions sharply (though not to zero), and in time the fossil boiler can be replaced with a low-carbon solution. Options to do so include heat storage, resistive electric heat, or a back-up hydrogen boiler.

Box 5.1
Preliminary assessment of key criteria for electrical heat, hydrogen boilers and hybrids

Safety and reliability.

- These criteria are fundamental. The Government should not consider any type of heating system which cannot prove its safety or reliability.
- **Electrical heat:** Heat pumps, storage heaters, and other forms of resistive heating are all are safe and reliable when installed and operated correctly.
- **Hydrogen:** Hydrogen boilers should be as reliable as conventional fossil gas boilers, but the safety case is unclear and currently in the process of being proven. In particular, the Government needs to assess the additional measures households need to use hydrogen safely, and the costs and disruption associated with installing them.

Public acceptability.

- The Government is proposing to change how we heat buildings on a scale not seen since the 1960s. It needs to engage the public to help them understand the pros and cons of the different heat low-carbon options, building on nascent enthusiasm for Net Zero while learning about (and adapting to) sincere concerns.[52,53]
- Choice underpins acceptability; a key benefit of electrical heat is that consumers have more freedom to choose when to switch over. In contrast, hydrogen-based heat and heat networks require much more local coordination. While 'hydrogen-ready' boilers can mitigate this to an extent, the process of timing neighbourhood switches (from fossil gas to hydrogen) presents non-trivial challenges. The public may also value choices between heat options (e.g. a modern form of smart storage heater which is cheaper to run than a heat pump but has lower efficiency).
- **Electrical heat:** People who have installed heat pumps are generally happy with them. Research by Nesta showed that 70% of households were 'fairly' or 'very' satisfied with their heat pump, and this was unaffected by the age of their property.[54] Running costs were a concern (and the Government must address this, recommendation R2022-063); although gas boiler owners reported even lower satisfaction with running costs (59% satisfied) than heat pump owners (67% satisfied). The Government needs to support the appeal of electrical heat as it scales up.

- **Hydrogen:** The preparations for the village-scale hydrogen trial in Whitby shows how fragile public opinion can be.[22,23] A lack of Government visibility and engagement is undermining public confidence and increasing the risks of project failure. The Government needs to provide more active support to the neighbourhood and village-scale hydrogen trials – standing behind the Local Authority and working to inform the local communities.

Emissions from use and time to deliver abatement.

- **Electrical heat:** Heat pumps and other electrical heat sources produce no direct emissions; and indirect emissions from generation should be largely eliminated by 2035. They deliver emissions savings from the point of installation. The time to deliver abatement is mostly constrained by the size of the heat pump market and its rate of growth.
- **Hydrogen:** Hydrogen boilers produce almost no direct emissions (especially in contrast to methane boilers). However, they may produce some NO_2 and there are likely to be some fugitive emissions of H2, which can act as an indirect greenhouse gas (Box 5.2). Emissions from hydrogen production depend on the source of hydrogen (e.g. from zero-carbon electricity or fossil fuels with CCS). The UK will have limited supplies of hydrogen for the foreseeable future. As such widespread use of hydrogen for heat is unlikely before 2035 and much of the fuel used would likely be 'blue' hydrogen produced from fossil gas with CCS. This would save 60-85% of emissions compared to a fossil gas boiler (on a lifecycle basis).
- **Hybrids:** these can be installed immediately, retrofitted around existing boilers, cutting emissions sharply. Hybrids produce significantly fewer emissions than fossil boilers; but those that include a fossil gas boiler (as opposed to electric resistive) will have ongoing emissions from fossil gas combustion when the boiler is used. In time the fossil boiler can be replaced with a low-carbon solution (e.g. storage, electricity, hydrogen). Hybrid-hydrogen systems may have similar implications for fugitive hydrogen emissions as pure hydrogen boilers.
- **Uncertainties:** The scale of fugitive emissions from hydrogen boilers, hydrogen hybrids, pipework within buildings, hydrogen production and storage facilities, and gas network infrastructure. These have not been quantified for hydrogen boilers. While the heat pump part of hybrid systems can save the majority of space-heating emissions in principle, the proportion they will actually save in practice is subject to uncertainty.

Affordability (Opex and Capex)

- **Electrical heat:** The upfront costs for heat pumps are high and rose in the past two years before falling in 2022 (Figure 5.2i). Reducing these costs is a core aim of the Government's Clean Heat Market Mechanism.[14] Other forms of electrical heat, such as resistive or storage heating, are generally much cheaper to install. The cost of installing a heat pump (to replace a boiler) is often more costly because it includes other upgrades to the heating system. Subsequent end-of life replacements of one heat pump with another will be cheaper. Electrical heat (powered by renewables) should be cheaper than any fossil gas or hydrogen option – however policy choices and energy market arrangements mean that this is not currently the case (Figure 5.2e).
- **Hydrogen:** Capex for hydrogen boilers is likely to be broadly similar to fossil boilers, but their much lower efficiency across the energy chain means that hydrogen is and will remain more expensive than heat pumps. Hydrogen use at scale for buildings is likely to require a substantial contribution from blue hydrogen based on imported fossil gas. This raises the risk that the running costs of hydrogen boilers could be subject to considerable market volatility.
- **Hybrids:** The affordability of hybrids is influenced by a range of factors. They were the lowest-cost option trialled by the Electrification of Heat Demonstration Project – with an average system cost of £10,200.[19] Hybrids can be cheaper than regular heat pumps because many do not require additional thermal storage as part of the system upgrade. But they are currently more expensive to install than fossil gas boilers, and in some settings can be more expensive than heat pumps.

- **Uncertainties:** The extent to which the capital costs of heat pumps and hybrids can be reduced through market processes is currently unknown. Similarly, we do not have precise estimates for the costs of hydrogen supply, with its implications for the operating costs of low-carbon heat.

Energy security and energy priority.

- **Electrical heat:** Using zero-carbon electricity to drive heat pumps provides around four times the benefit compared to its use to produce hydrogen for boilers, when considering both system-wide emissions reductions and reductions in fossil gas use (Figure 5.9)
- **Hydrogen:** The UK is unlikely to be able to produce enough non-fossil hydrogen to meet domestic demand significantly before 2040, and there are higher-priority use cases than heat. Even by 2050 the UK may need to import some energy to meet hydrogen demands, especially in higher-hydrogen scenarios, whether imported as fossil gas (for domestic conversion to hydrogen with CCS), zero-carbon hydrogen or zero-carbon electricity.
- **Uncertainties:** The scale and nature of future global markets for hydrogen is unknown, as is the potential scale of UK's exposure to them and any price volatility that might follow.

Infrastructure and system requirements.

- **Electrical heat:** The no- and low-regrets options outlined above, along with the mass electrification of surface transport and industry, imply a significant expansion of the UK's transmission and distribution grids for electricity. Already there are parts of these networks which cannot accept new connections because they are at capacity.[55]
  - Additional demand for either electricity or hydrogen will sit on top of this baseline; depending on the policy choices made by the Government. For electrification any added demand will require more renewables and grid capacity.
- **Hydrogen:** In the case of hydrogen there will be a baseline level of infrastructure investment needed to meet the demands of a reliable decarbonised power system. This includes electrolysers, storage, and any network upgrades required to transport hydrogen and minimise leakage. Additional demand will require more of this infrastructure. Unless the Government elects to use imported hydrogen, additional renewable electricity capacity to supply electrolysers would also be required.
- **Hybrids:** These will have lower peak electricity demands than pure heat pumps, implying that grid constraints would be less of barrier in the near term and that some upgrade costs could be avoided in the longer term. Deployment of hybrid heat pumps that later switch the boiler to hydrogen would still require hydrogen pipeline and storage infrastructure similar to that for full hydrogen use. However, the volumes of hydrogen required would be several times less, reducing the need for hydrogen production capacity and energy imports.
- **Uncertainties:** The speed at which network infrastructure can be identified, navigated through planning processes and delivered by relevant supply chains is uncertain. The Government recognises that electricity transmission capacity currently presents a particular risk to the ability to access and utilise available low-carbon electricity. Whether it would be best to deliver hydrogen transmission and distribution capacity via conversion of existing natural gas grids or via entirely new capacity remains unclear (e.g. due to uncertainty over whether embrittlement issues could mean conversions are not possible).

Deliverability and readiness.

- **Electrical heat:** While heat pumps are a mature technology, the current delivery model is not working well and may not scale to deliver tens or hundreds of thousands of units annually. The Electrification of Heat Demonstration Project concluded that the majority of UK housing types are suitable for heat pumps; this suggests that deployment could be going substantially faster. Energy companies are showing increasing confidence in heat pumps; British Gas recently offered a guarantee that heat pumps they install will operate as well as a boiler.[56]

- **Hydrogen:** The delivery model for hydrogen is well understood within individual buildings. The process is close to (but not exactly the same as) a like-for-like swap with an existing fossil boiler. However, the process to switch entire neighbourhoods over from fossil gas to hydrogen is less well understood. The switchover from town gas provides a precedent, demonstrating that a nationwide transition is possible; but there are new and specific logistical challenges that need to be assessed.[57] This is a key goal of the Government's neighbourhood and village trials.
- **Uncertainties:** Exactly how whole neighbourhoods will be switched over to hydrogen, and how this will be coordinated at a regional and national scale, is uncertain. Exactly how innovation can lower capital costs and improve deliverability of electrical heat and hybrid heating systems also remains to be seen.

The future of markets.

- The Government needs to consider the risks to local markets where low-carbon heating systems rely on major point-sources to anchor either supply or demand. It should consider the potential need for assurances that those anchors will not disappear in the future – and mitigations in case they do.
- There is significant uncertainty about the future scale of regional or global hydrogen markets. Whether they will be sufficiently large and diverse to ensure stable low prices and meet demand remains to be seen.

Box 5.2
Recent evidence on the indirect warming effect of fugitive hydrogen

There is increasing evidence relating to hydrogen's role as an indirect greenhouse gas.

While hydrogen is not a strong absorber of infrared radiation and does not directly contribute to the greenhouse effect itself, it interacts with other chemicals in the atmosphere that then leads to an increase in the atmospheric lifetime of other greenhouse gas emissions.

Hydrogen reacts with, and consequently depletes, hydroxyl radicals in the earth's atmosphere, which play an important role in reducing the lifetime of methane. Increased levels of hydrogen in the atmosphere then reduce the ability of the hydroxyl radicals to control methane, indirectly increasing the warming effect of methane in the atmosphere.

While this effect has previously been considered at the troposphere – the lowest layer of the earth's atmosphere – new evidence has explored the effect at the stratosphere – the second lowest layer of the earth's atmosphere – and estimates that the GWP of hydrogen may be higher than initially thought.

Greater attention may therefore need to be given to hydrogen leakage and its role offsetting some of the benefits of a hydrogen-based economy. However, it is currently not possible to quantify hydrogen leakage and its scale is therefore uncertain.

The recent evidence has not yet been considered in our analysis and will be explored in further detail in our future work.

Source: BEIS (2022) *Atmospheric implications of increased hydrogen use*; Frazer-Nash Consultancy (2022) *Fugitive hydrogen emissions in a future hydrogen economy.*

Heat networks are also a key tool to decarbonise heat, and other technologies may also play a limited role. The Government needs to also consider these within its overarching approach.

- **Heat networks** are a mature, safe and reliable technology. Most existing networks use fossil gas; but low-carbon heat sources will be the norm for all new networks, and retrofits of existing ones.

  - Electrical heat will likely be the most common source, with options to use some hydrogen; waste heat has some limited use, but is highly location-dependent. The emissions profile for a heat network depends on the heat source used.

  - They are large, capital-intensive infrastructure projects. In principle networks can deliver some of the lowest-cost heat; but consumers are not currently protected by the energy price cap (although the Energy Security Bill aims to address this).[27] Networks can incorporate heat storage and provide flexibility which could support a lower-cost energy system.

  - While there are existing business and delivery models for heat networks, they can be difficult to implement in practice. The ongoing issue of high capital costs does limit the ability to deliver them nationwide at scale.

- **Electrical resistive heating and biofuels** are alternatives to hydrogen for hybrid heat pumps. These options have limited uses in some property types. Biofuel hybrids may help off-gas homes where electrical heat cannot meet peak demands for heat on the coldest days. However, ongoing improvements to high-temperature heat pumps may render these systems obsolete. These options will not see widespread use and should not have a significant bearing on the Government's strategic decisions.

- **Blending of biomethane and hydrogen** (the latter at up to 7% by energy) could have a small, transitional role in decarbonising gas supplies while markets for other options grow to maturity.[58,59]

  - The primary value of doing so is to provide a near-term market for these fuels, reducing investment risks to production capacity.

  - However, there is a risk that promotion of these alternative fuels could reduce consumers' sense of urgency about the need for low-carbon heat, or create confusion about the relative merits of the options.[48]

- **Solid biomass**, outside of some very limited situations, using the UK's limited supplies of biomass for heat is an inefficient option. The best uses for bioenergy in a Net Zero Energy system are to combine it with the use of CCS in the production of hydrogen, electricity, industrial products and potentially also aviation biofuels.

(iii) Narrowing the options

We recommend the Government prioritises early decisions and action, public engagement, electrification as a default, support for hybrid heat pumps, a narrowed role for hydrogen for heating, regulation for boiler replacements and Governance framework for energy planning.

Rapid and forceful pursuit of the no- and low-regrets options outlined in section (b) will reduce emissions and cut fossil fuel dependence this decade, while also helping to develop the supply chains and public acceptance that are crucial enablers for subsequent acceleration of electrified heating solutions.

In addition, the Government should now seek to narrow the solution space for on-gas properties. We recommend that it does the following:

- **Early decisions and action.** The Government should prioritise pace over perfection in progressing heat decarbonisation. This means taking decisions now that can enable rapid progress this decade and narrow the scope of future decisions.

  - The Government should clearly affirm that all buildings (new and existing) which are off the gas grid – and outside areas of high potential for heat networks – will use electrical heat. It should unambiguously rule hydrogen out for these properties; and it should rule that new buildings should not be connected to the gas grid (priority recommendation R2023-190).

  - It must also sustain funding for energy efficiency and low-carbon heat measures in fuel-poor and social homes. And it should increase support for the development of heat networks.

Public engagement is essential for the heat transition. The Government needs to lead here, using a multi-year campaign to raise awareness, provide information, and build trust.

- **Step up public engagement.** The Government should engage the public to improve their understanding of low-carbon heat, its benefits, and the choices they will be able to make.

  - The number of homes installing low-carbon heating needs to rise from thousands annually to hundreds of thousands annually during this decade. This can only be done with the consent of a well-informed public. The current approach is largely business-led, but the Competition and Markets Authority (CMA) has raised concerns about some of the claims being made and conflicting messages.[48] These are compounded by a general lack of information which makes it harder for consumers to make decisions; and may put them off from buying low-carbon heating products.[60] The Government has an institutional role here, to guide people through this transition.

  - The Government has managed major transitions before – one example is the highly successful switch-over from analogue to digital TV. It will need a similar approach to public engagement here. The Government should initiate a multi-year, nationwide campaign to set expectations, guide people to support and advice (such as DESNZ's proposed one-stop shops), and provide trusted information and testimonials about the costs, benefits and co-benefits associated with the transition to heat (recommendation R2023-193).

  - Public engagement is essential, and the direction of this engagement will both depend on, and feed into, the Government's strategic decisions. In particular, messaging about the local or regional potential for hydrogen would be beneficial.

  - In addition to information, the Government also needs to ensure that it uses policy levers to ensure that consumers have real choices for low-carbon heat; and that all the options are safe, reliable and affordable.

- **Embrace electrification as the default solution for buildings**. The efficiency and readiness of heat electrification solutions means that, from a strategic perspective, pushing forward with heat electrification should be the default choice where it is feasible. The Government should affirmatively embrace electrical heat now as widely as possible, and address barriers to uptake including permanently rebalancing prices of electricity and gas and remove unnecessary planning constraints such as the 'one-metre' rule.*

* Heat pumps are currently covered by permitted development rights. However, the rules state that they must be installed at least one metre from the property boundary (or from the edge of a flat roof). Many properties cannot currently meet this requirement (a legacy from older heat pumps which could be noisier than newer models).

- **Support hybrid heat pumps.** In areas where network capacity limits the scale of possible near-term deployment for full heat pumps, hybrid heat pump systems – which have lower peak electricity demands – can provide a solution until grid operators can complete network upgrades. These solutions can also offer more rapid uptake of electrified heat, given the ability to retrofit such solutions around existing boilers rather than wait until they stop working, and help develop public acceptance of heat pumps (recommendation R2023-194).

- **Publicly narrow the potential role for hydrogen.** The potential value of hydrogen in buildings decarbonisation lies in helping to cope with peak energy demand on the coldest days and in decarbonising those buildings for which there are no other viable solutions. It would aid clarity on buildings decarbonisation for the Government to make such a statement.

  – While the evidence does not currently support ruling out any future role for hydrogen, the planning assumption should be that hydrogen is limited at most to a back-up role in hybrid heat pump systems and only in limited areas of the country.

  – The decision to limit the role for hydrogen to this size, at most, would mean that any hydrogen roll-out could be compressed into a shorter period than is currently being considered (i.e. mostly in the 2040s). In turn, this would mean it could start later, allowing a greater role for non-fossil hydrogen – with less reliance on a transitional role for hydrogen based on fossil fuels with CCS – and a proper window for electrification to be attempted at scale.

  – Regions of the country should be identified with high, low or no potential to use hydrogen on a whole-system and economy-wide basis. The Government should use this information to guide low-regret investments that can proceed immediately; for instance, taking decisions now on the electrification of some regions and upgrading networks and targeting policy for electrified heat and energy efficiency to support this (priority recommendation R2023-128).

- **Consider regulation for boiler replacements**. The EU is planning to use product standards for heating systems to create a de-facto mandate that all boiler replacements from 2029 must have significantly lower emissions than a fossil fuel boiler. Other countries (such as Netherlands and Germany, which make widespread use of fossil gas for heat) have gone further (Box 5.3). The UK Government should consider similar policies to ensure that timely progress is made on moving away from fossil boilers.

- **Governance framework for energy planning.** A clear process and governance framework should be established for energy planning across national, regional and local levels (priority recommendation R2023-176). This should consider a role for local plans to take decisions on electrifying, where there is public support for doing so, and where this can be accommodated through existing networks or network upgrades.

- **A fair, deliverable transition.** Alongside necessary actions to engage the public, it will be essential to ensure that the transition to low-carbon heating is affordable. There are choices over the long-term balance of subsidies, grants, obligations, regulation and carbon pricing, but there must be an underlying principle that choosing the low-carbon option does not leave people worse off.

Box 5.3
Other countries' mandating of lower-carbon heating systems

Other nations are taking similar strategic decisions about building-scale heat. In some countries this is more straightforward – in Denmark 65% of homes are already connected to a heat network,[61] so the only action is to ensure that the network's heat source is low-carbon. Others are more like the UK and depend on gas for heat in buildings.[62] Some of these countries are exploring the potential of hydrogen – primarily for power generation, heavy surface transport, and industrial uses. Most of these countries are focusing on electrification for building-scale heat.

- The Netherlands is the only country in Europe which depends on fossil gas for heating more than the UK (89% vs 84% in 2018).[62] The Government is planning to mandate that households must replace fossil boilers with a heat pump or hybrid from 2026.[63] It has allocated around €7.5 billion to support the development of hydrogen – mostly through investment in electrolysers – and €750 million to develop a national hydrogen transport network.[64,65] The main focus is to deliver enough green hydrogen to displace fossil gas in the Netherlands' power system by 2035. The Government has not ruled hydrogen out for building-scale heat, but it is not (currently) prioritising it.[66]
- Germany relies on fossil gas for around 50% of its heating and hot water demand.* Its Government has introduced legislation to ban all new fossil heating systems from 2024. This law would require all new heating systems to use at least 65% renewable energy, implying widespread use of heat pumps and hybrids.[67,68] The law may permit hydrogen-ready boilers which would initially run on biomethane, then at least 65% hydrogen from 2035.[69]

* 2018 figures.

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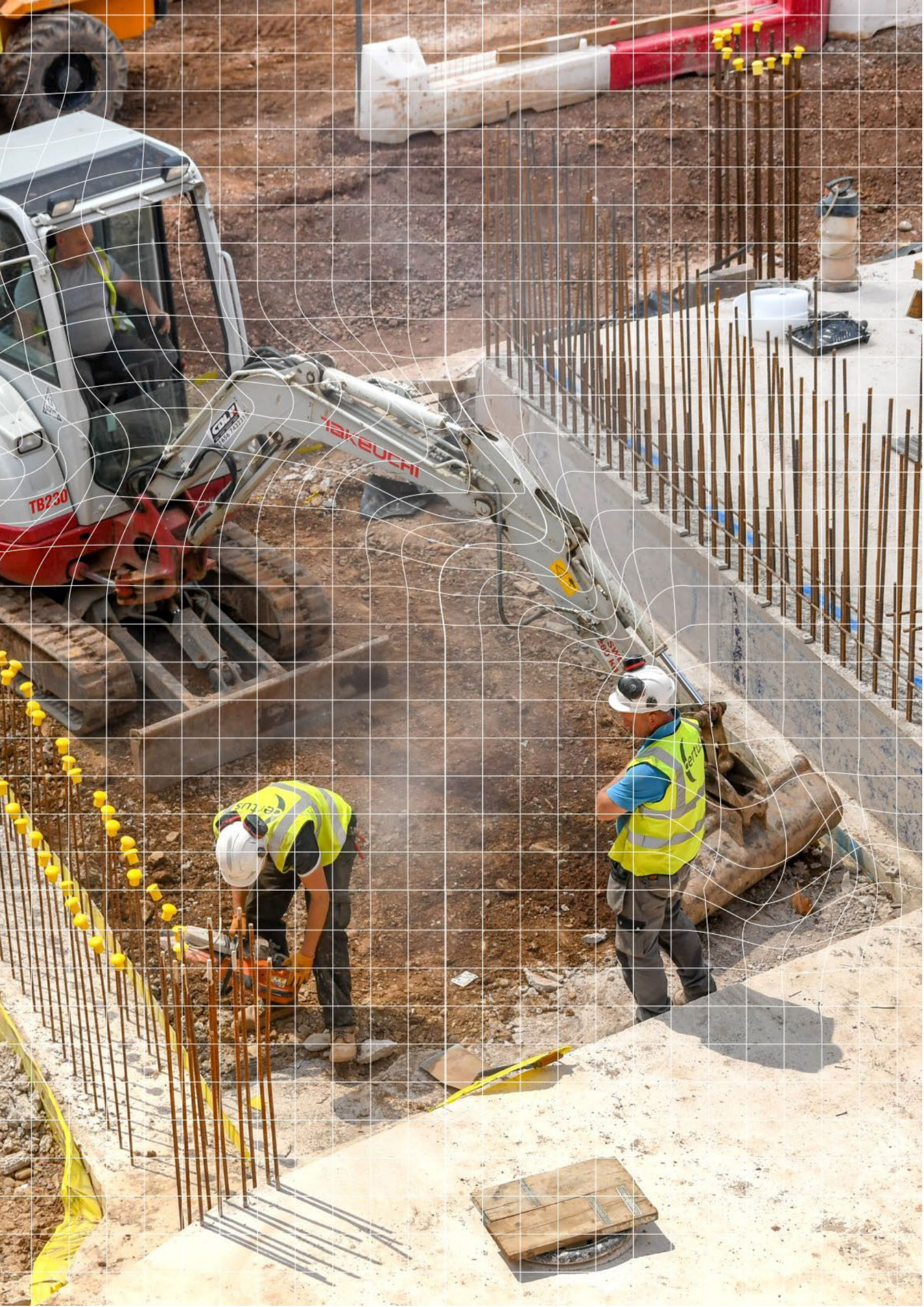
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63 $MtCO_2e$, 14% of UK emissions in 2022

Introduction and key messages

Industry* remains the UK's third highest-emitting sector. The Government's Carbon Budget Delivery Plan (CBDP) targets a reduction in industrial emissions of 69% by 2035, relative to 2022 levels.[1]

The CBDP provides more detail on the expected level of abatement from different policies. The plan includes the same abatement strategies as the CCC's Balanced Pathway, and projects a similar level of overall emissions reductions by the end of the Sixth Carbon Budget period, though with smaller reductions in earlier years. However, the CBDP relies less on energy and resource efficiency and more on carbon capture and storage (CCS). Over the Sixth Carbon Budget period (2033-2037), the CBDP sees an annual average abatement in industry of 6.6 $MtCO_2e$ from CCS, compared to 5.3 $MtCO_2e$ in the CCC pathway.

Our assessment of progress shows there are significant risks to decarbonisation of industry. We find there are 'insufficient plans' for most of the abatement projected in the CBDP for the Fifth and Sixth Carbon Budgets. The risk is higher than in last year's assessment due largely to a continuing lack of progress in the major areas we have previously highlighted, as summarised under 'Policy gaps' below. In particular, the need for greater action to support electrification has become even more critical now the Government has made clear it expects the steel sector to decarbonise through electrification.

Our key messages are:

- **Emissions.** The UK's industrial emissions fell by 3% in 2022 to 63 $MtCO_2e$. The pace of industrial decarbonisation will need to speed up in the next decade to meet the Government's ambition for this sector. The CBDP sees industrial emissions fall by 8% on average annually between 2022 and 2030.

- **Competitiveness.** As UK industry decarbonises it will face two risks related to international competition. The first is the risk of carbon leakage – the relocation of production to countries with fewer restrictions on emissions. The Government is consulting on potential policies to address this risk, including a carbon border adjustment mechanism (CBAM), mandatory product standards and emissions reporting requirements. The second risk is that companies investing in industrial decarbonisation overlook the UK in favour of countries providing greater policy support. This risk is growing due to measures such as the United States' Inflation Reduction Act and the EU's proposed Green Deal Industrial Plan. The UK must carefully design industrial policy to minimise carbon leakage and incentivise investment in the UK.

- **Policy progress** on industrial decarbonisation continues to focus on industrial CCS and hydrogen. In these areas there has been progress on business models, funding allocation and identification of potential early projects. The Government also announced up to £20 billion of largely new funding to support deployment of carbon capture, usage and storage (CCUS) over the next 20 years. This will help to deliver the Government's targets of 6 $MtCO_2$ of industrial CCS annually by 2030 and 9 $MtCO_2$ by 2035. Despite this progress, there remain some risks to delivering these solutions at the scale and speed required. There is also still no clear plan for incentivising CCS and hydrogen outside the 'Track 1' and 'Track 2' clusters.

* Industry was called 'manufacturing and construction' in the CCC's 2022 Progress Report. The scope remains the same but we are referring to the sector as 'industry' to align with the Government and other stakeholders.

- **Policy gaps**. Overall UK policy is not yet sufficient to achieve the level of industrial decarbonisation needed to meet the Sixth Carbon Budget. Although there has been some progress in the following four areas where last year's progress report identified significant policy gaps, it is insufficient. This is a major factor in our assessment that there are significant risks to decarbonising industry at the required speed:

  - **Industrial electrification.** There is still no clear plan to support industrial electrification and little evidence that industry is preparing to electrify at scale. The lack of policy is particularly evident in the steel sector, where the CBDP makes clear that the Government expects electrification to have a major role. Barriers include the price of electricity, cost and difficulty of upgrading network connections and, for some industries, uncertainty about the most appropriate fuel-switching technologies. One important development was the announcement of British Industry Supercharger – a plan to exempt energy-intensive industries from a range of levies on electricity. However, further measures will be needed to reduce the price of electricity to a level that encourages industrial electrification.

  - **Resource efficiency.** The Government expects significant industrial emissions reductions from resource efficiency. However, there is a lack of policy to support this on the required scale. The Government has indicated it will strengthen policy in this area and has commissioned work to improve its understanding of the range of options. These insights must be developed into concrete policies at pace.

  - **Off-road mobile machinery.** There continues to be a lack of policy or strategy to support the decarbonisation of off-road mobile machinery. The Government has commissioned a study of decarbonisation options for the sector and plans to issue a call for evidence later in 2023 before starting work on a decarbonisation strategy.

  - **Small and dispersed sites.** There is a lack of policy targeting the decarbonisation of dispersed sites outside industrial clusters. The £5 million Local Industrial Decarbonisation Plans competition is a positive step, but a small one given the size of the task. There is no clear strategy for decarbonising small facilities not covered by the UK ETS, which represent around 40% of industrial emissions.

- **Private-sector commitments.** Decarbonisation of industry is particularly reliant on private-sector action. It is therefore encouraging that companies in this sector are increasingly setting public emissions reduction targets. However, our analysis shows that current targets fall far short of what is required (Figure 6.2k), suggesting the need for Government to incentivise more ambitious corporate commitments.

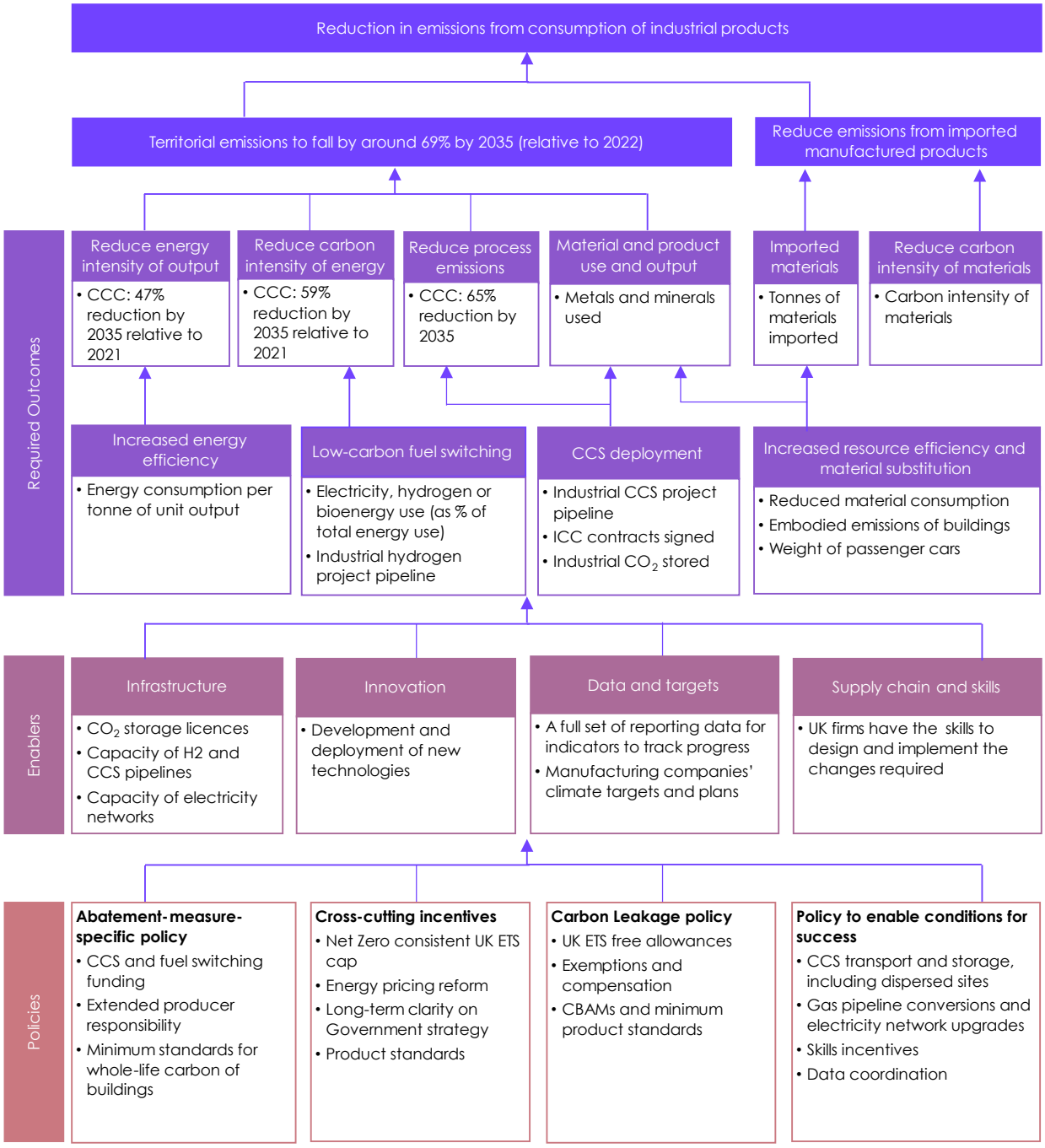
- **Data availability.** There continues to be a lack of available data in this sector, critically limiting monitoring, evaluation and policy implementation. As we recommended last year, the Government should review, invest in and reform industrial decarbonisation data collection and reporting.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 6.1 Monitoring map for industry



Source: CCC analysis.
Notes: Numbers are from the Government's Carbon Budget Delivery Plan unless stated otherwise.

The CCC's monitoring map for industry (Figure 6.1), sets out the policies, enablers and required outcomes for a successful transition. This report focuses on 11 key indicators, with additional indicators available in the supplementary material presented alongside this report. Our Monitoring Framework documents the full list of indicators we track and our approach for assessing progress.

The indicators of progress for industry show a mixed picture (Figure 6.2), implying that progress will not be sustained without further policy intervention. This finding is consistent with our assessment of policies and plans (section 6.2). Important aspects of industrial decarbonisation are difficult to track due to insufficient data. Our Monitoring Framework highlights these data gaps.

The pace of industrial decarbonisation needs to speed up significantly to meet the Government's ambition.

Territorial emissions. A provisional estimate of direct territorial emissions from industry is 63 $MtCO_2e$ in 2022, a 3% reduction from 2021 (Figure 6.2a). This reduction is likely driven by a decline in manufacturing output, which fell by 4% between 2021 and 2022.[2] The pace of decarbonisation will need to speed up significantly over the next decade to meet the Government's ambition for decarbonisation in this sector.

- The sector's emissions come from a diverse range of subsectors and different combustion and non-combustion processes (Figure 6.3). The fall in 2022 was driven by emission reductions in chemicals (6% reduction), food and drink (7% reduction), and other manufacturing (5% reduction). Emissions reductions were achieved in all sub-sectors except iron and steel where emissions increased by 5%.

- Industrial emissions fell by 17% from 2014 to 2022, an average reduction of 2% each year. The Government's CBDP pathway sees industrial emissions fall by an annual average of 8% between 2022 and 2030.

According to the Government's pathway, industrial emissions need to fall by an average of 8% each year between 2022 and 2030.

Indirect industrial emissions. Industry's indirect emissions from the consumption of electricity were 17 $MtCO_2e$ in 2021, a 12% increase relative to 2020, a rebound likely related to the pandemic. Over the longer term, the sector's indirect emissions have fallen sharply from 38 $MtCO_2e$ in 2014 to 15 $MtCO_2e$ in 2020. This fall is driven largely by the ongoing decarbonisation of the UK's electricity system.

Drivers of emission reductions over the past decade. From 2012 to 2021, total CO_2 emissions from industry – both direct and indirect – fell by 29% (Figure 6.4).*

- **Overall changes.** The fall in emissions over the past decade happened despite a rise in industrial output (measured by GVA) of 2% relative to 2012, which was offset by improvements in the energy-intensity of industry and a structural shift towards a less carbon-intensive mix of industrial output. About half of the reduction was due to the lower emissions-intensity of grid electricity.

- **Differences in traded and non-traded sectors.** Within the traded sectors – those covered by the UK ETS – CO_2 emissions have fallen by 30% between 2012 and 2021– slightly more than in industry as a whole. This was driven by improvements in energy-intensity offsetting increases in industrial output. In the non-traded sector, the decrease in emissions was 27%, slightly lower than in industry as a whole and predominantly driven by decarbonisation of the electricity system.

* Based on analysis commissioned by the CCC in 2014 and updated with data to 2021. The model considers changes in overall output (GVA), energy-intensity, fuel mix, process emissions and structural effects. Further details are available at: https://www.theccc.org.uk/wp-content/uploads/2014/07/Project-Report-FINAL.pdf

Most of the emissions related to industrial goods consumed in the UK are related to imports manufactured overseas.

Consumption emissions. Emissions from the supply chains of UK businesses, regardless of where they occur, continued to be substantially more than territorial industrial emissions in 2019 (the most recent year for which consumption emissions data are available). In 2019 emissions from consumption of industrial products decreased 2% relative to 2018, to 157 $MtCO_2e$ (Figure 6.2b).

Industrial process emissions. Emissions from industrial processes – those arising from a range of chemical reactions, such as from the calcination of limestone for cement, rather than combustion – increased slightly in 2022 to 10.2 $MtCO_2e$ (Figure 6.2c). Process emissions have been stable for the past 10 years and will need to start falling rapidly to meet emission reduction targets. In the CCC Balanced Pathway process emissions fall by an average of 9% each year between 2023 and 2037.

The data does not show that industry is switching from fossil fuels to electricity or low-carbon hydrogen. Bioenergy use has risen since 2011, but we are unable to assess whether this limited resource is being well used.

Fuel switching. Progress in low-carbon fuel switching is limited, with the percentage of electricity use in industry decreasing to 24% in 2021 while the percentage of bioenergy use has stalled at 13% since 2020. Industrial electricity use and hydrogen uptake need to accelerate. The Government has not set out a specific level of ambition for fuel switching for each fuel type – we therefore compare current uptake to our own pathways.

- **Electricity.** Industrial electricity use (Figure 6.2d) is slightly behind the CCC's recommended pathway. Despite electricity use increasing 2% between 2020 and 2021, to 85 TWh, this increase has been outpaced by increases in fossil fuel use. Industrial use of natural gas increased 10% and the use of petroleum increased 3%. We are unable to establish the cause of changes in electricity use with current data.

- **Hydrogen.** UK industry currently uses around 700 kt annually of hydrogen as a process gas.[3] Existing hydrogen production is carbon-intensive, and there is currently no industrial use of low-carbon hydrogen either as a fuel or as a process gas (Figure 6.2e). Low-carbon production will need to ramp up in the next two to three years. We currently lack the data to assess whether the project pipeline is sufficient to meet expectations for low-carbon use in industry (Figure 6.2h).

- **Bioenergy.** Bioenergy use (Figure 6.2f) is ahead of the CCC's pathway and rose at a fast rate between 2011 and 2021. It is not clear what has driven the increase. The CCC pathway – and stated Government policy – sees a limited role for bioenergy in fuel switching, predominantly in industries that already make use of bioenergy (e.g. cement and pulp) or those with the potential to fit CCUS. Much of the increase over the last decade has been driven by 'other industries' and it is difficult to assess if this is the best use of this limited resource.

Carbon capture and storage. Beyond 2025, industrial decarbonisation depends heavily on CCS. According to publicly-available information, the current pipeline is insufficient to meet the Government's target of 6 $MtCO_2$ by 2030. However, we recognise that not all projects in development have been made public, so we have noted this as a data gap (Figure 6.2g).

Energy efficiency. Progress in energy efficiency is difficult to track due to insufficient data. The data available, including on the drivers of emission reductions set out above, suggest that energy efficiency is improving, but it is unclear whether this is in line with Government targets.

- Energy consumption per unit of industrial GVA (Figure 6.2i) fell in 2021 compared to 2020. This improvement follows a decline in industrial energy efficiency between 2019 and 2020, likely brought about by underutilisation of plants during the pandemic. Energy consumption per unit of GVA is slightly lower than pre-pandemic (2019) levels but will need to improve significantly to achieve the Government's ambitious energy efficiency emission reductions.

Climate Change Agreements have contributed to reductions in energy use and emissions.

- The Government's evaluation of the Climate Change Agreements scheme shows it has contributed to improved energy efficiency in industry. The analysis estimated the scheme led to annual energy savings of 1.2-2.3 TWh per year in 2017 and 2018, equating to carbon savings of 0.3-0.7 $MtCO_2e$ per year.[4]

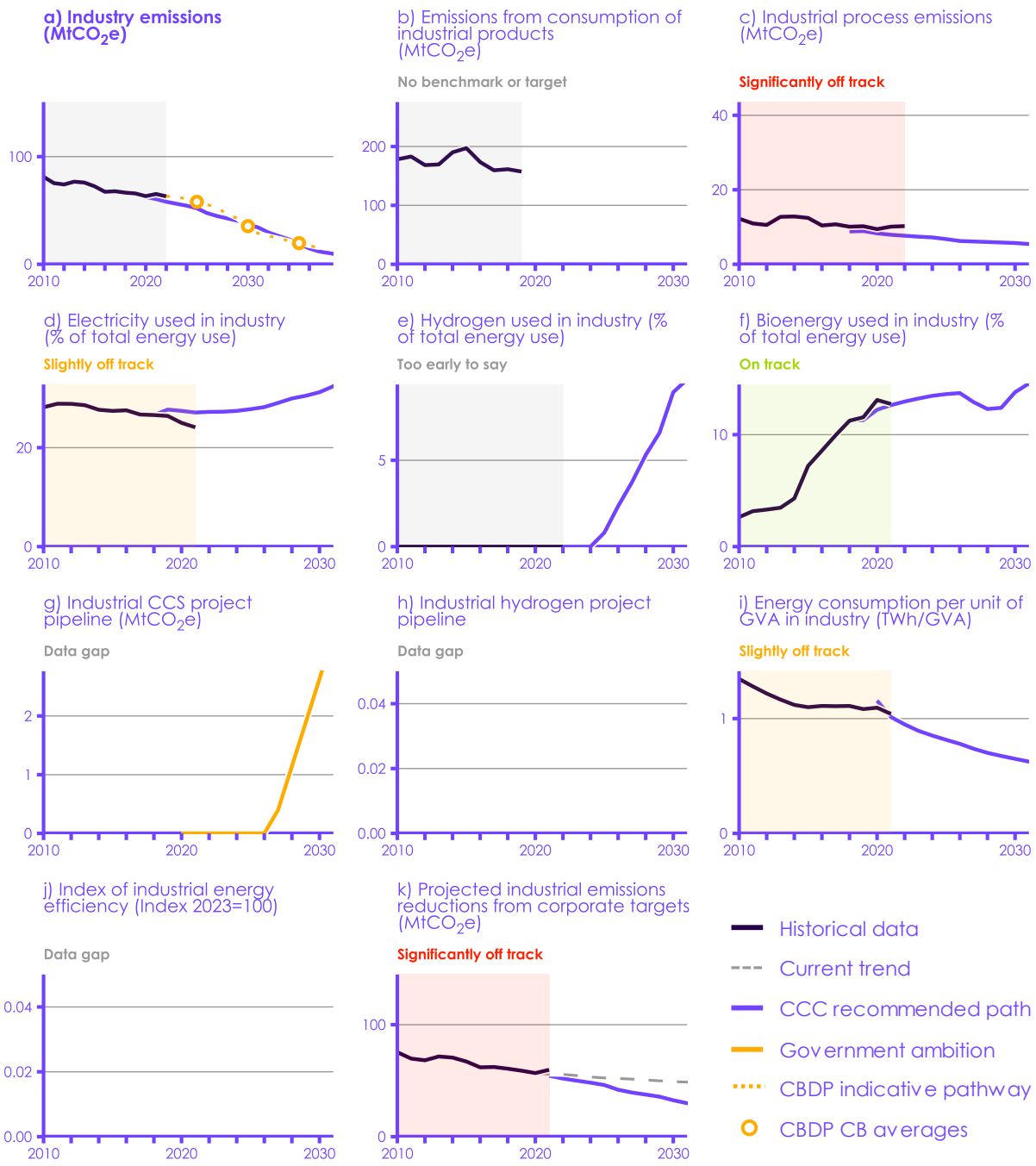
- One potential way to better track energy efficiency changes, would be to measure the energy-intensity of a fixed 'basket' of industrial products. We recommend that the Government defines a benchmark or target for this indicator (recommendation R2023-158).

Many UK manufacturing companies have public emissions reduction targets. However, even if all these targets are met, the aggregate reduction would fall far short of what's needed.

Private-sector targets. Companies increasingly disclose emissions reduction targets, often verified through schemes such as the Science Based Targets initiative. The CCC has commissioned analysis to model how such corporate targets align with our Balanced Pathway for industrial decarbonisation (Figure 6.2k).[5] We find that, in aggregate, if manufacturing companies meet their targets, it would result in a reduction in emissions equivalent to 32% of the reduction in the CCC Balanced Pathway by 2030, and just 19% by 2050.*

* This analysis includes emissions from manufacturing but not off-road mobile machinery. The corporate targets projection includes emissions reduction targets of companies for which site emissions are included in the National Atmospheric and Emissions Inventory, accounting for 70% of UK manufacturing emissions.

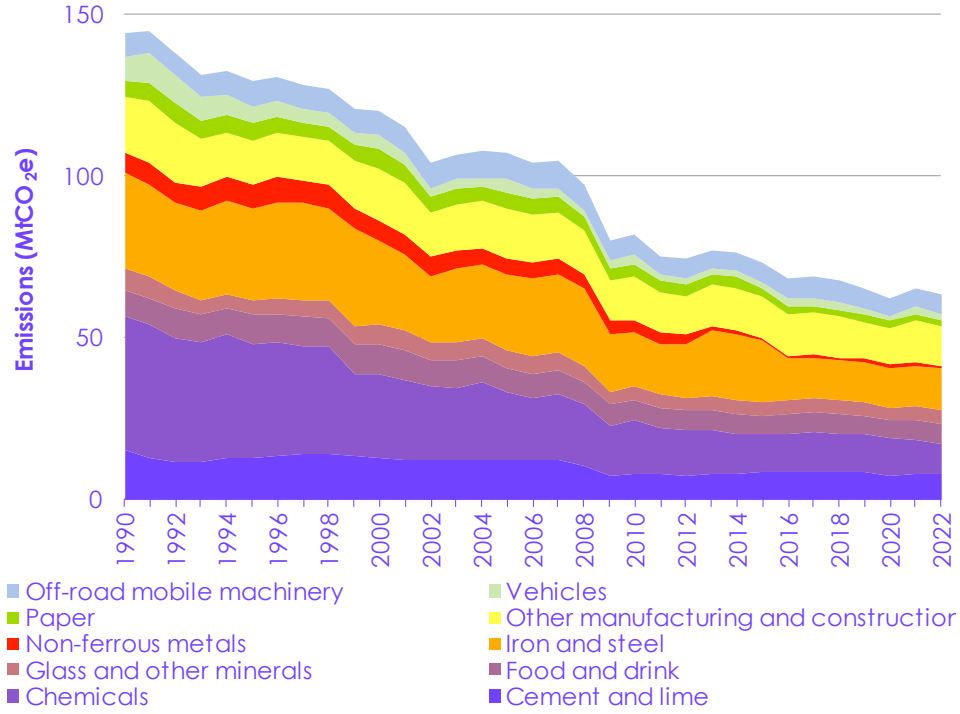
Figure 6.2 Key indicators for industry



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path and considering the wider contextual factors that may have a temporary impact (e.g. recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (3) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions.

UK territorial emissions in industry have fallen by an average of 3% per year since 1990. Emissions were 63 $MtCO_2e$ in 2022, a 3% reduction from 2021.

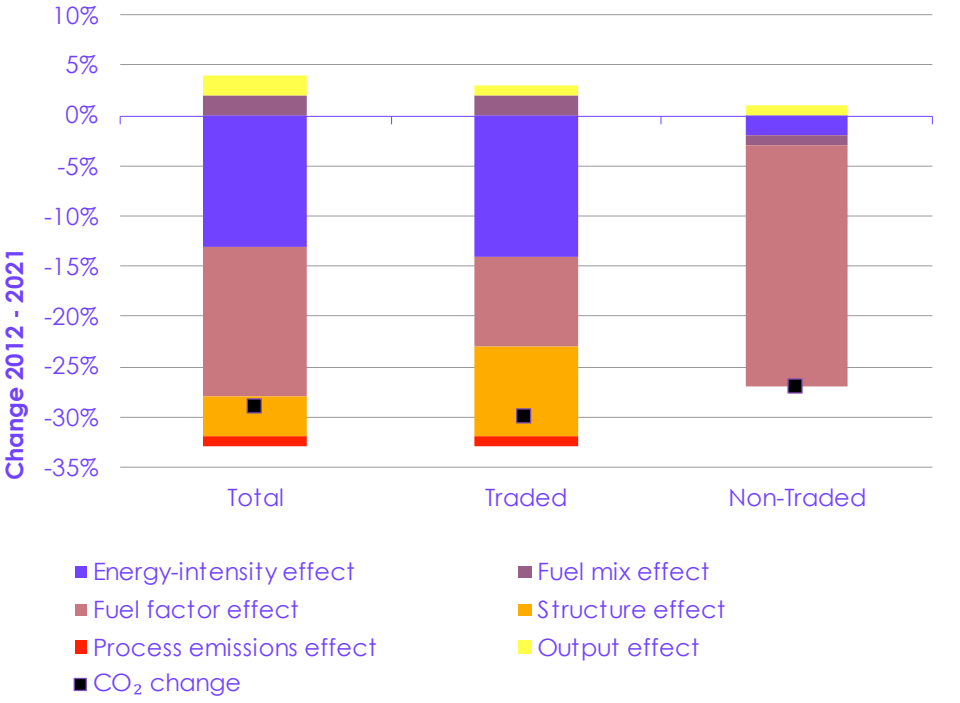
Figure 6.3 Industry emissions by sub-sector (1990-2022)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*
Notes: Figure excludes emissions from refineries. Data are provisional and subject to change.

Between 2012 and 2021 CO_2 emissions from industry – both direct and indirect – fell by 29%. This was due to improvements in energy-intensity, grid decarbonisation and a less carbon-intensive mix of both fuels and industrial output.

Figure 6.4 Drivers of emissions reductions in manufacturing



Source: CCC analysis of updated 2023 modelling from Ricardo using methods described in the report noted below.
Ricardo (2014) *Drivers of Industrial Carbon Dioxide Emissions and Energy Use: a decomposition analysis.*[6]

There is a continuing lack of progress in major areas of industrial decarbonisation. In the Sixth Carbon Budget period 70% of planned abatement is at significant risk or insufficient.

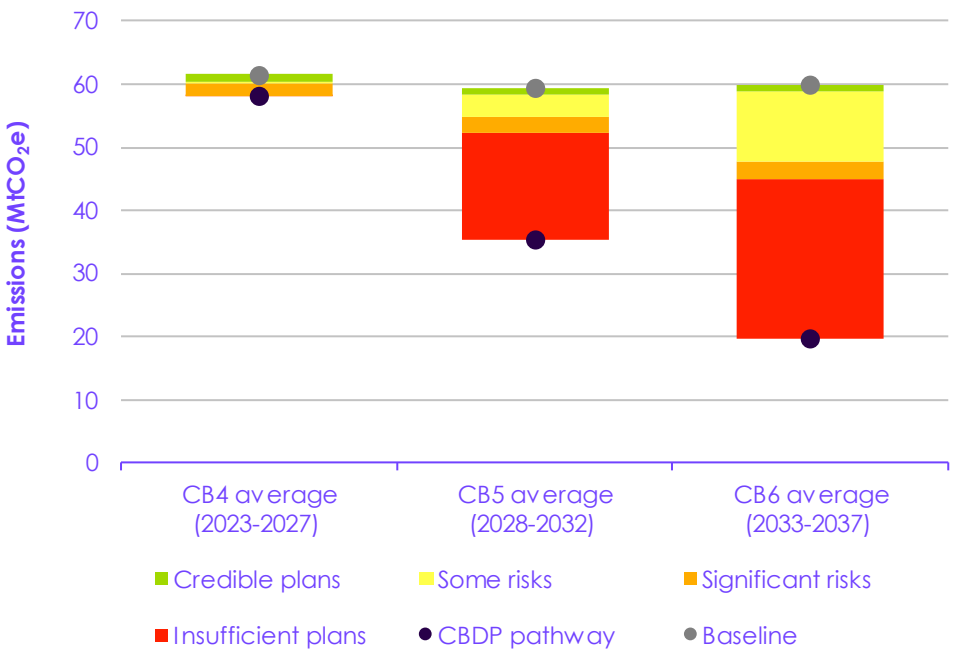
There has not been enough progress in the industry sector this year. Plans are either insufficient or have significant risks for 70% of the required emissions reduction by the Sixth Carbon Budget period (Figure 6.5, Table 6.1). Our assessment is based on the criteria outlined in Annex 1. The risk is higher than in last year's assessment due largely to a continuing lack of progress in major areas of abatement. The risk is particularly acute for industrial electrification due to its potential importance in decarbonising dispersed sites, the steel sector and off-road mobile machinery.

Table 6.1 shows a summary of recent progress and what still needs to be addressed. The detailed recommendations for this sector are in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 6.1.

The policy assessment in this report focuses on measures to reduce emissions, but industry must also adapt to future climate impacts. Industry sites, activities and supply chains can be disrupted by flooding and storms, coastal erosion, reduced water availability and higher temperatures. In the CCC's recent report: Progress in adapting to climate change – 2023 Report to Parliament, we made a number of recommendations in this area. These include improving information on the climate resilience of essential supply chains, strengthening adaptation reporting requirements and defining common standards for business adaptation plans.

The areas with insufficient plans in CB6 are electrification, steel, resource efficiency and off-road mobile machinery.

Figure 6.5 Assessment of policies and plans for industry



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan. See Annex 1 for the assessment criteria. (2) As the Government did not disaggregate abatement from fuel switching, we split this between hydrogen (70%) and electricity (30%). (3) Emissions from refineries are included in the CCC's fuel supply sector. (4) All bioenergy is included as BECCS under Industrial CCS.

Table 6.1
Policy scorecard for industry

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Industry overall assessment	O	O	O	R	O
Industrial carbon capture and storage 17% of abatement over CB6 period	G	G	Y	Y	Y
Industrial hydrogen 14% of abatement over CB6 period*	Y	G	Y	Y	Y

Industrial carbon capture and storage

This scoring and assessment relate specifically to policy on industrial carbon capture. Chapter 14 presents our assessment of wider CCS development.

Progress:

- The Government has continued to pursue its ambition to deploy CCS in at least two industrial clusters by the mid-2020s, and to deliver 6 $MtCO_2$/year of industrial CCS by 2030 and 9 $MtCO_2$/year by 2035.
- In December 2022, the Government published updated versions of its business models and draft contract for Industrial Carbon Capture (ICC).[7] The Government plans to publish final versions in summer 2023.
- Three industrial carbon capture projects were selected to proceed to negotiations for support to connect to the first CO_2 transport and storage networks.[8]

To be addressed:

- Chapter 14 presents several concerns with the development of CCS infrastructure and business models on which industrial carbon capture depends.
- Some industry-specific risks remain because the ICC business model is not yet proven in practice. Specific delays to the Government's ICC programme to be addressed are:
  - Elements of the ICC business model and associated contracts are yet to be finalised, including technical provisions on free allowances, metering and the monitoring of CO_2 (recommendation R2022-253).
  - No industrial CCS projects have yet been guaranteed government support as funding for the successful bidders is still subject to the outcome of negotiations.

Industrial hydrogen

This scoring and assessment relate specifically to policies to support use of hydrogen in industry as a fuel or as a feedstock, and assumes a sufficient supply of low-carbon hydrogen. Chapter 8 presents our assessment of progress in the production of low-carbon hydrogen.

Progress:

- The first window of the Phase 2 funding rounds for the Industrial Energy Transformation Fund (IETF) was launched in October 2022, and the winners have been announced. The IETF has also been extended, with an additional £185 million available in Phase 3, starting in 2024.[9]
- Innovation in hydrogen use in industry has continued across four competitions delivered through the Net Zero Innovation Portfolio.[10]
- The Government published an external research study, and summary of responses to a consultation, on hydrogen-ready industrial boiler equipment.

* The CBDP includes a single figure for abatement from fuel switching. We have disaggregated hydrogen using the fuel switching splits in the Balanced Pathway in the Sixth Carbon Budget.

- The Government launched the £26 million Industrial Hydrogen Accelerator (IHA) which has funded nine feasibility projects,[11] and Phase 2 of the £55 million Industrial Fuel Switching (IFS) competition, which has already progressed 21 Phase 1 feasibility projects.[12]
- The Government awarded £19 million across five successful projects of the Low Carbon Hydrogen Supply 2 competition – Stream 1 Phase 2.[13] Potential applications of these projects include dispersed industrial sites and off-road mobile machinery.

To be addressed:

- Chapter 8 describes several uncertainties related to the Government's low carbon hydrogen production ambition.
- A hydrogen production delivery roadmap to 2030 is needed to provide greater clarity to industrial hydrogen users, including existing users of high-carbon hydrogen.
- Further details and a delivery timeline for the hydrogen levy are required. The levy should support low-carbon hydrogen production while not biasing towards hydrogen and away from electrification, where electrification is an option (recommendation R2023-097).
- A plan for the distribution and storage of hydrogen outside clusters, particularly for dispersed industrial sites, is needed. A consultation on strategic planning for hydrogen transport and storage has been run, but a response is yet to be published and a business model is not expected until 2025 (recommendation R2022-256).

Energy efficiency 7% of abatement over CB6 period	Y	Y	O	O	O

Progress:

- The Government will extend the Climate Change Agreement (CCA) scheme by two years to 2027.[14] It has consulted on the details of this extension as well as on proposals for a potential future CCA scheme after 2027.
- The extension of the IETF (mentioned above) will continue to fund energy efficiency measures.
- The Government has set an ambition to reduce energy demand from buildings and industry by 15% by 2030. To help achieve this, it has pledged £6 billion in new funding from 2025 to 2028, but has not said how much of the funding is for industry. The Government has established an Energy Efficiency Taskforce to advise on delivering this ambition.[15]
- The Government plans to legislate to strengthen the Energy Savings Opportunity Scheme (ESOS). Participants in the next phase of ESOS (2024-2027) will have to publish an action plan, report annually on actions and include a Net Zero element in audits.[16,17]
- In 2023 the Government will launch a digital energy service providing energy efficiency advice to small businesses. It will also pilot a new energy audit and grant scheme to help small businesses implement energy efficiency measures.

To be addressed:

- The CBDP includes a sharp increase in abatement as a result of industrial energy efficiency in the period of the Fifth Carbon Budget (2028-2032). However, there are no new measures to achieve this and some current policies are due to end before 2028 (recommendation R2023-086).
- For sites within the UK ETS the carbon price is likely to contribute to some energy efficiency improvements, but this in unlikely to be enough on its own to drive the significant abatement targeted by Government. The Government has not released figures on the quantity of abatement from the ETS specifically as it is considered to be an enabling policy.
- The Government has not stated its ambition for annual abatement from industrial energy efficiency, or the contribution of industry to its 15% energy demand reduction target.
- While ESOS, CCAs and IETF have been extended, their longer-term future is still uncertain (recommendation R2023-087). There is also a lack of public information quantifying the emissions reductions achieved through ESOS.
- There is a lack of incentives for industrial SMEs to implement energy efficiency measures. The digital energy service is unlikely to be sufficient (recommendation R2023-089).

	• A lack of data impedes the tracking of energy efficiency changes in industry (recommendations R2022-240, R2023-158). • For sites within the UK ETS that participate in the CCA scheme, energy efficiency targets are based solely on electricity consumption. This may disincentivise electrification, as using more electricity risks missing the targets, even if overall energy efficiency improves (recommendation R2022-244).
Resource efficiency 18% of abatement over CB6 period	O | R | O | R | O **Progress:** Resource efficiency means both reducing consumption and using fewer resources in production. • The UK Government has a range of small-scale initiatives and high-level commitments to encourage resource efficiency in production. It has: – Funded eight projects in 2022 through the Timber in Construction Innovation Fund and opened the fund for 2023 applications.[18] – Announced an intention to consult on an approach to measure and reduce embodied carbon in new buildings by the end of the year.[19] – Included resource efficiency in the remit of the Energy Efficiency Taskforce. – Launched a consultation on addressing carbon leakage risk, which includes mandatory product standards as a potential option.[20] – Began a research project to identify the potential for resource efficiency in 11 industry sub-sectors. • Progress in reducing consumption of resources, that could influence industrial emissions, includes: – a commitment in the Environmental Improvement Plan 2023 to deliver a new maximising resources and minimising waste programme in England.[21] – a UK Government commitment to introduce Extended Producer Responsibility for packaging across the UK from 2024, and a Deposit Return Scheme for drinks containers from 2025 (in England, Wales and Northern Ireland).* **To be addressed:** • The CBDP includes significant emissions reductions from resource efficiency, especially during the Fifth and Sixth Carbon Budgets. There is an urgent need to set out new policies to achieve this ambition (recommendations R2022-262, R2023-132). • There is a need for more measures to improve the resource efficiency of production. Previous research has identified particularly large opportunities in construction and vehicle manufacturing (recommendations R2022-251, R2022-252).[22] • There are very few policies to reduce consumption, e.g. through greater sharing, re-use and longer use of products (recommendations R2023-132, R2023-133). • Further details and a timeline are needed on the maximising resources and minimising waste programme in England (recommendation R2023-133). • Improvements in access and consistency of data on material use are needed to track improvements in resource efficiency (recommendation R2022-249).
Electrification 6% of abatement over CB6 period†	R | O | O | R | R **Progress:** • The Government has consulted on the British Industry Supercharger,[23] a scheme to reduce the cost of electricity for energy-intensive industries, starting in spring 2024. Under the proposed

* Scotland's Deposit Return Scheme will start in March 2024 (https://depositreturnscheme.zerowastescotland.org.uk).

† The CBDP includes a single figure for abatement from fuel switching. We have disaggregated electrification using the fuel switching splits in the Balanced Pathway in the Sixth Carbon Budget. This percentage excludes steel sector abatement which the CBDP indicates will result largely from electrification.

	changes some manufacturers would be fully exempt from a range of electricity levies and compensated for network charges. • The extension of the IETF (mentioned above) will continue to fund industrial electrification. • Successful projects for Phase 1 of the Industrial Fuel Switching competition, announced in May 2022, include two studies into the electrification of industrial heat processes. • The Government will increase the main rate of Climate Change Levy for gas to match the rate for electricity, with effect from 1 April 2024. • The Government plans to issue a call for evidence on industrial electrification in 2023. **To be addressed:** • There is a lack of policies to drive industrial electrification. The Government has made some initial positive steps outlined above, but they fall short of what is likely to be required (priority recommendation R2023-080). • Current funding for industrial electrification is inadequate and a small fraction of that available for hydrogen or CCS (recommendation R2023-079). • A lack of data prevents accurate monitoring of industrial electrification. There is little current evidence that industry is preparing to electrify on a large scale (recommendation R2022-240). • High electricity prices continue to be a strong disincentive to industrial electrification. UK industry's electricity costs are high relative to gas and to the price paid by many international competitors (recommendation R2023-076). • There is a need for clarity on the Government's approach to ensuring electricity networks have the capacity to meet increased demand from industry (recommendation R2023-077). • While the UK ETS should in theory incentivise industrial electrification for eligible sites, there is a lack of evidence this is happening. • For sites within the UK ETS that participate in the CCA scheme, energy efficiency targets are based solely on electricity consumption. This may disincentivise electrification, as using more electricity risks missing the targets, even if overall energy efficiency improves (recommendation R2022-244).
Off-road mobile machinery 12% of abatement over CB6 period	R | O | R | R | R **Progress:** • The IETF has been expanded to include support for off-road mobile machinery. • The Government has commissioned a study of decarbonisation options for off-road mobile machinery and sector pathways aligned with the UK's Net Zero target. • Later in 2023 the Government plans to issue a call for evidence on decarbonisation options in this sector. Work will then start on a decarbonisation strategy. **To be addressed:** • There is no strategy and a lack of policies to support the decarbonisation of off-road mobile machinery. Although the Government has said it intends to publish a strategy, it has not said when (recommendation R2022-250).
Iron and steel 27% of abatement over CB6 period	R | O | R | R | R **Progress:** • The CBDP indicated that the Government intends the steel industry to substantially decarbonise during the periods of the Fifth and Sixth Carbon Budgets, largely through electrification. **To be addressed:** • There is no strategy or timeline for the decarbonisation of the iron and steel industry, the UK's largest-emitting industrial sector. There has been no activity on the £250 million Clean Steel Fund since December 2020 (priority recommendation R2023-088).

Bioenergy*	O	Y	R	O	O

Progress:

- The Industrial Fuel Switching Competition awarded funding to three projects targeting biofuels as part of its first phase, focussed on feasibility studies. Phase 2 will fund demonstration projects and closed in November 2022. Bioenergy projects continue to be eligible for Phase 2, but results have not yet been announced.
- Fuel switching to bioenergy is only eligible for the IETF where there are limited commercial alternatives, although so far no bioenergy projects have been awarded funding.
- The Combined Heat and Power Quality Assurance Programme (CHP QA) awards benefits on the basis of energy efficiency and environmental performance, which should encourage bioenergy uptake in CHP. The share of bioenergy use in CHP has continued to increase, making a small contribution to total bioenergy use in industry.

To be addressed:

- While bioenergy use in industry has grown substantively in the past 15 years, it is not clear whether it is being prioritised where most needed. Government should look to better understand what is driving recent trends in industrial bioenergy use (recommendation R2023-157).
- No progress has been made on an economy-wide plan for biomass use since the publication of the Biomass Policy Statement last year – the Biomass Strategy has still not been published, despite stated Government intent to do so in 2022. Clear plans and mechanisms are needed to direct the use of bioenergy (in industry and across the economy) where abatement can be maximised (recommendation R2022-222).
- Bioenergy use in industry should be prioritised for sectors where CCUS can be fitted. This will rely on progress in developing CCUS.

Cross-cutting issues

Progress:

- The Government has launched a consultation on potential policy measures to address the risk of carbon leakage, including a carbon border adjustment mechanism, mandatory product standards and emissions reporting requirements.
- The £5 million Local Industrial Decarbonisation Plans (LIDP) competition is due to open in summer 2023. This will offer grants to support the development of decarbonisation plans for industrial manufacturers in dispersed sites.[24]

To be addressed:

- To give businesses the confidence to make investment decisions, there is a need for long-term clarity on Government strategy and support in all areas of industrial abatement.
- **UK Emissions Trading Scheme**
  - The UK ETS will have a tightened cap from 2024 to align with the Government's Net Zero trajectory. This will help to drive manufacturing decarbonisation. However, until the new cap comes into effect, surplus emissions allowances will continue to accrue. These surplus allowances will be carried over into future years, reducing the impact of the new cap.
  - The Government has not set out a long-term pathway for the UK ETS cap beyond 2030 (recommendation R2023-090).
  - Smaller sites outside the UK ETS have few incentives to decarbonise and fewer resources to apply for funding. These sites, representing about 40% of the sector's emissions, need clear incentives and tailored support to electrify (priority recommendation R2022-241).
  - The UK ETS Authority has started a project to evaluate the scheme's effectiveness. Phase 2 of this project will explore the impact of the UK ETS on carbon abatement and carbon leakage. However, Phase 2 is not due to finish until 2026 until which time there is a lack of evidence on how the scheme drives industrial decarbonisation.

* Bioenergy is included in the CBDP as BECCS and is therefore incorporated in abatement from Industrial CCS.

- **Dispersed sites and SMEs**
  - There is a lack of policy targeted at the decarbonisation of dispersed sites outside the clusters. The Local Industrial Decarbonisation Plans competition is a positive step, but a small one given the size of the task (recommendation R2023-089).
  - There is no clear strategy for decarbonising small facilities not covered by the UK ETS, which represent around 40% of industrial emissions (recommendation R2023-089).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan. (3) Emissions from refineries are included within the CCC's fuel supply sector.

Endnotes

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48 $MtCO_2e$, 11% of UK emissions in 2022

Introduction and key messages

Reducing emissions from electricity generation, and then using low-carbon electricity to power the economy, is a central pillar of reaching Net Zero. Sector emissions have fallen rapidly over the last decade, and the Government has made a strong commitment to fully decarbonise the sector by 2035, subject to security of supply.[1] The key challenge is to ensure that these ambitions are delivered on, via the rapid scale-up of low-carbon electricity supply and the infrastructure required to support it, and ensuring that this delivers reliable and resilient supply.

Our key messages are:

- **Emissions.** Provisional estimates suggest that electricity supply emissions fell by 1% in 2022 compared to 2021. In 2022, UK electricity demand was lower than in 2021, as was the emissions-intensity of generation, largely due to record levels of wind generation. However, the UK was also a net exporter of electricity for the first time in more than 40 years, with record levels of exports. Emissions may have been lower had this not been the case.[2]

- **Policy progress.** Limited policy progress has been made in the last year. Developments include the launch of a number of valuable consultations, and publication of the Government's Powering Up Britain strategy, but this included few new policies.[3] The Government is still lacking a credible overall strategy for delivering its objective of decarbonising the sector by 2035. Overall, we find that credible plans are in place for around 30% of the emissions reduction required by the Sixth Carbon Budget period. Reflecting the lack of overall progress, we have downgraded our assessment of the sector. Further progress is required across all areas of policy to put emissions reductions on track.

- **Recommendations and next steps.** The overriding challenge for electricity supply is to ensure that the Government's ambitions are delivered, particularly in addressing the 70% of emissions reductions that do not currently have fully credible policy.

  - A key gap in comparison to other sectors (e.g. heat and buildings, transport) remains the absence of an overarching stand-alone plan or strategy for delivering a decarbonised, resilient electricity system by 2035. This would facilitate a more coordinated and strategic approach to delivery and improve investor visibility and confidence. The need for a strategy, first recommended by the CCC in 2020, has been echoed by the National Audit Office, the House of Commons Business, Energy and Industrial Strategy Select Committee and others.[4,5,6] It should be published as soon as possible this year.

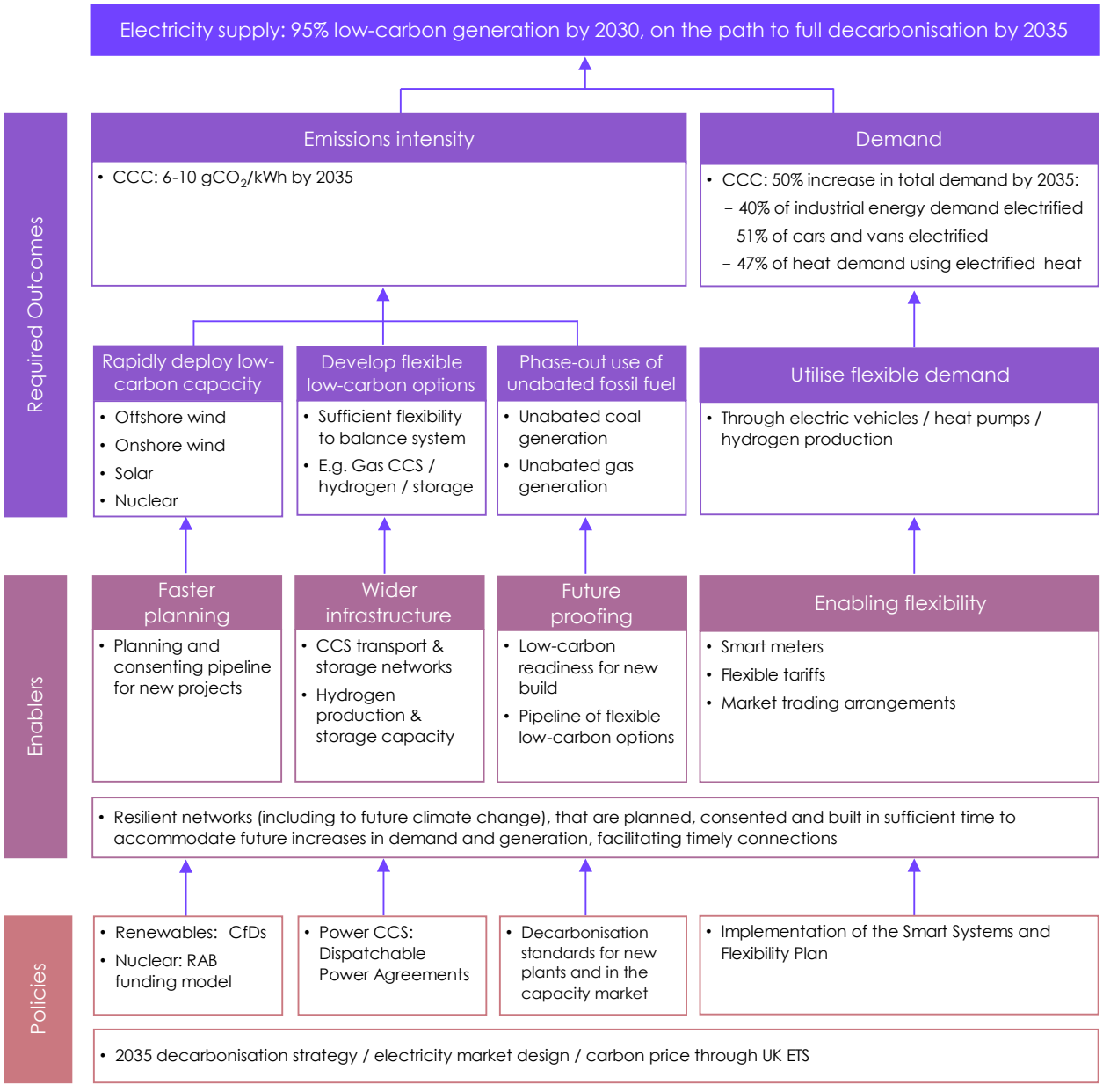
  - In parallel, barriers and enablers will also need to be tackled. Ensuring sufficient network capacity and timely grid connections is a critical priority to support an increasingly electrified economy and enable available low-carbon generation to be fully utilised. Potential supply-chain bottlenecks should be addressed to avoid delaying investment.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 7.1 Monitoring map for electricity supply



Source: CCC analysis.

The CCC's monitoring map for electricity supply (Figure 7.1) sets out the policies, enablers and required outcomes for a successful transition. This report focuses on ten key indicators, with additional indicators available in the supplementary material presented alongside this report. Our Monitoring Framework documents the indicators we track and our approach for assessing progress.[7]

Emissions in the electricity supply sector fell slightly in 2022, down 1% since 2021 to 48 $MtCO_2e$.

Emissions. Electricity supply emissions fell slightly in 2022, down 1% since 2021 to 48 $MtCO_2e$ (Figure 7.2a and 7.3), despite a rise in total UK electricity generation. The UK was a net exporter of electricity for the first time in recent history.

UK electricity demand fell in 2022 compared to 2021, due to lower consumption in industry and residential buildings.

Electricity demand. Demand within the UK fell to 273 TWh in 2022,* a decrease of 4% compared to 2021, due to lower consumption in industry and residential buildings (Figure 7.4).

- Both residential and industrial demand, including iron and steel, fell by around 6% relative to 2021 levels. Demand from other final users, including commercial demand, increased by 1% compared to 2021 levels.

- This decrease in electricity demand likely reflects the impact of increased electricity prices as a result of the spikes in fossil fuel prices following Russia's invasion of Ukraine, incentivising consumers to reduce consumption.

Emissions-intensity of UK generation decreased by 7% in 2022. 56% of electricity generated came from low-carbon sources.

Emissions-intensity. The emissions-intensity of UK generation decreased by 7% to 167 gCO_2/kWh. Although generation from fossil fuels increased slightly compared to 2021, low-carbon generation increased its share of the generation mix. Overall, 56% of electricity generated in 2022 came from low-carbon sources, with the majority of the remaining production coming from gas (Figure 7.5).

- **Low-carbon generation.** Electricity generation from low-carbon sources was 9% higher in 2022 than in 2021, largely due to record levels of wind generation.

  – Wind generation increased to a record 80 TWh, up 24% on 2021. This was due to a 3 GW increase in capacity (up 12%) and wind speeds returning to more normal levels following unusually low wind speeds in 2021 (Figure 7.6).

  – Solar generation increased to 14 TWh, up 15% compared to 2021, due to an increase in the number of hours of sunshine (up 19%) and a 0.7 GW increase in capacity (up 5%).

  – Nuclear generation increased by 4%, despite operational nuclear capacity reducing by 25% by the end of 2022, due to the closures of Hunterston B and Hinkley Point B.[2]

- **Generation from fossil fuels.** There was a fall in overall emissions-intensity, despite generation from fossil fuels increasing by 1% in 2022 compared to 2021.

  – Gas generation rose by 2 TWh to 125 TWh, an increase of 2% compared to 2021.

  – Coal generation fell by 1 TWh to 6 TWh, a decrease of 14% compared to 2021. Coal now provides less than 2% of electricity generation (Figure 7.5).

The UK became a net exporter of electricity for the first time in more than 40 years.

Electricity exports. Total UK generation increased by 6% in 2022 compared to 2021, despite falling demand within the UK, as electricity exports rose to record levels. The UK became a net exporter of electricity for the first time in more than 40 years (Box 7.1).

* As measured by final consumption.

- Total exports rose to a record 21 TWh, an increase of 400% compared to 2021. This increase was likely driven by lower gas prices in the UK compared to mainland Europe and by French nuclear outages.

- In particular, the UK's capacity to import liquefied natural gas (LNG) meant that it was able to act as a 'land bridge', importing gas and re-exporting some of this energy through interconnectors both as fossil gas and electricity (i.e. generated using UK gas-fired capacity).

Box 7.1
UK electricity exports in 2022

Change in UK electricity exports in 2022. In 2022, the UK became a net exporter of electricity for the first time in more than 40 years, with net electricity transfers changing from 25 TWh imported into the UK to an export of 5 TWh (Figure B7.1).

- Total electricity exports from the UK rose to record levels of 21 TWh, an increase of 400% compared to 2021.
- The biggest change was seen on interconnectors connecting to France, with net imports to the UK changing from 14 TWh in 2021 to -10 TWh in 2022.

Drivers. The UK's shift to a net electricity exporter in 2022 was likely due to lower wholesale gas and electricity prices in the UK relative to mainland Europe, and outages in the French nuclear fleet.

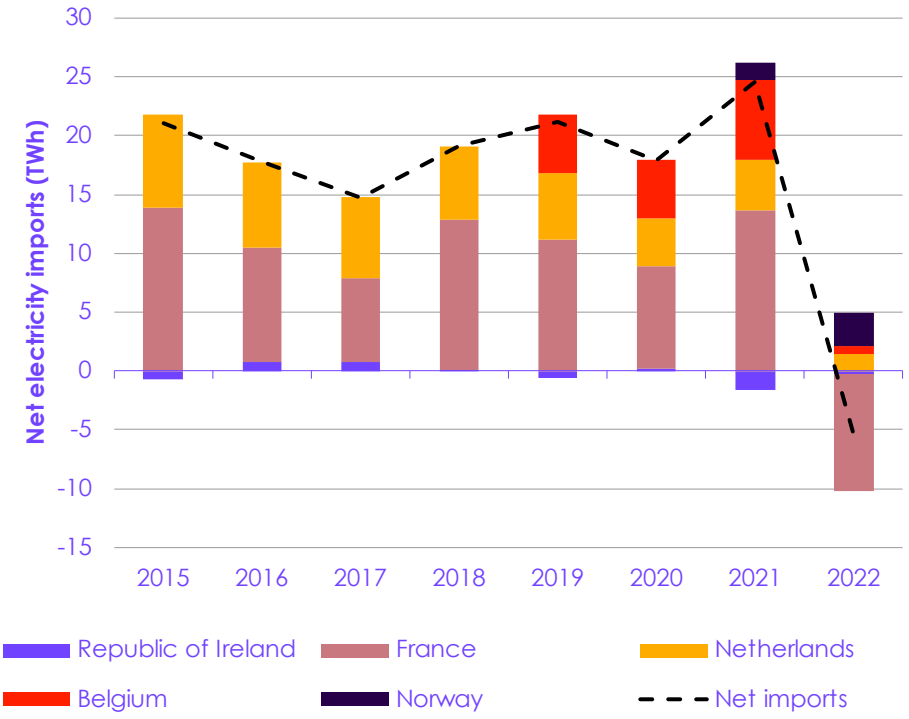
- Lower gas prices in the UK relative to mainland Europe:
  - Following Russia's invasion of Ukraine, European countries have moved to reduce their pipeline imports of Russian natural gas. As a result, European demand for LNG surged, leading to high global gas prices.
  - As the UK is less dependent on pipeline imports of Russian natural gas and had capacity to receive LNG imports in excess of UK demand, the UK had lower wholesale gas prices relative to those in mainland Europe. This meant that the UK was able to act as a 'land bridge', importing gas and re-exporting some of this energy through interconnectors both as fossil gas and electricity (i.e. generated using UK gas-fired capacity).
- Outages in the French nuclear fleet:
  - French nuclear generation fell by 82 TWh in 2022 compared with 2021, a decrease of 23%, leaving mainland Europe short on generation capacity.[8] The average unavailability rate of French nuclear reactors was around 46% in 2022, as a result of maintenance delayed due to the COVID-19 pandemic and corrosion stress problems in some reactors.[9]
  - High river temperatures during the summer heatwave also restricted EDF's access to river water for cooling, leading to a further temporary reduction of output.[10]

It is unclear whether 2023 will bring a return of the long-term trend of net electricity imports to the UK. While the availability of France's nuclear fleet is slowly increasing, which may see capacity shortages ease on the continent, it is less clear whether the differential in gas prices between the UK and mainland Europe will be a significant driver in the longer-term.

Emissions impact of increased electricity exports. It is difficult to determine the impact of increased electricity exports on the UK's emissions in 2022. It is impossible to directly attribute electricity exports to a particular generation source and the counterfactual scenario, in the absence of the invasion of Ukraine, is uncertain. However, it is likely that UK territorial electricity supply emissions would have fallen further in 2022 if exports had been in line with historical levels. This is supported by both the overall reduction in UK electricity demand and the decrease in the emissions-intensity of generation in 2022.

We estimate that around 3 $MtCO_2e$ (6%) of the UK's electricity supply emissions in 2022 might be attributable to the increase in electricity exports based on the change in generating patterns.

Figure B7.1 UK net electricity imports by country (2015-2022)



Source: DESNZ (2023) *Energy Trends*; CCC analysis.
Notes: Figure shows net imports (i.e. total imports minus total exports).

Source: CCC analysis.

Indicators. For the electricity supply sector, we use a range of indicators in our progress monitoring of renewables, low-carbon flexibility and utilisation of flexible demand (Figure 7.2). These have been updated relative to last year to reflect new analysis undertaken for, and subsequent to, our recent report on Delivering a reliable decarbonised power system.[11]

Renewable energy generation capacity continued to grow in 2022, but below the rate required to meet the Government's stretching targets.

- **Deployment of renewable energy.** Renewable energy generation capacity continued to grow in 2022 but below the rate required to meet the Government's stretching targets.
  - A further 2.7 GW of offshore wind was deployed in 2022 (Figure 7.2b), which is slightly off track for the Government's ambitious target to reach up to 50 GW by 2030.[12] An average annual deployment rate of 4.5 GW is required to deliver 50 GW of offshore wind by 2030.
  - Both onshore wind and solar deployment are progressing more slowly than offshore wind, in part due to barriers in the planning system, despite being among the cheapest forms of electricity generation.
    - Only 0.3 GW of onshore wind was deployed in 2022 (Figure 7.2c). The Government does not have a target for onshore wind capacity, but current deployment rates are slightly off track relative to the Balanced Pathway from our Sixth Carbon Budget analysis.

- In 2022, 0.7 GW of solar was deployed (Figure 7.2d). The deployment of solar capacity is significantly off track to meet the Government's target of 70 GW by 2035.[12] An average annual deployment rate of 4.3 GW is required to deliver 70 GW of solar by 2035.

The share of unabated gas in electricity generation remains high at 38% in 2022, which we consider to be slightly off track.

- **Phase-out of unabated gas.** The share of unabated gas remains high at 38% in 2022, which we consider to be slightly off track (Figure 7.2e).
  - Generation from unabated gas is expected to fall as low-carbon capacity continues to grow and needs to be almost completely phased-out by the mid-2030s. It is a high-level indicator of whether progress in decarbonising the sector is on track.
  - The unabated gas share of generation in a given year will depend on a wide range of factors, including: the overall level of electricity demand; the amount of installed low-carbon capacity and flexible resources on the system; weather conditions; availability of network capacity; requirements for ancillary services; the degree of interconnector usage and whether the UK is a net importer or exporter of electricity (which was one driver of unabated gas use in 2022).
  - As illustrated in our March 2023 report on Delivering a reliable decarbonised power system, the share of unabated gas in electricity generation will need to approximately halve from 2022 to 2025. We therefore consider this indicator to be slightly off track, noting that all of our above renewables deployment indicators are currently off track.

Our modelling suggests that we will need to significantly ramp up deployment of dispatchable low-carbon capacity this decade.

- **Dispatchable low-carbon capacity.** While it is too early to say whether current progress in this area is on track overall, our modelling suggests that these solutions will need to ramp up significantly this decade (Figure 7.2f and 7.2g).
  - A portfolio of dispatchable low-carbon capacity (e.g. gas with carbon capture and storage (CCS) and hydrogen-fired gas plants) is essential for a resilient, low-carbon electricity system and will need to be deployed rapidly and at scale. The next three years will be critical in delivering the planning and infrastructure changes necessary for the deployment of these technologies, as well as commercialising new business models.
  - The capacity of dispatchable low-carbon generation in operation will need to reach 3-6 GW by 2028 (Figure 7.2f). To achieve this, projects need to be in development several years prior. Our modelling suggests that 4-11 GW of dispatchable low-carbon capacity needs to be in development by 2025. Our analysis indicates that there is currently at least 7 GW of dispatchable low-carbon capacity in development based on eligible power CCS projects in the Government's Cluster sequencing Phase-2 process and known hydrogen power plant projects.[13] We consider this to be on track to meet requirements for 2025 (Figure 7.2g).

Grid storage capacity is growing, with a considerable pipeline of battery storage in development.

- **Grid storage and active demand response.** We consider grid storage to be on track due to a considerable pipeline of grid-scale battery storage in development, assuming these are able to gain network connections. It is

too early to say whether current progress on active demand response is on track, but we expect to see tangible progress by 2025.

  - The power output capacity of grid storage is currently around 2 GW.[14] This will need to rise to 7 GW by 2025 and 8-9 GW by 2028 (Figure 7.2h). Grid storage capacity in Great Britain will more than double by next winter, as 2.3 GW of new-build battery storage won contracts for delivery in 2023/24 in the recent T-1 Capacity Market auction.[15] A further 5.0 GW of new-build battery storage won contracts for delivery in 2026/27 in the recent T-4 auction.[16] Overall, there is around 50 GW of capacity in the pipeline.[17] Based on this considerable pipeline, we judge this indicator to be on track.

  - Our modelling suggests that active demand response will need to reach 2-3% of total demand by 2028 (Figure 7.2i).

  - However, a full picture of the extent to which peaks in demand for electricity are reduced by flexibility (time-shifting of demand or reduction) is difficult to determine at present due to data gaps. As a result, we consider it is too early to say whether progress on active demand response is on track.

The roll-out of smart meters is slightly off track, with smart meters making up 55% of total electricity meters in 2022.

- **Smart meter uptake.** The roll-out of smart meters is slightly off track, with smart meters making up 55% of total electricity meters in 2022 (Figure 7.2j).

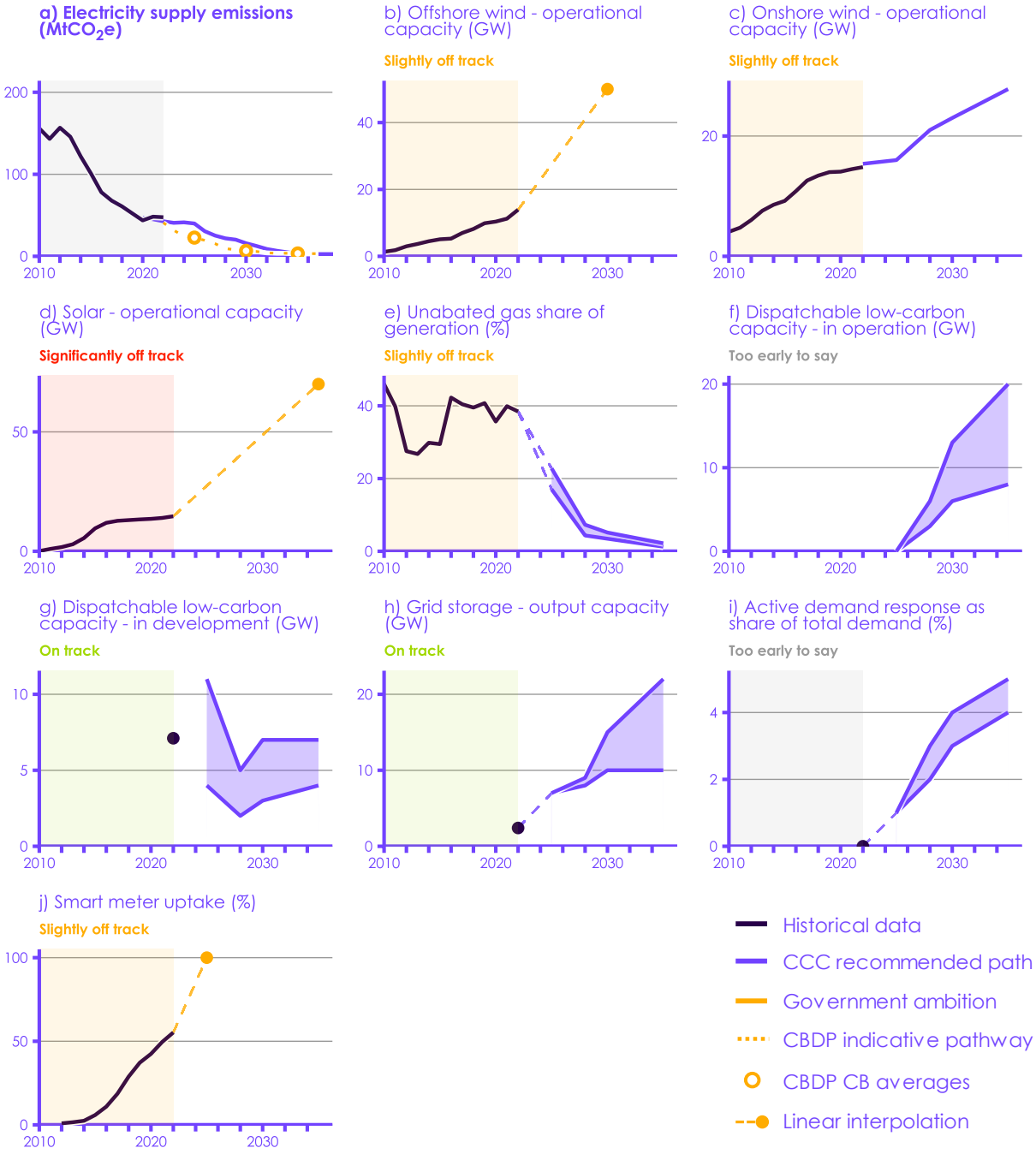
  - Smart meters are a critical enabler for delivery of a decarbonised power system by 2035 as they are needed to measure the use of electricity on a half-hourly basis and reward flexibility. The Government has set out a firm commitment and policy framework to drive a market-wide roll-out of smart meters by 2025.[18]

  - In 2022, 50% of domestic and non-domestic electricity meters were smart meters operating in smart or advanced mode.* This does not include an additional three million smart meters which have been installed but are currently operating in traditional mode. Overall, 55% of domestic and non-domestic electricity meters were smart meters in 2022. Although there is a clear policy framework in place, we currently judge this to be slightly off track as uptake needs to accelerate out to 2025 and there is a risk remaining domestic and non-domestic customers may have lower appetite or face other barriers to installation.

  - Delivering on a market-wide roll-out of smart meters will not deliver demand flexibility benefits on its own. It also needs to be ensured that all smart meters have adequate communication performance in practice, so that network and system operators can use the data they collect. This is covered in more detail in Section 2.

* Smart meters operating with smart functionality are referred to as 'operating in smart or advanced mode'. Advanced mode refers to advanced meters, which are a subset of smart meters that are available to non-domestic customers and must, at a minimum, be able to store half-hourly electricity and hourly gas data, to which the non-domestic customer has timely access, and the supplier has remote access. Smart meters that have temporarily lost smart functionality (e.g. due to a switch of energy supplier) are referred to as 'operating in traditional mode'.

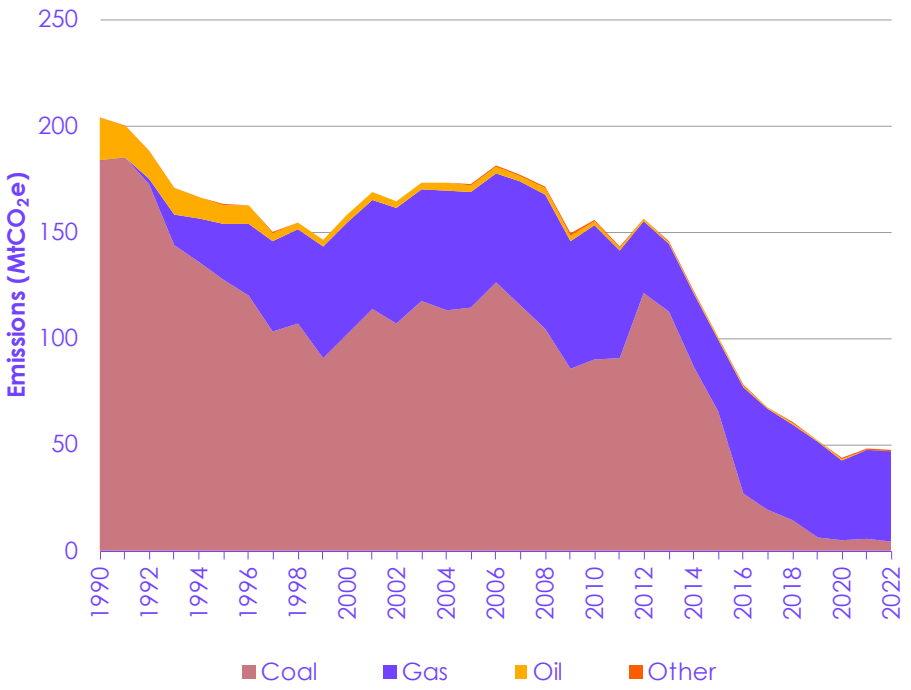
Figure 7.2 Key indicators for electricity supply



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path and considering the wider contextual factors that may have a temporary impact (e.g. recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) Dashed lines indicate the linear rate of change that would be required to meet the target, whereas solid lines show modelled pathways. (3) Shaded areas indicate the range of modelled scenarios. (4) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions (5) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (6) Figure b): The Government's stated ambition is 'up to 50 GW'. (7) Figures e) – i): The indicator ranges shown are based on our 2023 report on Delivering a Reliable Decarbonised Power System. (8) Figure g): The 2022 value is a lower-bound estimate based on eligible power CCS projects in the Government's Cluster sequencing Phase-2 process and known hydrogen power plant projects. The pathway falls between 2025-2028 due to the non-linear deployment pathway, development lead times and projects moving to the construction phase. (9) Figure j): Data includes smart meters operating in traditional mode. The Government target is displayed as 100%.

Electricity supply emissions have fallen significantly since 1990, as coal has been displaced in the generation mix by low-carbon sources and gas.

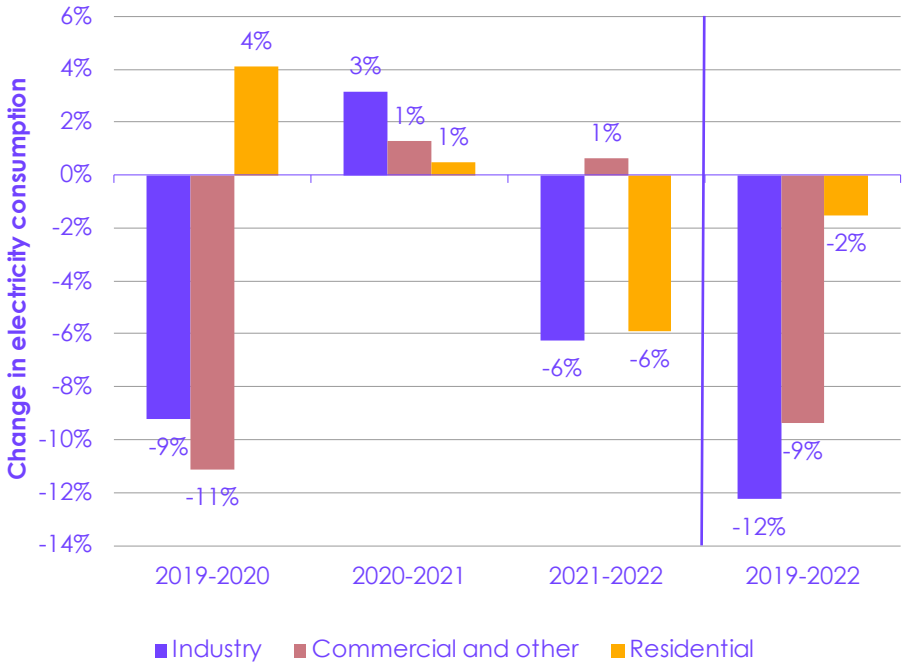
Figure 7.3 Electricity supply emissions (1990-2022)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*
Notes: Other category includes power station emissions from combustion of other solid fuels.

Electricity demand has fallen overall since 2019 and is yet to recover to levels seen before the COVID-19 pandemic.

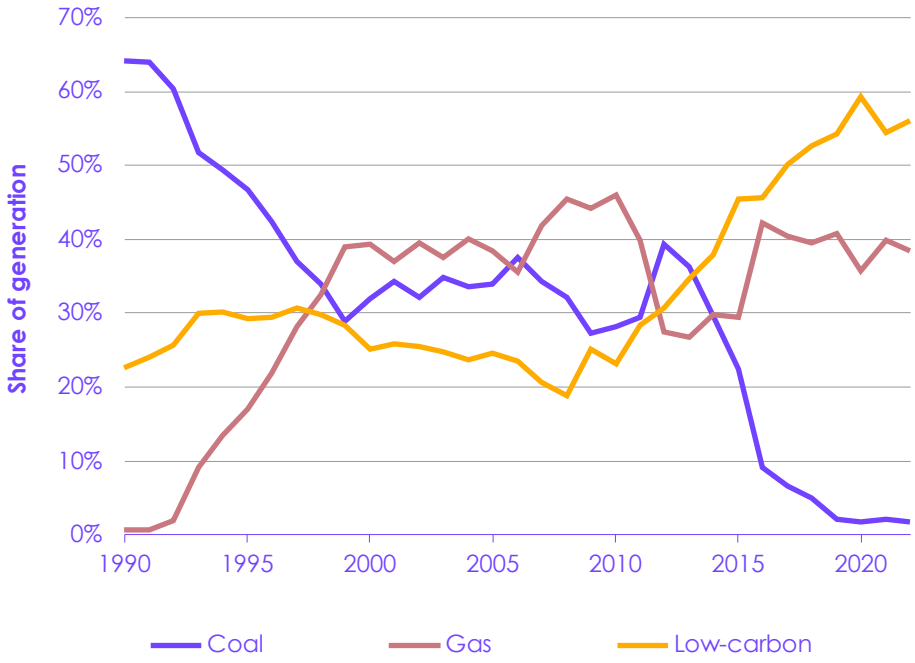
Figure 7.4 Changes in electricity consumption by sector (2019-2022)



Source: DESNZ (2023) *Energy Trends.*

Overall, 56% of electricity generated in 2022 came from low-carbon sources, with almost all of the remaining production coming from gas.

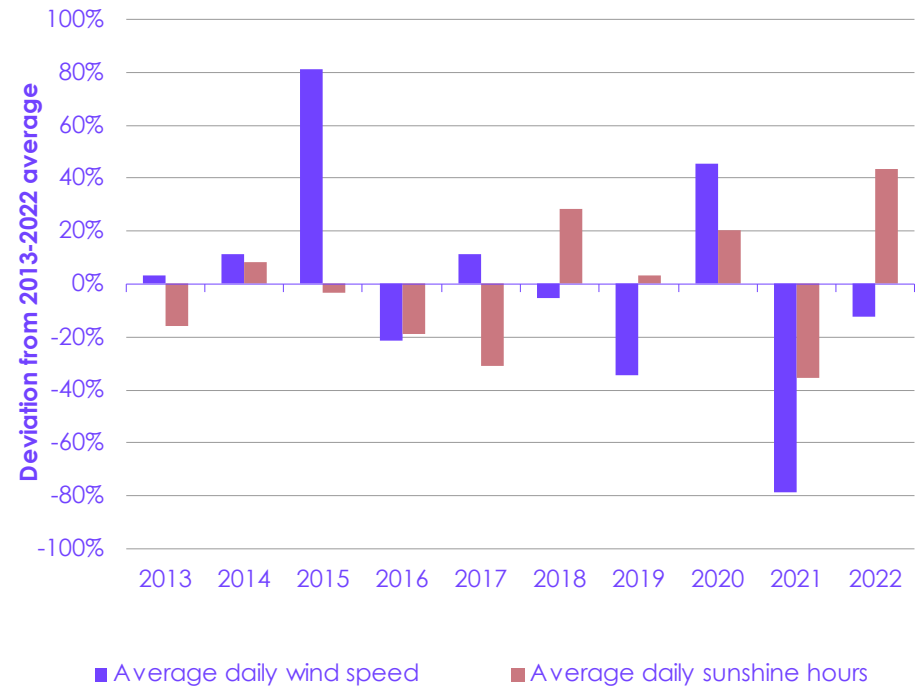
Figure 7.5 Share of electricity generation by source (1990-2022)



Source: DESNZ (2023) *Energy Trends*; BEIS (2022) *Digest of UK Energy Statistics (DUKES)*; CCC analysis.
Notes: Low-carbon includes nuclear, hydro (natural flow), wind, solar and bioenergy.

In 2022, wind speeds and sunshine hours increased compared to 2021, contributing to increased renewables generation.

Figure 7.6 Weather variability (2013-2022)



Source: DESNZ (2023) *Energy Trends*.

2. Policy assessment

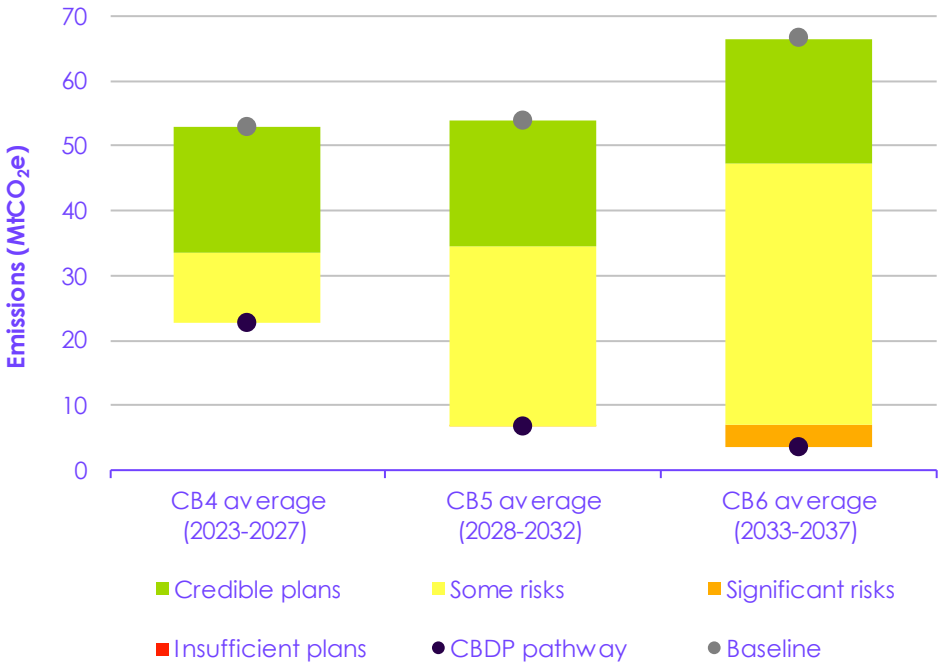
Policy progress has been mixed in the electricity supply sector, with further development required across most policy areas in order to address risks and facilitate delivery. Credible policies are in place to meet around 30% of the required emissions reduction by the Sixth Carbon Budget period (Figure 7.7, Table 7.1). Our assessment is based on the criteria outlined in Annex 1.

Having looked in more detail at the challenges in our March 2023 report on Delivering a reliable decarbonised power system, we have downgraded our assessment compared to last year. This reflects the continued absence of a 2035 delivery strategy from Government, and our updated assessment of delivery risks for new low-carbon projects, particularly around planning and consenting, and access to network connections.

A summary of recent progress is given in Table 7.1, alongside a summary of what still needs to be addressed. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 7.1. Further context to these recommendations is available in our March 2023 report on Delivering a reliable decarbonised power system.

The policy assessment in this report focuses on measures to reduce emissions, but the electricity supply system must also ensure a year-round, reliable supply of electricity and be well adapted to future climate impacts. In the CCC's recent report, Progress in adapting to climate change – 2023 Report to Parliament, we set out a number of recommendations in this area.[19] These include ensuring that future system design explicitly plans for the range of climate hazards that will face the energy system over its lifetime and mandating reporting on climate risk and adaptation progress by electricity generators, network operators and regulators.

Figure 7.7 Assessment of policies and plans for electricity supply



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; CCC (2020) *The Sixth Carbon Budget*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, Tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) Using information from the CBDP, we have estimated the breakdown of emissions savings by generation type. The CBDP provides no breakdown on electricity supply emissions savings due to interdependencies between policies. (3) Energy from waste is assessed in the CCC's waste sector. (4) The baseline used is from CCC's Sixth Carbon Budget analysis, so that emissions savings from low-carbon generation can be assessed (this is largely included within the CBDP baseline). Baseline emissions increase over time as it is assumed that new electricity demands are met by unabated gas.

Table 7.1
Policy scorecard for electricity supply

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Electricity supply overall assessment	G	G	O	Y	Y
Renewables 70% of 2035 electricity generation	G	G	O	Y	Y

Electricity supply overall assessment

Progress:

- Published the Powering Up Britain strategy.[3]
- Commissioned and published the Skidmore Review and Government response.[20,21]
- Published a consultation on a Strategy and Policy Statement for energy policy in Great Britain.[22]

To be addressed:

- The Government has committed to decarbonising electricity supply by 2035, subject to ensuring security of supply. It has also committed to ambitious targets for building new renewables and nuclear capacity, and has published a number of plans expanding on some aspects required for decarbonising the sector.[12] However, in contrast to other sectors, the Government has not yet published an overarching delivery plan or strategy. This makes it difficult to assess the credibility of individual policies and whether they are sufficient, the extent to which they take into account key interactions and trade-offs, and key delivery risks and contingencies. A comprehensive long-term strategy is therefore required for the delivery of a decarbonised, resilient, power system by 2035 (priority recommendation R2023-138). This strategy should be a standalone document, which includes the following:
  - A portfolio approach to delivery, covering the full range of low-carbon flexibility options, including demand flexibility, storage, hydrogen, gas CCS and interconnection capacity, and setting out how these will be delivered, as well as clarifying the scale of any minimal residual role for unabated gas by 2035 and the strategy for phase-out.
  - A demonstration of how the suite of relevant policies and regulatory levers (including those of devolved governments) will work together to deliver the objective for decarbonising electricity supply by 2035 and do so with sufficiently reliable supply at least cost. This should include identifying key interactions and dependencies and how they will be managed.
  - Setting out where strategic decisions are required to guide effective delivery.
  - A comprehensive timeline for delivery, which takes into account lead times, sequencing, and maps out milestones and decision points on the critical path.
  - An assessment of the key delivery risks (e.g. network development, planning and consenting, CCS, hydrogen and nuclear), and plans and contingencies for addressing them on a coordinated basis.
  - Governance arrangements, including the role of different parties in overseeing delivery, and monitoring and evaluation of progress towards the 2035 objective.
- More widely, there is a need for the responsibilities of the Future System Operator (FSO), Ofgem and Ministers to be clarified and formalised. This includes making responsibilities clear with respect to delivering Net Zero and ensuring climate and weather resilience and recognising the critical role of strategic investment in delivering these outcomes (priority recommendation R2023-126).

Renewables 70% of 2035 electricity generation

Progress:

- Published a consultation on local planning changes for onshore wind.[23]
- Committed in the Powering Up Britain strategy to publish a solar roadmap in 2024 towards their target of 70 GW installed capacity by 2035.[3]

- The Fourth Auction Round for contracts for low-carbon capacity took place in 2022.[24] 10.8 GW of capacity was contracted, of which 7 GW was for offshore wind and 2.2 GW for solar. A record low price of £37/MWh was set for fixed-bottom offshore wind.
- The Fifth Auction Round is taking place in 2023, with a £205 million budget confirmed.[25] This will be the first annual auction. A key risk to the success of the auction is the impact of supply chain inflation on the prices developers are able to bid in at, with the maximum price available set by the Government at £44/MWh for offshore wind.[26]

To be addressed:

- The Government has set ambitious targets for renewables capacity, including for up to 50 GW of offshore wind by 2030 (four times current levels), and 70 GW of solar by 2035 (five times current levels).
  - This year we have downgraded our assessment of renewables to reflect increased delivery uncertainty over these timescales. That includes the lack of a forward-looking annual auction schedule, barriers around planning and consenting for projects, and increasing risks around network connections.
  - A Minister-led infrastructure delivery group is needed to expedite the removal of barriers, particularly around planning and connections (priority recommendation R2023-129).
  - Achieving these targets will also require well-functioning supply chains, with sufficient capability (e.g. in port capacity, skills) for meeting the build rates required. The Government should identify and address potential supply chain bottlenecks (recommendation R2022-206).

Nuclear
15% of 2035 electricity generation

O	O	O	O	O

Progress:

- The Government approved Sizewell C and in 2022 took a 50% stake in the project for £700 million.[27] However, no Final Investment Decision has been taken on the project yet.
- The Future Nuclear Enabling Fund (worth up to £120 million) and Phase B of the Advanced Modular Reactors Research, Development and Demonstration programme (worth up to £55 million) were launched in late-2022.[28,29]
- The Government has accepted the recommendation in the Skidmore Review to set out a clear roadmap in 2023 for nuclear deployment, including interim targets towards 2050.

To be addressed:

- Develop the deployment roadmap towards Government ambition of up to 24 GW capacity by 2050, as part of a wider strategy for decarbonising the power sector.
- Continue with existing plans to establish Great British Nuclear and ensure this has sufficient funding to deliver the Government's deployment roadmap.

Flexible low-carbon generation and storage
10% of 2035 electricity generation

Y	Y	O	O	Y

Progress:

- Published a consultation on low-carbon readiness standards for new gas plants.[30]
- Passed legislation for Dispatchable Power Agreements, which will support deployment of power CCS projects.[31]
- Taken Net Zero Teesside Power forward to negotiation, which could be the UK's first ever power CCS project.[32]
- Announced an intention to consult in 2023 on the need and potential design options for market intervention to support hydrogen to power.[33]
- Committed to set out an ambition for interconnector capacity beyond 2030 before spring 2024.[33] Current ambition is for 18 GW by 2030, compared to around 8 GW today.[34]
- Commitment to put in place an appropriate policy framework by 2024 to enable investment in large-scale long-duration energy storage (LODES).[33]

	• £69 million in Government funding allocated to final projects through the LODES competition, to develop and deploy innovative energy storage technologies.[35] **To be addressed:** • The Government's view on the scale of new flexible low-carbon capacity required, and the role of unabated gas, is currently unclear. As part of developing a strategy for decarbonising electricity supply by 2035, the Government needs to assess the scale of flexible generation required and wider implications, including for hydrogen production and storage (priority recommendation R2023-138 and recommendation R2023-099). • Policy needs to signal that there is no long-term role for unabated gas or biomass plants in a decarbonised electricity system. – Given the lifetime of new gas plants (e.g. 25 years), it is important to ensure by 2025 that new gas plants are suitable for converting to low-carbon technologies (e.g. CCS and/or hydrogen) during their lifetime (recommendation R2023-125). – Large-scale unabated biomass power plants should be converted to bioenergy with carbon capture and storage (BECCS) as early as feasible and should not be given extended contracts to operate unabated at high load factors beyond 2027 (recommendation R2023-124). – A business model for power BECCS needs to be finalised in 2023 (recommendation R2023-106).				
Flexible demand	G	G	Y	Y	G
	Progress: • National Grid Electricity System Operator (NGESO) launched their Demand Flexibility Service, allowing consumers to save money by rewarding them for voluntarily reducing or shifting demand. Over winter 2022/23, 3.3 GWh of electricity demand was reduced or time-shifted under the scheme.[36] • Government is consulting on a proposal for multi-year contracts for demand-side response in the Capacity Market, which will improve revenue certainty compared to the current one-year contracts.[37] **To be addressed:** • Smart meters and half-hourly market settlement are both needed to unlock the potential for smart demand flexibility (e.g. from electric vehicle charging). The Government has programmes in place to roll-out smart meters, aiming for full uptake by 2025, and to move to half-hourly market settlement by 2025.[18,38] These should continue to be progressed. • Limited data are currently available to monitor electricity savings achieved by smart demand flexibility at a UK-wide level. Improving data collection so that uptake of smart demand flexibility can be monitored in a reliable manner will be important for tracking progress and understanding the level of flexibility available on the system.				
Networks	O	Y	O	O	O
	Progress: • NGESO published the first transitional Centralised Strategic Network Plan, including the Holistic Network Design (HND) (facilitating the connection of offshore wind), and the UK Government and Ofgem published the Electricity Networks Strategic Framework in 2022 (setting out an overarching vision for the future electricity network).[39,40] • Government appointed Nick Winser as Electricity Networks Commissioner, to accelerate delivery of network infrastructure. • Commitments in the Powering Up Britain Energy Security Plan to publish: a grid connections action plan in summer 2023; the Electricity Network Commissioner's report on accelerating transmission network infrastructure in summer 2023 and a Government response this year; a full Centralised Transmission Networks Review in 2025, which will provide a blueprint for the whole electricity network; and recommendations for a future framework for offshore grid connections from the Offshore Transmission Networks Review in summer 2023.[33]				

	• The Offshore Coordination Support Scheme was launched in 2022, with up to £100 million available for offshore electricity projects to coordinate their transmission infrastructure.[41] • Ofgem set out, through its Accelerating Strategic Transmission Investment decision, an accelerated regulatory approval process for transmission projects identified in the HND.[42] • NGESO has launched a five-point plan to speed up the current connections queue and launched the longer-term Connections Reform Project.[43] • Ofgem has recognised the need to improve the network connection process, to deliver shorter average connection dates to better meet customers' needs and enable a timely transition to Net Zero, and is seeking views on proposals.[44] **To be addressed:** • Our recent report on Delivering a reliable decarbonised power system by 2035 highlighted the need for a substantial increase in network capacity, as well as identifying significant ongoing delivery risks, particularly in relation to planning and consenting, and network connections. – Despite the wide range of work in train to address these issues, the magnitude of the challenge has led us to downgrade our score to reflect the material risks posed to delivery of the overall 2035 objective. – For instance, requests for transmission connections continue to grow, with an 80% increase in connection applications last year and 280 GW of new generation capacity now holding connection agreements. 70% of applicants who received an offer in the last 12 months received connection dates that are five or more years away and over a quarter received connection dates beyond 2032.[44] • Ensuring adequate electricity network capacity is a key enabler for decarbonising the electricity system, so that new low-carbon capacity can connect to the grid and the electricity generated can be effectively utilised. – Strategic investments in network capacity need to be identified with a view to delivering a decarbonised and resilient electricity system (recommendation R2023-130). – In addition to delivering the right transmission infrastructure, sufficient distribution network capacity will be needed for homes and businesses to be able to benefit from increasing electrification – network development should not pose a barrier to the uptake of heat pumps and electric vehicles. – Strategic investment needs on an economy-wide basis must be informed by a cross-vector assessment. Ahead of the 2026 decision on decarbonising heating, and by 2024 at the latest, Government and the FSO should undertake a piece of work to identify which areas of the UK are unlikely to be suitable for hydrogen - such that electrification can be progressed - alongside potential candidate areas for hydrogen. This should be used to inform a set of low-regret infrastructure investments that can proceed immediately (priority recommendation R2023-128). – By 2025, a more comprehensive cross-sectoral infrastructure assessment should be undertaken looking across liquid and gaseous fuels, CO_2 and heat networks. Further detail is set out in Chapter 15 (recommendation R2023-127). – Delays in the planning system and other regulatory processes remain key barriers to deploying low-carbon infrastructure. The Government should set up a Minister-led infrastructure delivery group to ensure enabling initiatives for infrastructure build are taken forward at pace, so that investments can be planned, consented and built in sufficient time (priority recommendation R2023-129).	
Electricity market design		G
	Progress: • Published a first consultation from the Review of Electricity Market Arrangements (REMA), covering high-level options for market reform.[45] • Published a Government response to the first consultation, narrowing the range of options for market reform.[45]	

	• Government is aiming to publish a second consultation in autumn 2023, further refining options.[45] **To be addressed:** • Moving to a renewables-based electricity system by 2035 – and realising the benefits of cleaner, cheaper power – will bring challenges for which current market arrangements and policy are not designed. The Government has started a process of reviewing this and should continue to progress the REMA review, developing a strategy as soon as possible on market design for the medium- to long-term (recommendation R2023-139).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: See Annex 1 for the assessment criteria.

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33 $MtCO_2e$, 7% of UK emissions in 2022

Introduction and key messages

The fuel supply sector contributed 7% of total UK emissions in 2022. Emissions came predominantly from fossil fuel supply, with small contributions from hydrogen production,* and bioenergy supply.†

Historically, emissions in fossil fuel supply have decreased steadily by 3% per year on average since 1990. However, these reductions have been primarily due to the decline of fossil fuel extraction, rather than direct measures taken to decarbonise the sector.

As part of the North Sea Transition Deal, the Government committed to reduce emissions in the oil and gas industry to 50% below 2018 levels by 2030, and reaffirmed its commitment to the target in its Carbon Budget Delivery Plan (CBDP).[1,2] This target is less ambitious than the 68% reduction we estimated could be achieved. Even against this less-ambitious target, considerable delivery risks remain.

We have downgraded our assessment of policy progress relative to last year, reflecting the Government's decision to approve a new coal mine, the continued delay of the Biomass Strategy, and new risks identified around the Government's level of hydrogen ambition.

Our key messages are:

- **Emissions.** The UK's fuel supply emissions increased by 6% in 2022 to 33 $MtCO_2e$. This was due to an increase in oil and gas production in 2022 following a period of low production in 2021, due to the pandemic and maintenance periods.‡ Fuel supply emissions in 2022 were 11% below pre-pandemic (2019) levels.

- **Approval of a new coal mine.** In December 2022, the Government approved the UK's first new deep coal mine for 30 years – despite the strong concerns we set out in a letter to the then Secretary of State for Housing, Communities and Local Government on 29 January 2021.[3,4] If development of the mine goes ahead following the decision, it will commit the UK to emissions from coking coal, for which there may be no domestic use after 2035. The mine will have a noticeable impact on emissions in the fuel supply sector, in addition to increasing global emissions.

- **New licensing round for oil and gas production.** The Energy Security Strategy committed to an increase in North Sea oil and gas production to reduce the UK's dependency on imports and with a view to reducing prices for consumers.[5] In line with this commitment, the North Sea Transition Authority launched a new licensing round for oil and gas projects in October.[6]

    - We outlined in a letter to the then Secretary of State for the Department for Business, Energy and Industrial Strategy (BEIS) on 24 February 2022 that increases in domestic oil and gas extraction would

* This chapter accounts for emissions that might stem from low-carbon hydrogen production. Emissions from current UK high-carbon hydrogen and ammonia (e.g. used in industry and agriculture) are included in Chapter 6.

† Bioenergy emissions are currently accounted for in other sectors. Chapter 9 covers emissions associated with the cultivation of energy crops and UK forestry. Chapters 4, 10, and 11 include emissions from transporting fuels and biomass by land, air, and sea.

‡ 2022 emissions are provisional and non-CO_2 emissions are not reported to the same level of accuracy. Non-CO_2 emissions accounted for 17% of 2021 fuel supply emissions.

have, at most, a marginal effect on prices.[7] The best way to reduce the UK's exposure to volatile markets is instead to cut fossil fuel consumption through measures such as rapidly shifting to renewables, improving energy efficiency and electrifying end uses (such as heating, industry and transport).

  - Potential increases in oil and gas production make it even more important to ensure that the emissions footprint of North Sea production is as low as possible. We have identified significant risks with Government progress in reducing this footprint, particularly on the electrification of platforms. Government, regulators and industry must take steps to strengthen ambition well beyond the 50% target set out in the North Sea Transition Deal (e.g. to reduce emissions by over 60% relative to 2018 levels by 2030) and cement delivery mechanisms, if fossil fuel supply emissions are to be minimised and increases in emissions avoided.

- **Hydrogen deployment.** The Government has committed to deliver up to 10 GW of low-carbon hydrogen production capacity by 2030, with at least half from electrolytic hydrogen. However, greater clarity on targets for hydrogen production volumes and an acceleration of deployment plans are required.

  - The Government's target of up to 10 GW of low-carbon hydrogen production capacity by 2030 risks being on the lower end of what is required.[8] The Government should provide clarity on its hydrogen production ambition by publishing targets on a TWh/year basis, and review whether this target is sufficient to meet future demands.

  - There is an important role for Government in setting the strategic direction for hydrogen, with decisions on end-uses (e.g. how much hydrogen might be used for heating or electricity production – see Chapters 5 and 7) dictating the level of infrastructure required. Long infrastructure lead times imply a need for Government to fast-track hydrogen transport and storage business models, in order to keep options open on the scale of hydrogen usage by 2030 and 2035. The Government should identify a series of low-regret investments that can proceed now.

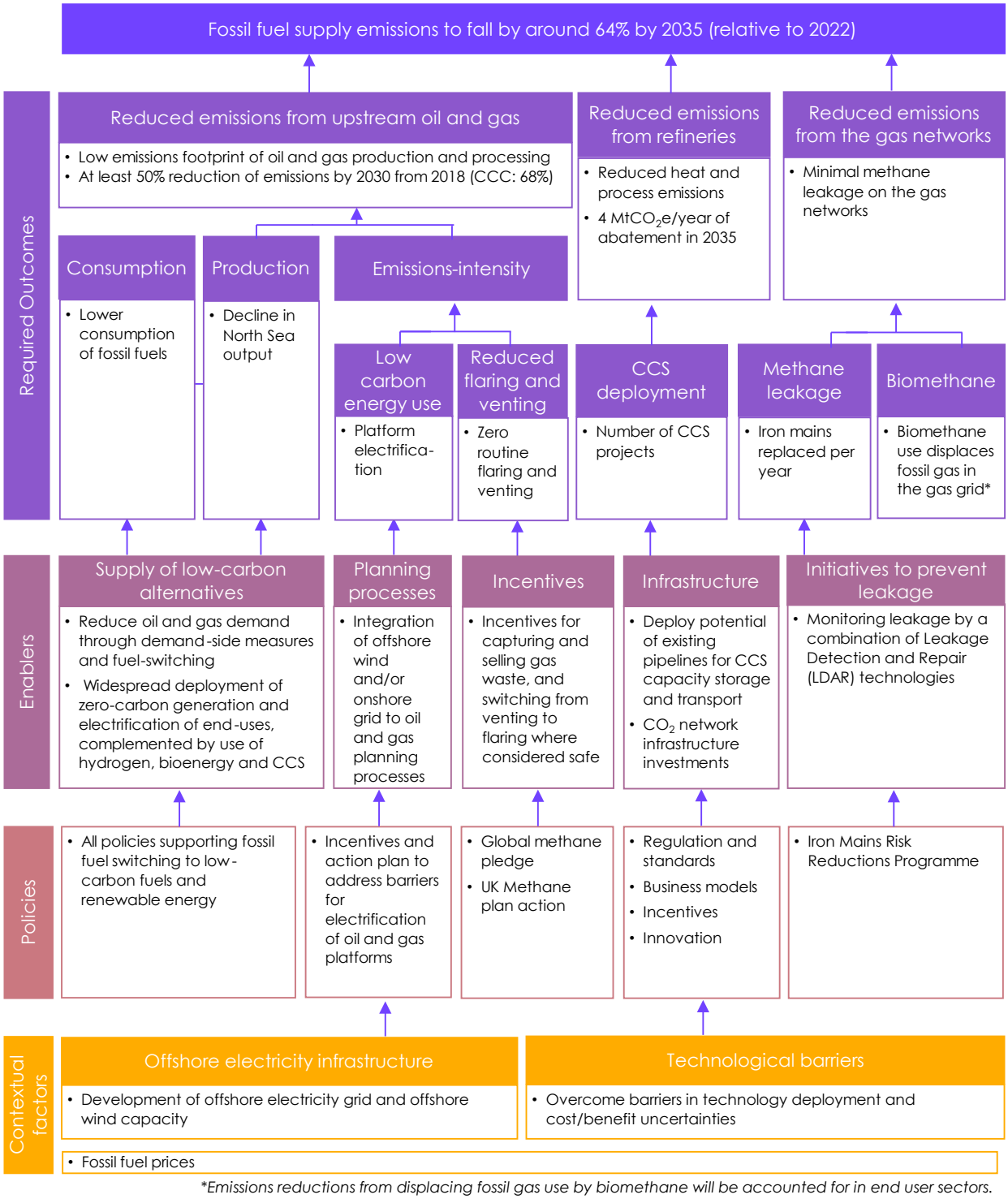
- **Biomass Strategy.** We continue to wait for the publication of the Government's Biomass Strategy, previously announced for publication in 2022 and now scheduled for later in 2023. The absence of the strategy is leading to significant uncertainty on plans and ambitions for bioenergy and it should be published urgently.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 8.1 Monitoring map for fossil fuel supply



Emissions reductions from displacing fossil gas use by biomethane will be accounted for in end user sectors.

Source: CCC analysis.
Notes: Numbers are from the Government's Carbon Budget Delivery Plan unless stated otherwise.

The CCC's monitoring map for fuel supply sets out the policies, enablers and required outcomes for a successful transition (Figure 8.1). This report focuses on six key indicators, with additional indicators available in the supplementary material presented alongside this report. New indicators on hydrogen have been added relative to last year, to reflect new analysis undertaken for, and subsequent to, our recent report on Delivering a reliable decarbonised power system.[8] Our Monitoring Framework documents the indicators we track and our approach for assessing progress.

Emissions in 2022 increased by 6% due to a rebound in oil and gas production and refinery activity. These areas previously saw emissions decline in 2020 and 2021 due to the pandemic and extensive maintenance periods.

Emissions. Fuel supply emissions rebounded in 2022 following an accelerated drop in emissions in 2020 and 2021. In 2022, emissions increased by 6% relative to 2021 to 33 $MtCO_2e$ (Figure 8.2a) but were 11% below pre-pandemic (2019) levels.

- There has been a steady decline in fuel supply emissions since 1990, largely due to a decline in domestic fossil fuel production (and in particular coal), rather than due to reductions in the intensity of emissions associated with production (Figure 8.3).

- Emissions reductions accelerated slightly from 2019 to 2021 due to a drop in total oil and gas production and refinery activity (Figure 8.4 and Figure 8.5 respectively). Lower production was due to a combination of reduced demand for petroleum during the pandemic and an extensive period of maintenance (both planned, and including delays from 2020) shutting down major terminals. Oil and gas production and refinery activity both increased in 2022.

- Driven by the reduction in coal production, methane emissions in the fuel supply sector have greatly reduced since 1990 (Figure 8.6). However, progress has slowed in recent years with methane emissions from the gas distribution and transmission networks now dominating.

Fossil fuel supply. The provisional emissions for 2022 show that the emissions from refineries and oil and gas production increased from 2021 (Figure 8.3).*

- Emissions from refineries contributed 37% of UK fuel supply emissions in 2022 (Figure 8.2b and Figure 8.3). Emissions closely followed refinery activity with the increases in refinery activity in 2022 resulting in an increase in the provisional 2022 emissions. The indicator is now slightly off-track.

Government and industry can and should set a more ambitious 2030 target for decarbonising the oil and gas industry.

- To track overall progress in reducing emissions from oil and gas production, we look in tandem at indicators for both the total emissions and the emissions-intensity of production. We estimate that there is room for the Government and industry to increase their 2030 ambition for reducing emissions from oil and gas supply, and we have therefore assessed progress against our pathways rather than the Government's. Both emissions and emissions-intensity have increased relative to last year. It is too early to tell the extent to which this trend will be sustained, although it remains clear that further action is needed to drive down the emissions-intensity of production (e.g. through the electrification of platforms and reduced flaring and venting).

  – Total oil and gas production emissions (Figure 8.2c) show a similar pattern to refineries, with emissions aligned with production. It is too

* Provisional estimates do not update non-CO_2 emissions and are subject to change. In 2021, non-CO_2 emissions accounted for only 0.2% and 7.9% of refineries and oil and gas production emissions, respectively.

early to tell whether the rebound in 2022 will be sustained in the following years.

– The Government's lower ambition for decarbonising oil and gas production relative to the CCC's contributes to noticeable differences in targeted emissions-intensity, with the Government's pathway allowing for it to increase slightly to 2030 (Figure 8.2d). While an increasing emissions-intensity is a common feature of depleting oil and gas fields, policy action should be taken to offset some of this increase. The emissions-intensity of oil and gas production increased between 2020 and 2022 and is off-track relative to our pathway.

We have set out a series of indicators that reflect the range and scale of hydrogen's possible future roles across the economy. It is currently not possible to determine if the Government is on track to meet the low-carbon hydrogen production and storage capacities required.

Hydrogen supply. As the transition progresses, hydrogen will play an increasing role in the UK's supply of energy. However, the scale of hydrogen use remains uncertain. There is an important role for Government in setting the strategic direction for hydrogen, with decisions on end uses influencing the scale of capacity and infrastructure required.

We have developed a set of indicators to reflect the range and scale of possible future roles for hydrogen (covering both non-power demands and use in low-carbon dispatchable generation). These are based on the analysis undertaken for our recent report on Delivering a reliable decarbonised power system, with additional analysis having been undertaken since to develop an updated lower bound for our hydrogen indicator ranges.[8] It is currently too early to say if the Government is on track to meet the low-carbon hydrogen production and storage capacities required.

- CCC's analysis suggests that low-carbon hydrogen production will need to rise sharply to between around 40 and 120 TWh/year by 2030 (Figure 8.2e). The projected ramp-up in production begins in 2025. We have not identified data on the volume currently in production, but it is expected to be very small.

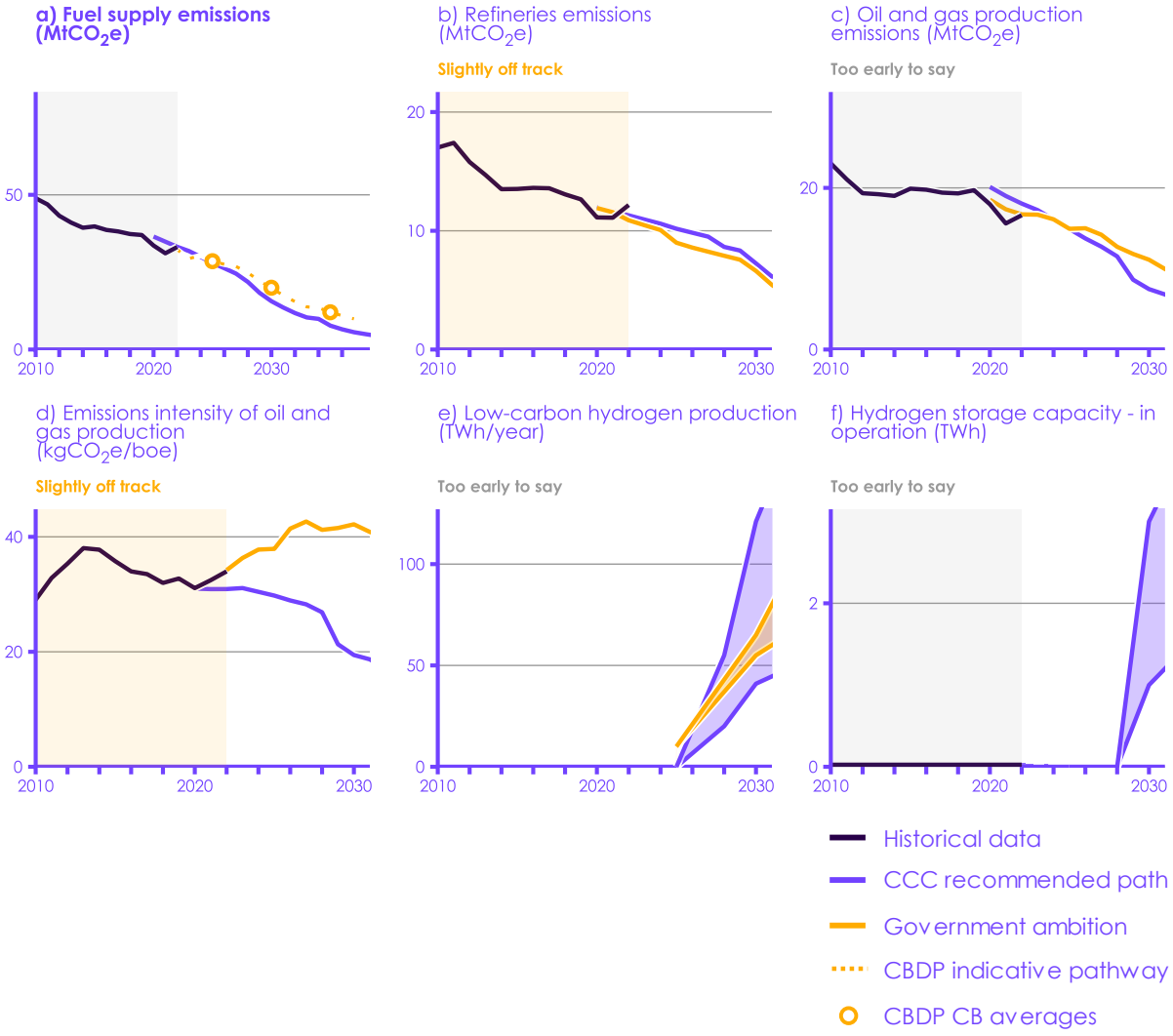
- Alongside this, hydrogen storage capacity in operation will need to ramp up quickly from 2028, to between 1 and 3 TWh by 2030 (Figure 8.2f). There is currently 0.025 TWh of hydrogen storage capacity in operation.[9]

- To enable the ongoing tracking of these indicators, we require Government to publish data on low-carbon hydrogen production on a TWh/year basis, and on hydrogen storage capacity. The data should set out capacities in operation, under construction and in development.

We will develop bioenergy supply indicators following the publication of the upcoming Biomass Strategy.

Biomass supply. Following the publication of the UK Government's Biomass Strategy, we intend to develop a set of indicators to track progress on biomass supply and the deployment of uses compatible with Net Zero.

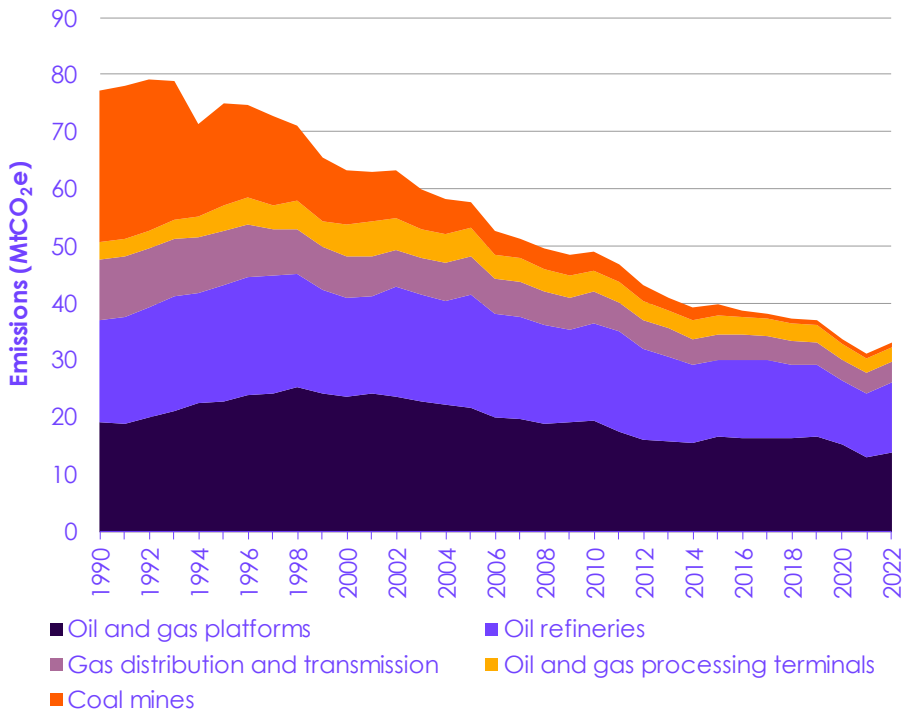
Figure 8.2 Key indicators for fuel supply



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps. DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*; NSTA (2023) *February 2023 oil and gas production projections*; DESNZ (2022) *Hydrogen Transport and Storage Analytical Annex*.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path, and considering the wider contextual factors that may have a temporary impact (e.g. recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (3) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions.

Fuel supply emissions have steadily reduced since 1990, mainly due to a decrease in fossil fuel production, particularly coal.

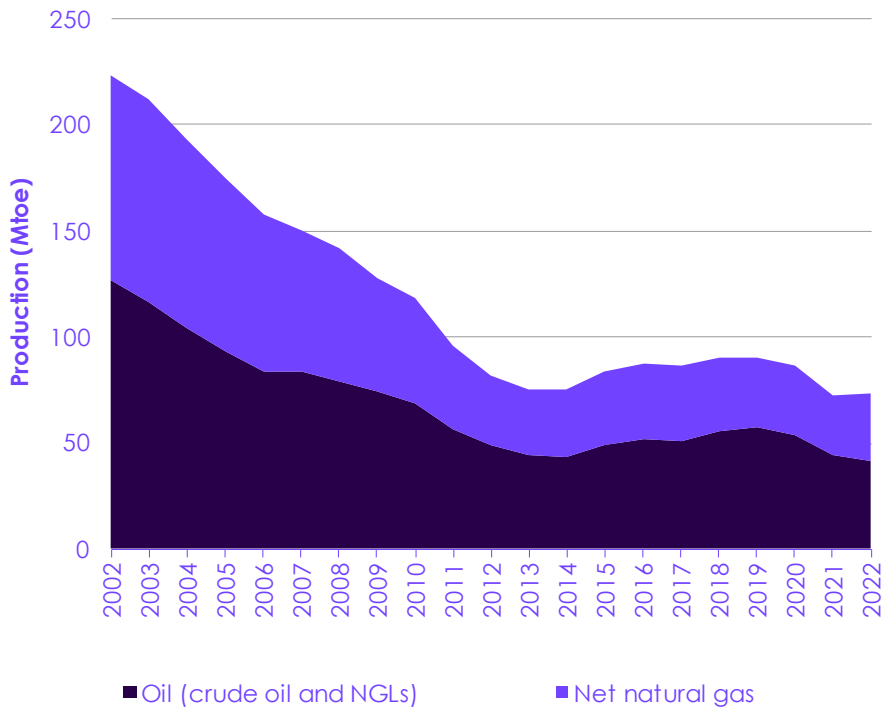
Figure 8.3 Fuel supply emissions since 1990



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*

Total oil and gas production increased in 2022 following a drop in 2020 and 2021, due to the pandemic and extensive maintenance periods.

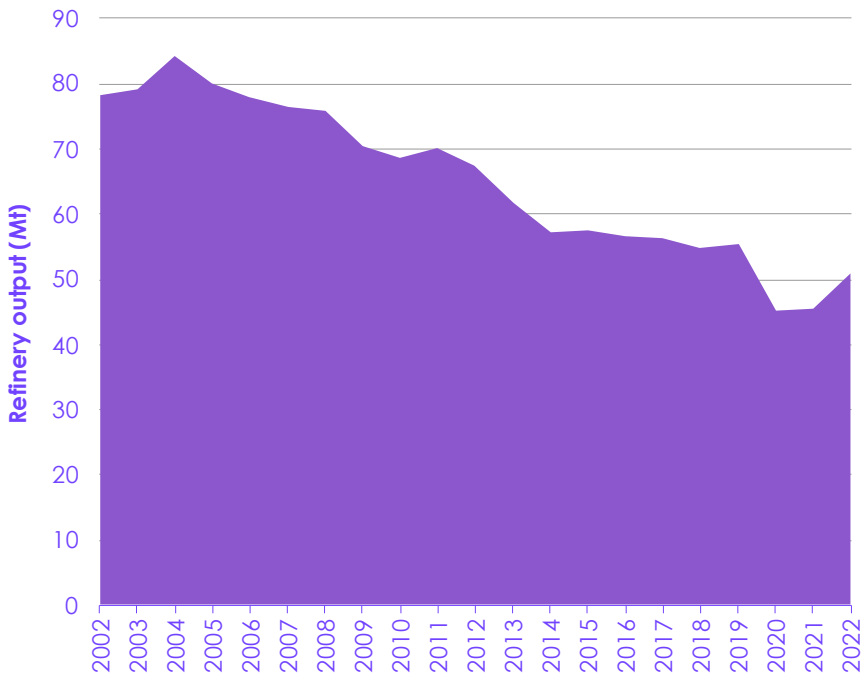
Figure 8.4 UK oil and gas production since 2002



Source: NSTA (2023) *February 2023 oil and gas production projections.*
Note: NGLs are Natural Gas Liquids.

Refinery activity rebounded in 2022 following a drop in 2020 and 2021 due to the pandemic and maintenance periods (both planned and delayed from 2020).

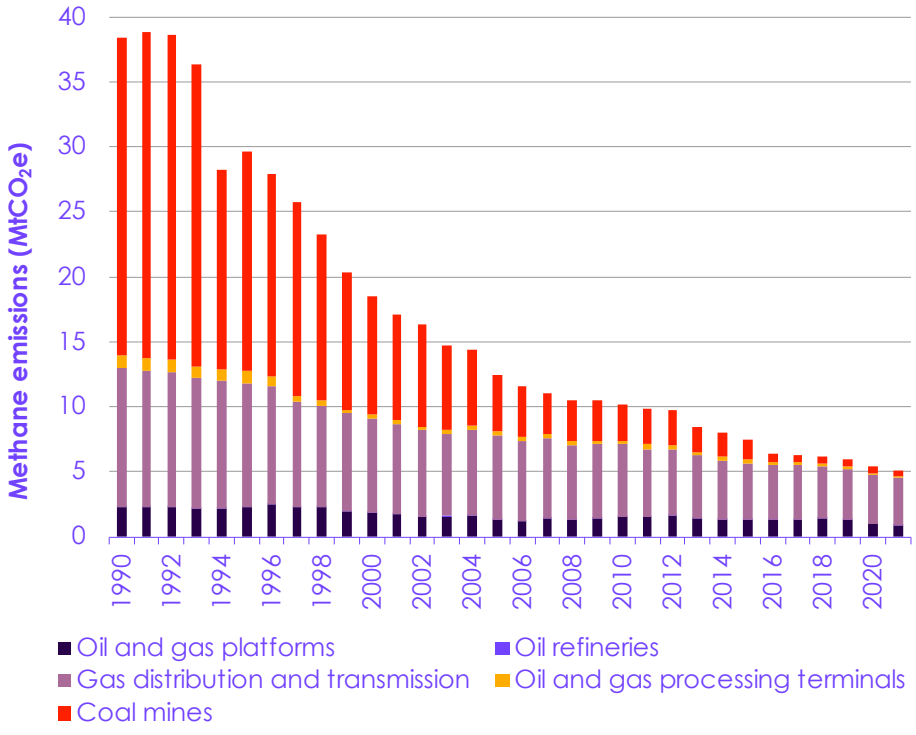
Figure 8.5 Refinery output of petroleum products



Source: DESNZ (2023) *Energy Trends: UK oil and oil products, Refinery throughput and output of petroleum products (ET 3.12 – March 2023).*

Decreasing coal demand has driven a reduction in methane emissions in the fuel supply sector. Methane emissions from the gas distribution and transmission networks now dominate.

Figure 8.6 Methane emissions in the fuel supply sector



Source: BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*
Notes: The 2022 provisional emissions inventory does not update non-CO_2 emissions.

We have downgraded our assessment of policy progress compared to last year, reflecting the Government's decision to approve a new coal mine, the continued delay of the Biomass Strategy and risks around the Government's level of hydrogen ambition.

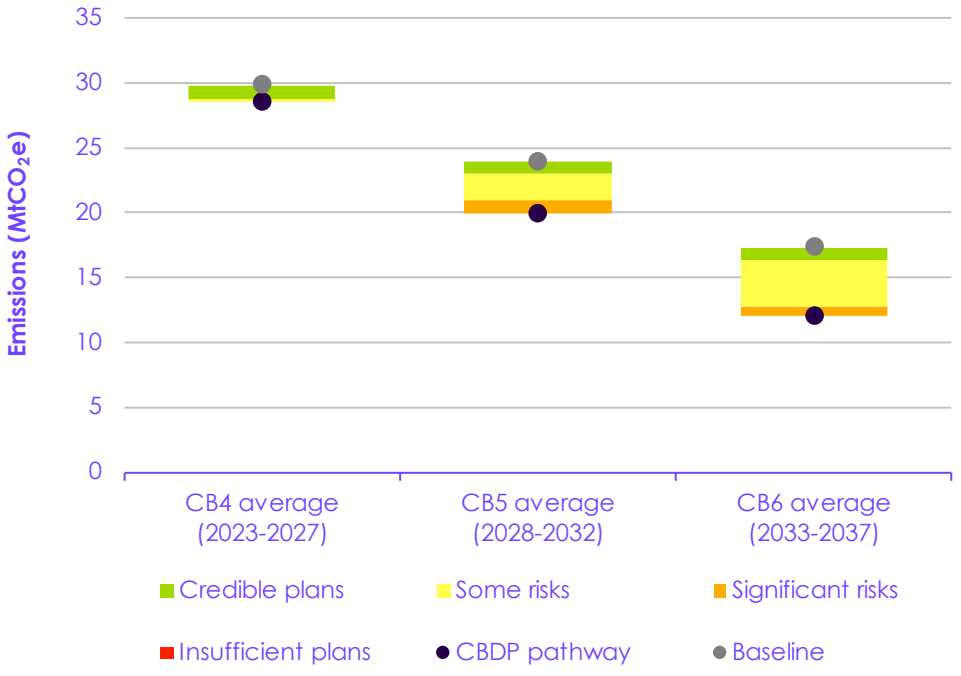
Our assessment of policy progress in the fuel supply sector found some risks in most areas, with credible policies in place to meet only 17% of the required emissions reduction by the Sixth Carbon Budget period (Figure 8.7, Table 8.1). Our assessment is based on the criteria outlined in Annex 1. We have downgraded our assessment compared to last year. This reflects Government's decision to approve the UK's first new deep coal mine for 30 years, the continued delay of the Biomass Strategy and new risks we have identified around the Government's level of hydrogen ambition, in light of our recent report on the delivery of a 2035 decarbonised power system.[8]

Table 8.1 gives a summary of recent progress and what still needs to be addressed. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 8.1.

The policy assessment in this report focuses on measures to reduce emissions, but the fuel supply sector must also be well adapted to future climate impacts. In the CCC's recent report - Progress in adapting to climate change – 2023 Report to Parliament – we assessed progress in making the energy system resilient to climate change. Recommendations include designating Ofgem and the new Future System Operator (FSO) with a clear mandate to ensure weather and climate resilience, and commissioning further research to improve understanding of how climate change is altering key weather hazards that will impact the energy system.

Our assessment is that credible policies are in place to meet only 17% of the required emissions reductions in the Sixth Carbon Budget.

Figure 8.7 Assessment of policies and plans for fuel supply



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan. See Annex 1 for the assessment criteria. (2) Emissions from refineries are included within the CCC's fuel supply sector.

Table 8.1
Policy scorecard for fuel supply

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Fuel supply overall assessment	Y	Y	O	O	O
Electrification of oil and gas platforms 13% of abatement over CB6 period	O	O	R	O	O

Progress: In the 2021 North Sea Transition Deal, Government and industry committed to reduce emissions in the oil and gas industry to 50% below 2018 levels by 2030.[1] The North Sea Transition Authority (NSTA) has confirmed that it views this as representing a minimum level of ambition, which industry should aim to surpass.[10]

The electrification of oil and gas platforms will be key to meeting this target. With regard to new offshore oil and gas platforms, the NSTA updated its Field Development Plan Guidance in 2021 to include a 'net zero evaluation', requiring field operators to demonstrate that they have considered electrification or considered making a field electrification ready, prior to approval.[11] A series of electrification policies were also outlined in the North Sea Transition Deal and in an update on progress provided in 2022.[12] These included £1 million of funding to support the development of electrification studies, the creation of the Innovation and Targeted Oil and Gas (INTOG) leasing round to integrate offshore wind projects into oil and gas platforms in Scottish waters and the formation of the Government and Regulators Electrification Group (GREG) to explore how barriers can be addressed.

Since our last progress report, the following developments have taken place:

- The NSTA announced its ambitions to have at least two electrification projects commissioned by 2027.[13]
- The winners of the first INTOG leasing round were announced in March 2023.[14] 5 GW of offshore wind has been allocated to provide renewable electricity directly to oil and gas infrastructure, with option agreements expected in 2024.
- The NSTA published a letter setting out further detail around the approach it takes to assessing compliance with decarbonisation obligations in its Strategy.[15]

To be addressed:

- Significantly greater decarbonisation ambition is required. Given the potential for new North Sea oil and gas production, industry should be redoubling efforts to cut emissions at source, required and incentivised by Government policy and NSTA regulation. In our Sixth Carbon Budget advice, we estimated that the electrification of compressors and generators on oil and gas platforms can contribute almost seven times more average annual abatement across the Sixth Carbon Budget than the CBDP aims for.[16] Government, regulators and industry must take steps to strengthen ambition well beyond the 50% target set out in the North Sea Transition Deal (e.g. to reduce emissions by over 60% relative to 2018 levels by 2030).
- Greater clarity is needed over the requirements for new oil and gas installations to electrify. The expectation should be for new oil and gas installations to electrify wherever viable, with platforms that cannot be immediately electrified being built fully 'electrification-ready' and required to electrify as soon as possible. Delivering this will require barriers (e.g. around grid connections and consenting pathways) to be addressed urgently (recommendation R2023-094).
- While progress has been made in a range of areas relating to electrifying existing oil and gas infrastructure, gaps remain. For instance, following the conclusion of the INTOG leasing round, there is currently no plan in place to demonstrate how electrification will be rolled out to further platforms, both in and outside of Scottish waters. A delivery plan for the

	decarbonisation of oil and gas infrastructure is needed, including a timetable for electrification and the phase-down of production. Given important interdependencies, this should be published alongside, or as part of, an offshore industries integrated strategy, as recommended by the Skidmore review (recommendation R2023-096).[17]				
Reduced venting and flaring 4% of abatement over CB6 period	G	Y	Y	O	Y
	Progress: Policies and regulations are already in place to reduce emissions from flaring and venting: • The NSTA has guidance in place on flaring and venting, which sets out the principles and approaches used to consider applications for flaring and venting consents and outlines the aim for facilities to achieve zero routine flaring and venting by 2030.[18] • Operators found to have exceeded their flaring and venting consents face NSTA fines.[19] The NSTA reports that flaring has reduced by 50% since 2018.[20] This progress has been reflected in the delivery mechanism and responsibilities assessment rating. • All new developments are expected to be planned on the basis of zero routine flaring. **To be addressed:** • While the consenting policy is proving to be effective, we recommended greater ambition as part of our Sixth Carbon Budget advice. Targets for flaring and venting should be strengthened and brought forward for those facilities planned to remain in operation post-2030, with flaring and venting only permitted beyond 2025 when necessary for safety reasons (recommendation R2023-095).				
Reduced methane leakage 17% of abatement over CB6 period	Y	Y	Y	Y	Y
	Progress: Actions on reducing methane emissions from the fuel supply sector are required as part of the UK's contributions under the Global Methane Pledge, an international initiative to reduce global methane emissions by 30% by 2030, relative to 2020.[21] • The Iron Mains Risk Reduction Programme - where ageing metallic pipes in the gas distribution network are switched with plastic pipes - is ongoing.[22] • Ofgem sets individual shrinkage volume targets (gas lost from the network through leakage, operator's own use and theft) for each gas distribution network and provides financial incentives for the network operators to reduce this through its price control frameworks.[23] **To be addressed:** • Although they are credible policies, based on the Government's projections it is unclear whether the Iron Mains Risk Reduction Programme and Ofgem's shrinkage targets and linked incentives are consistent with the achievement of the 3.6 $MtCO_2e$ of abatement we estimate is deliverable by 2035. These risks are reflected in the policy assessment ratings. • Decommissioning will need to be considered as part of planning for ongoing iron mains replacement. Where assets pose an unacceptable safety risk they should be replaced. Any further replacement should ensure the risk of asset stranding is minimal in light of the likely future need for natural gas or hydrogen supply.				
Low-carbon hydrogen No quantified abatement in the Government's pathway*	Y	Y	O	O	O
	Progress: In its 2022 Energy Security Strategy, the Government set an ambition to deliver up to 10 GW of low-carbon hydrogen production capacity by 2030, with at least half from electrolytic hydrogen.[5] A series of supporting policies to meet the target have been previously set out including the Net Zero Hydrogen Fund, the Hydrogen Production Business Model, and the Low-carbon Hydrogen Standard.[24,25,26] The main developments since the last progress report are: • An updated version of the Hydrogen Net Zero Investment Roadmap was published in April 2023, setting out investment opportunities and timelines for hydrogen deployment.[27] The				

* Emissions reductions from low-carbon hydrogen use are accounted for in end-use sectors. Hydrogen production is associated with a slight increase in emissions in the fuel supply sector due to blue hydrogen production.

roadmap also presented the known pipeline for hydrogen projects, with the potential capacity totalling around 20 GW (including both electrolytic and CCS-enabled) in 2030.

- The Energy Bill, introduced to Parliament on 6 July 2022, contains provisions to underpin delivery of low-carbon hydrogen production.[28]
- The Government has published the Heads of Terms for the Hydrogen Production Business Model contract,[29] as well as a consultation on proposed regulations in relation to the low-carbon hydrogen production business model.[30]
- The Government awarded £19 million of funding across five successful projects of the Low Carbon Hydrogen Supply 2 competition.[31] The first winning projects from the Net Zero Hydrogen Fund strands 1 and 2 have also been confirmed. Nearly £38 million will be allocated to support development and deployment of low-carbon hydrogen production across 15 projects.[32]
- The Government has also committed to work with industry and other stakeholders to develop a hydrogen production roadmap over the course of 2023 on scaling up production and supply chains.[33]
- The first electrolytic hydrogen production allocation round was launched in July 2022 and a shortlist of projects announced in March 2023.[34] The round expects to award contracts totalling up to 250 MW of capacity. A second allocation round is expected by the end of 2023 with the long-term intention to move to price competitive allocation in 2025.
- A consultation on new business models for hydrogen transport and storage infrastructure was published in August 2022, with the Government committing to develop the final models by 2025.[35] Among other things, this consultation also covered the need for, and potential approaches to, strategic planning of hydrogen transport and storage infrastructure.
- The Government has announced plans to use the Low Carbon Hydrogen Standard to develop a globally recognised certification scheme for low-carbon hydrogen, with the intention of being introduced by 2025.[36]
- Jane Toogood was appointed as the UK's Hydrogen Champion in July 2022 as an independent expert advisor to engage with industry to identify barriers to investment. This position has been extended for six months until July 2023 and will build on recommendations set out in the Hydrogen Champion's Report.[37]

To be addressed: While the Government has made valuable progress over the past year, our recent report on the delivery of a 2035 decarbonised power system found that greater clarity on Government hydrogen production ambition is required, with new risks around the level of ambition being identified. We also found that progress on business models and infrastructure needs to be accelerated.[8] Given the level of the target and the pace of business model development remain fundamental to overall delivery, these factors have led to an overall assessment of increased risk relative to last year.

- In light of analysis set out in our recent report, the Government's target of up to 10 GW of low-carbon hydrogen production capacity by 2030 risks being on the lower end of what could be required. Strategic decisions may be needed around the scale of hydrogen use across sectors, or to adjust the level of the target (recommendation R2023-099).
- The Government's Carbon Budget Delivery Plan identifies that up to 50% of the 2030 hydrogen production ambition depends on CCUS, which carries delivery risks which could materially affect the successful delivery of the associated carbon savings.[2] More detail on the contribution of CCS to the government's hydrogen production targets is needed. Risks relating to CCS are discussed in greater detail in Chapter 14.
- Funding models to enable hydrogen production need to be finalised, ensuring they limit emissions, while avoiding bias towards hydrogen where electrification is competitive (recommendation R2023-097).
- Long lead-times associated with infrastructure build suggest that the Government's timeframes for supporting policy may not be sufficiently ambitious to achieve the levels of infrastructure which could be required. The Government should fast-track the development of new business models for hydrogen transport and storage with a view to keeping options open for larger scale hydrogen use by 2030 (recommendation R2023-098). In addition, there is a need to publish a plan for distribution and storage of hydrogen outside clusters (recommendation R2022-256).

	• While the scale of the hydrogen network is highly dependent on decisions yet to be taken in high-demand sectors (e.g. the 2026 hydrogen for heat decision), late network delivery has the potential to act as a blocker to storage and production infrastructure. Government must identify a set of low-regret investments that can proceed now (priority recommendation R2023-128).

Bioenergy best use and CCS No quantified abatement in the Government's pathway*	O	Y	Y	O	O

Progress:

- The Green Gas Support Scheme remains in place and provides financial incentives for the generation of biomethane by anaerobic digestion, with the biomethane then injected into the network.[38] The scheme is planned to close in 2025/26.

To be addressed:

- Future support for the generation of biomethane and its injection into the natural gas network should be developed to follow the closure of the Green Gas Support Scheme. The support must facilitate the production of biomethane with CCUS on the biogas-upgrading process to maximise abatement.
- The Government previously committed to publishing a Biomass Strategy in 2022. However, it has not yet been published and is now scheduled for later in 2023. We have downgraded the overall rating in light of this, to reflect the ongoing uncertainty around plans and ambitions for bioenergy. The published strategy needs to be integrated into the Land Use Framework, set out mechanisms to support sustainable expansion on domestic biomass supply, demonstrate how bioenergy with CCS (BECCS) will be rapidly deployed and inform the best use of bioenergy resources. This needs to fully account for sustainability (including impacts on nature) and food security concerns (recommendation R2022-222).
- The UK should continue to take a global lead on further developing and improving UK and international biomass governance and sustainability criteria (recommendation R2022-221).

CCS in refineries 66% of abatement over CB6 period	Y	G	Y	Y	Y

Progress:

- The development of CCS in refineries is heavily dependent on wider progress in CCS. We set out the key developments and areas to be addressed for CCS in Chapter 14 and Chapter 6. Key developments include a commitment for up to £20 billion for early development of CCUS, progress in developing the key design aspects of business models and announcements on the eight projects that will progress to negotiations to form the first two CCS clusters. The Government has also launched the process for confirming the next two clusters for deployment in Track 2.

To be addressed:

- Chapter 14 presents several concerns with the development of CCS infrastructure and business models on which CCS in refineries depends. These include risks that the various funding and business models are not yet proven and that there is no specific policy framework currently in place for dispersed sites.
- Of the eight projects selected to progress to negotiations to form the first two CCUS clusters, none are CCS in refineries projects.

* Emissions reductions from bioenergy will be accounted for in other sectors (e.g. surface transport, agriculture and land & use, aviation and shipping).

Size of fossil fuel extraction industry No quantified abatement in the Government's pathway	R

New sites continue to be identified for UK fossil fuel exploration and extraction.

- **Coal mining**
  - In December 2022, the UK Government granted approval to the UK's first new deep coal mine for 30 years. If development of the mine goes ahead following the decision to award planning permission to 2049, the UK will be committed to emissions from coking coal, of which we have outlined that there should be no domestic use after 2035. Furthermore, 85% of the coal is planned for export to Europe.[3]
  - Even before the mine enters operation, the decision undermines the UK position as a leader on climate action. It will have an appreciable impact on emissions in the Fuel Supply sector - we anticipate that the mine will increase UK emissions by 0.4 $MtCO_2e$ per year, greater than the level of annual emissions we have projected from all UK coal mines to 2050.
  - In January 2022, formal approval was also given for expansion of a mine in Wales.[39]
  - In a range of areas, planning and statutory frameworks are outdated and do not reflect the declining role of coal in the context of binding UK and international greenhouse gas emission targets. For instance, the Coal Industry Act requires the Coal Authority to maintain an economically viable coal-mining industry in Great Britain.[40] While the Scottish and Welsh Governments have both set out strong policy against the extraction of coal (through their preferred policy position and Coal Policy Statement respectively), the National Planning Policy Framework in England requires minerals planning authorities to identify areas where coal extraction may be acceptable.[41,42,43] It also explicitly allows planning permission to be granted to coal extraction schemes identified as environmentally unacceptable (where they can demonstrate national, local or community benefits that are deemed to outweigh the environmental impacts). Some permitted development rights also exist in relation to coal mining.[44] For further discussion on the misalignment of planning policy with Net Zero and adaptation see Box 15.5 in Chapter 15.
- **Oil and gas exploration**
  - In line with the announcement in the Government's Energy Security Strategy, the NSTA launched a licensing round for oil and gas projects in October 2022 with licenses expected to be awarded in the second quarter of 2023.[6]
  - Increases in UK extraction of oil and gas would have, at most, a marginal effect on the prices faced by UK consumers. The best way to reduce exposure to volatile markets is to cut fossil fuel consumption (improving energy efficiency, shifting to a renewables-based power system, electrifying end uses such as transport).
  - The Government developed a Climate Compatibility Checkpoint to check the compatibility of future oil and gas licensing rounds with the UK's climate objectives.[45] However, the scope of the checkpoint remains limited and it does not have a legislative basis, with the ultimate decision held by the NSTA.
  - As with coal, some planning frameworks continue to encourage oil and gas extraction. The National Planning Policy Framework requires minerals planning authorities to 'plan positively' for production when planning onshore oil and gas development.

To be addressed:

- The Government should align with the overwhelming evidence against new consents for coal and ensure that planning frameworks and guidance across the UK support a clear presumption against new consents for coal production. New extraction should only be permitted for safe decommissioning, or where firm policy requires the coal produced to be used (domestically or internationally) in a way that is compatible with Net Zero pathways (e.g. at least 95% CO_2 capture and storage). Local plans should not be required to proactively identify sites for future coal extraction – this practice is outdated and should be ended immediately (priority recommendation R2023-092).
- The tests for allowing any further oil and gas exploration and extraction should be strengthened and clarified. Stringent tests, with a presumption against exploration and in line with more ambitious decarbonisation targets (well beyond the 50% target set out in the North Sea Transition Deal, e.g. to reduce emissions by over 60% relative to 2018 levels by 2030), should be applied at each stage of the licensing and consent process. Greater transparency

	is required around the assessment processes and criteria for approval (priority recommendation R2023-093). • As part of the Glasgow Climate Pact, the UK committed to phase out inefficient fossil fuel subsidies. It is important that production subsidies for fossil fuels do not lock-in financial resource towards oil and gas extraction that could result in a breach of the UK's climate budgets or mean that assets that may need to be stranded to comply (recommendation R2023-195).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan.

Endnotes

[1] Department for Business, Energy & Industrial Strategy (BEIS) (2021) *North Sea Transition Deal,* https://www.gov.uk/government/publications/north-sea-transition-deal.

[2] Department for Energy Security and Net Zero (DESNZ) (2023) *Carbon Budget Delivery Plan,* https://www.gov.uk/government/publications/carbon-budget-delivery-plan.

[3] Department for Levelling up, Housing and Communities (DLUHC) (2022), *Called-in decision: former Marchon Site, Pow Beck Valley and area from the former Marchon Site to St Bees coast, Whitehaven, Cumbria (ref: 3271069 – 7 December 2022),* https://www.gov.uk/government/publications/called-in-decision-former-marchon-site-pow-beck-valley-and-area-from-the-former-marchon-site-to-st-bees-coast-whitehaven-cumbria-ref-3271069-7.

[4] CCC (2021) *Letter: Deep Coal Mining in the UK,* https://www.theccc.org.uk/publication/letter-deep-coal-mining-in-the-uk/.

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[6] North Sea Transition Authority (NSTA) (2022) *NSTA launches 33rd Offshore Oil and Gas Licensing Round,* https://www.nstauthority.co.uk/news-publications/news/2022/nsta-launches-33rd-offshore-oil-and-gas-licensing-round/.

[7] CCC (2022) *Letter: Climate Compatibility of New Oil and Gas Fields,* https://www.theccc.org.uk/publication/letter-climate-compatibility-of-new-oil-and-gas-fields/.

[8] CCC (2023) *Delivering a reliable decarbonised power system,* https://www.theccc.org.uk/publication/delivering-a-reliable-decarbonised-power-system/.

[9] DESNZ (2022) *Hydrogen Transport and Storage Analytical Annex,* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1100705/hydrogen-transport-storage-analytical-annex.pdf.

[10] NSTA (2022) *Emissions Monitoring Report,* https://www.nstauthority.co.uk/media/8439/emr-2022-final-v2.pdf.

[11] NSTA (2021) *Requirements for the planning of and consent to UKCS Field Developments*, https://www.nstauthority.co.uk/media/7803/fdp_guidance_111021.pdf.

[12] BEIS (2022) *North Sea Transition Deal: one year on,* https://www.gov.uk/government/publications/north-sea-transition-deal.

[13] NSTA (2022) *NSTA Corporate Plan 2022-2027,* https://www.nstauthority.co.uk/media/8166/corporate-plan-2022-final.pdf.

[14] Crown Estate Scotland (2023) *INTOG: 13 projects selected to support green innovation and help decarbonise North Sea,* https://www.crownestatescotland.com/news/intog-13-projects-selected-to-support-green-innovation-and-help-decarbonise-north-sea.

[15] NSTA (2023) *NSTA Industry Electrification Letter,* https://www.nstauthority.co.uk/media/9061/nsta-industry-electrification-letter-05042023.pdf.

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49 $MtCO_2e$, 11% of UK emissions in 2021

Introduction and key messages

Emissions from agriculture and land use were 49 $MtCO_2e$ in 2021 (48 $MtCO_2e$ from agriculture and 1 $MtCO_2e$ from land use), an increase of 1 $MtCO_2e$ compared with 2020, driven by increases in agricultural emissions. Over the longer term, emissions have fallen by 7 $MtCO_2e$ and 10 $MtCO_2e$ in the agriculture and land-use sectors respectively since 1990.

The 2023 Carbon Budget Delivery Plan (CBDP) sets out plans to reduce emissions in the agriculture and land-use sectors by 29% by 2035, compared to 2021 levels. Emissions savings with respect to the baseline under the CBDP by 2035 is now 32% less than set out in the 2021 Net Zero Strategy (NZS), driven by reduced ambition in the land use sector. Despite this reduction in emissions savings, methodology changes in how emissions are estimated in the Greenhouse Gas Inventory have resulted in slightly lower projected emissions for the land use pathway under the CBDP. Projected emissions in the pathway for both agriculture and land use are 1% lower in the CBDP compared to the NZS by 2035. It is not clear, however, how much of the reduction in emissions savings is due to methodology changes in the GHG Inventory.

Around a third of agricultural and land-use abatement in the CBDP is assigned to speculative technological and innovative measures that either have no supporting policies, are in development, or are highly dependent on market uptake, meaning they may not be taken up quickly enough to meet Net Zero targets. Around half of this abatement is assigned to the devolved administrations (DAs), but our previous analysis has shown that devolved delivery for the agriculture and land-use sectors are behind what is required. How the abatement assumptions in the CBDP translate into DA action is unclear, putting delivery at risk.

Agricultural CBDP abatement estimates are now 11% lower in 2035 compared to the NZS despite baseline estimates remaining unchanged. Agricultural methane emissions, which have remained stable since 2008, account for just under half of UK methane emissions. As such, this will hamper the UK's commitment to adhere to the Global Methane Pledge signed at COP26 (see Chapters 2 and 3).

Action to reduce emissions remains behind targets despite numerous policy announcements since our last Progress Report. This is particularly the case for land-based measures like tree planting and peatland restoration, with nationally set targets – which are below that set out in the CCC's Balanced Pathway – not being met. Delays in implementing land-based measures will severely jeopardise the land sector's ability to become a net sink by the mid-2030s, which is necessary to start offsetting residual emissions from other sectors of the economy, including agriculture.

Our key messages are:

- **A high dependency on innovation, with limited focus on demand-side measures**. The UK Government is still placing emphasis on innovation to reduce emissions in the CBDP rather than demand-side measures, such as encouraging healthier, more sustainable diets. The only diet policy is introducing voluntary eco-labelling on foods, which is unlikely to have a meaningful impact on emissions. Failing to address demand-side measures properly raises risks that emissions reductions will be insufficient, and that land is not released for sequestration. This will result in a missed opportunity for climate policy across the agriculture and land-use sectors, with benefits for human health.

- **Land-use change measures fall well short of what is required.** Despite recent policy announcements and related funding, delivery of woodland and peatland targets is falling substantially short of both the CCC's Balanced Pathway and Government-set targets. Planting of perennial energy crops has remained static since 2013. All require a dramatic increase over the coming years.

- **There are significant gaps in agri-environment policies and reliance mainly on voluntary measures is stalling progress.** A lack of clarity on policy and funding details is hampering uptake and confidence in post-Common Agricultural Policy (CAP) schemes. It is also affecting the uptake of low-carbon measures in the farming sector, which requires stability and confidence in policies before making changes to land management. Northern Ireland is particularly behind in developing post-CAP policies. Agri-environment policies should be supported by a strong regulatory baseline to ensure sustainable land management approaches are adhered to irrespective of whether voluntary schemes are entered into or not.

- **There has been some improvement in the last year.** This is most apparent for the next few years where funding commitments for peat restoration and tree planting have been confirmed, but delivery of these measures is still lacking. Beyond 2025, the lack of detail around funding means our assessment scores for policy subsectors continues to be a high risk to delivering the necessary abatement. Improvements since 2022 include:

  - Recent Environmental Land Management (ELM) policy announcements and continued slow fall in ruminant livestock numbers tracks our Balanced Pathway.

  - Financial support being offered for energy crops under England's Sustainable Farming Incentive from 2025.

  - New policies, funding and commitments on hedgerow enhancements in England, Scotland and Wales.

  - Defra released further detail on the ELM scheme earlier this year, but this still lacks detail for many elements. The Scottish and Welsh Governments have both set out the frameworks of their future agricultural policy, but option design and payment rates are still in development.

- **UK trade policy must protect risks of carbon leakage from trade in agricultural products.** Recent trade deals have not imposed minimum environmental standards on food and feed imports, which risks opening the door for imports of higher-carbon meat and undermines the required changes in UK land management. Equally, if the change in UK diets to eat less meat is not accompanied by a reduction in UK livestock numbers, a rise in exports will not reduce domestic methane emissions or release land required for carbon sequestration measures. It is uncertain whether maintaining UK livestock numbers and increasing exports would displace livestock farming elsewhere in the world, leading to lower emissions outside the UK.

- **A comprehensive UK land use strategy is still urgently needed.** Last year, the UK Government committed to delivering a Land Use Framework that will set out how land will be managed in England to deliver multiple functions such as food security, recreation, climate and nature. Originally

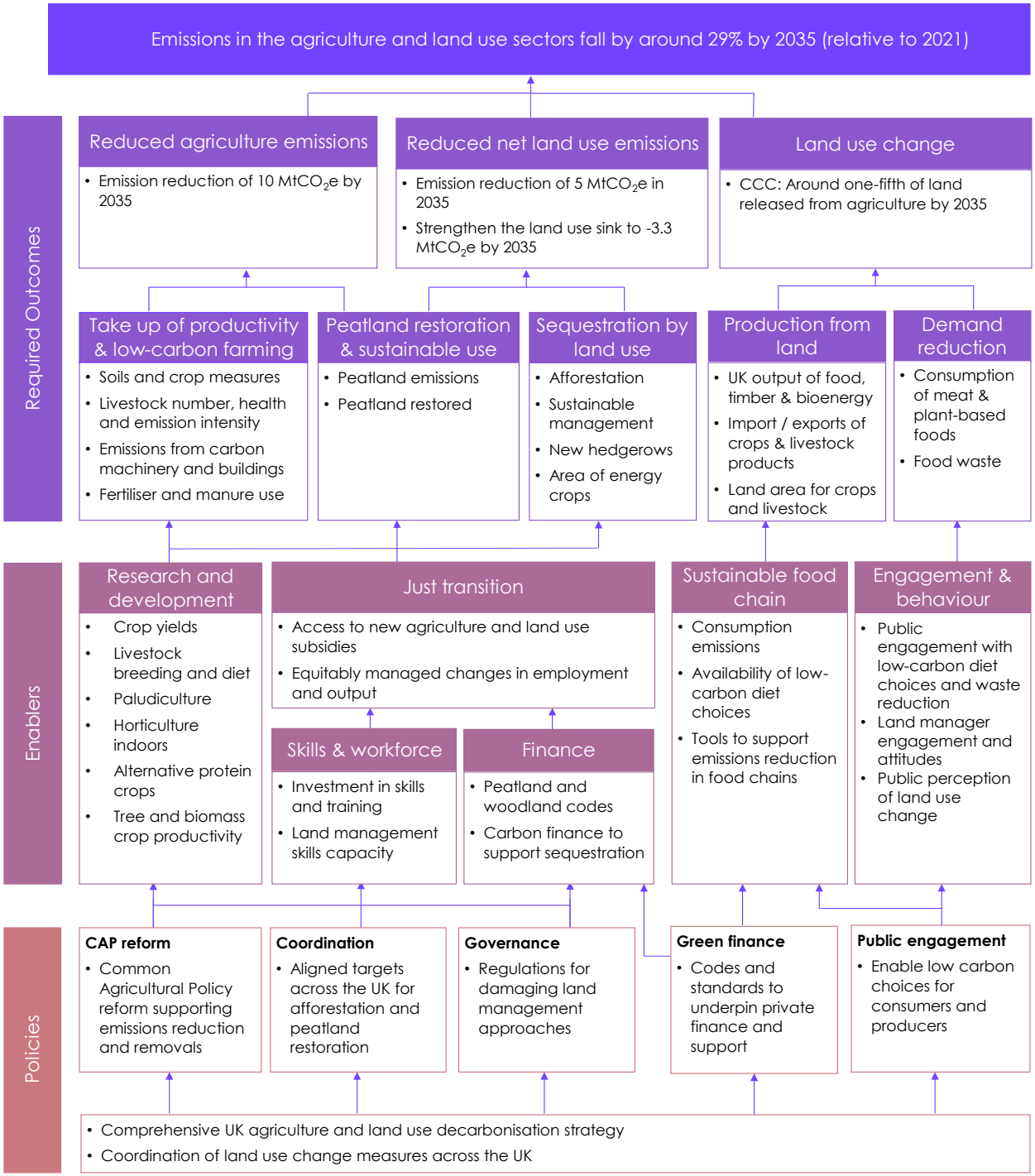
planned for summer 2023 publication, it has now been delayed to the autumn with no formal date scheduled. Land use and agriculture remain some of the few sectors where the UK Government has not set out a coherent, strategic approach to coordinated climate policy development. This is vital if current barriers to climate action are to be overcome and for action to be aligned across the devolved administrations.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 9.1 Monitoring map for agriculture and land use



Source: CCC analysis.
Notes: Numbers are from the Government's Carbon Budget Delivery Plan unless stated otherwise.

The CCC's monitoring map for agriculture and land use (Figure 9.1) sets out the policies, enablers and required outcomes for a successful transition. This report focuses on 11 key indicators (Figure 9.2), with additional indicators available in the supplementary material presented alongside this report. Our Monitoring Framework documents the indicators we track and our approach for assessing progress.

Emissions for agriculture and land use were 49 $MtCO_2e$ in 2021, an increase of 1 $MtCO_2e$ compared to the previous year. Emissions have remained constant over the last decade and the Government's pathway projects minor reductions in the early 2020s (Figure 9.2a).

- Emissions in agriculture increased in 2021, largely driven by a 0.8 $MtCO_2e$ (18%) increase in stationary and mobile combustion emissions, though increases were reported for each of the main sources of agriculture emissions (Figure 9.3). Over the last decade, agricultural emissions have remained relatively stable.

Failing to reduce methane emissions will hamper the UK's commitment to adhere to the Global Methane Pledge signed at COP26.

- Methane from enteric fermentation and livestock waste and manure management accounts for just under half of UK methane emissions and has not fallen in the last decade (Figure 9.4). Failing to reduce levels will hamper the UK's commitment to adhere to the Global Methane Pledge signed at COP26.

- There was a slight decrease in land-use emissions in 2021 due to small emissions reductions from grasslands and wetlands (Figure 9.6) However, net emissions from land use, land-use change and forestry (LULUCF) have stayed flat over the last decade.

- The carbon sink provided by the LULUCF sector has shown a general decline since 2010, dominated by a fluctuating but weakening forestry sink that has consistently reduced since 2017. Land source emissions have also declined overtime (e.g. 7% since 2010) mainly due to the fall in emissions from organic soils (Figure 9.6).

- Annual emissions assigned to the LULUCF sector are almost 3 $MtCO_2e$ lower than what was reported in the CCC 2022 Progress Report. This difference is due to inventory updates and methodology changes (largely due to how emissions from organic soils are reported) and do not represent delivery progress in this sector.

Delays in delivering land use measures risks not meeting the emissions reduction and sequestration required in the late 2020s and 2030s

Measures to reduce emissions in these sectors can show a time lag before they become effective; for example, net sequestration in newly planted woodlands may take several decades. Our indicators suggest that delivery progress in land and agriculture is insufficient for the required emissions reduction in the late 2020s and 2030s.

(a) Agriculture indicators

Actions to reduce emissions from agriculture need to include low-carbon agricultural practices, improvements to productivity and measures to reduce livestock numbers.

Reducing agricultural emissions will include shifting to low-carbon agricultural practices (e.g. improved nitrogen fertiliser use), improving productivity (e.g. sustainably increasing crop yields) and lowering ruminant livestock numbers.

Productivity and low-carbon agricultural practices. Uptake of low-carbon farming practices at scale is required but there are few signs of progress since last year.

- Survey data suggest that the proportion of farmers using low-carbon farming practices has fallen from 61% in 2019 to 58% in 2022.[1] Government

has set a target that 75% of farmers in England should be engaged in low-carbon practices by 2030, rising to 85% by 2035.[2]

- On-farm anaerobic digestion (AD) can be deployed to manage animal waste and generate renewable energy (Figure 9.2b). Favourable tariffs drove a historic spike in AD in 2014, but the uptake rate has dropped dramatically after the incentive came to an end.

- Wheat yields (Figure 9.2c) show large year-to-year variability, mostly due to varying weather conditions and use of inputs. Increases in wheat yield have stalled over the last decade. The CCC's Balanced Pathway suggests that, by 2050, current wheat yields need to increase by 41% to 11 tonnes per hectare; we therefore judge this indicator to be slightly off track.

Though livestock numbers have declined since 1990, numbers have been relatively stable over the last decade.

Livestock numbers and diets. Livestock numbers in the UK will need to reduce in line with reductions in meat consumption. However, in terms of ruminants, cow and sheep numbers have remained relatively stable in the last decade. While livestock numbers and the dietary shift are currently in line with the Committee's pathways, this could change quickly should the current trajectories remain.

- There has been a 21% fall in cattle numbers and 26% fall in sheep numbers since 1990, mainly driven by successive reforms to the Common Agricultural Policy up to the mid-2000s. Numbers consistently fell between 2017 and 2020, but have remained unchanged in 2021 (Figure 9.2d).

- Total exports of cattle and sheep dropped significantly between 2020 and 2021 (Figure 9.2e). Imports of cattle and beef, which are now almost entirely sourced from the EU, have increased over the past decade, while sheep and lamb imports have decreased substantially.

- The public have reported eating less ruminant meat (i.e. beef and lamb) since 2009, though ruminant meat availability data do not indicate a similar trend and it is not clear why these do not correlate (Figure 9.5).* The apparent willingness of the public to make dietary changes suggests that the CCC's more ambitious Tailwinds pathway, with a 28% decrease in meat consumption by 2035, is achievable.

Food waste. Reductions in food waste could lower emissions by avoiding unnecessary food production and reducing methane production from its decomposition. However, tracking progress of this indicator is difficult due to limited available data that are collected infrequently. The Waste and Resources Action Programme (WRAP) expect to publish the latest update later in 2023.

- The most recent data available for 2018 show that 7.3 million tonnes of food was wasted compared with 9.2 million tonnes in 2007 (Figure 9.2g). The Government has set an ambition for municipal food waste to be reduced by 50% by 2028.[3]

- An additional 3.3 million tonnes are estimated to be wasted on-farm, of which 2.9 million tonnes is deemed edible. At present, on-farm food waste is not included in the Government's ambition to reduce waste.

* Ruminant meat availability data is based on total UK ruminant meat production plus meat imports minus meat exports.

(b) Land use indicators

Delivery of land-use change measures is below government ambition. Action across all land areas needs to be rapidly increased.

Our land use indicators assess the extent to which non-agricultural land-based actions are being put in place across the UK to reduce emissions. These include actions to increase sequestration through afforestation and bioenergy planting, plus actions to reduce emissions such as restoring peatlands.

Woodlands. In our last progress report, we highlighted the large disparity between Government ambition for woodland creation and actual progress. Barriers to upscale planting rates include tenancy, skills and contractor availability, farmer and land manager reluctance and nursery capacity to meet demand. The picture remains the same this year.

Non-financial barriers such as tenancy, skills and contractor availability, and nursery capacity need to be addressed if planting rates are to increase.

- The rate of afforestation (Figure 9.2h) has not risen significantly since 2019, despite a small increase to 13,900 hectares in 2022 from 13,300 hectares in 2021. This is well short of the Government's target for 30,000 hectares of woodland creation annually by 2025,[4] requiring planting rates to more than double in the next two years.

- Most new woodland creation is delivered in Scotland (Figure 9.7). Planting rates must increase significantly across the UK this decade to address the weakening forest sink and for sequestration benefits to be realised well before 2050.

- Sustainable management of woodland* has flatlined in recent years, remaining at around 58% since 2015 (Figure 9.2i). Only 46% of broadleaved woodlands were sustainably managed in 2021, so is off track to meet the 80% by 2030 target, as set out in the CCC's Balanced Pathway.

Peatland restoration is still significantly off track.

Peatlands. Restoration of peatlands is already significantly off track compared to the CCC's Balanced Pathway (Figure 3.2j). Barriers that require addressing include increasing capacity to design, verify and deliver restoration plans.

- The rate of restoration for the UK was 12,700 hectares in 2022/23, an increase of 3,800 hectares since 2021/22 (Figure 9.2j). The combined Government targets for England, Scotland and Wales require 29,000 hectares per year by 2025, which is significantly lower than the CCC's recommended UK-wide rate of 67,000 hectares per year by that date.

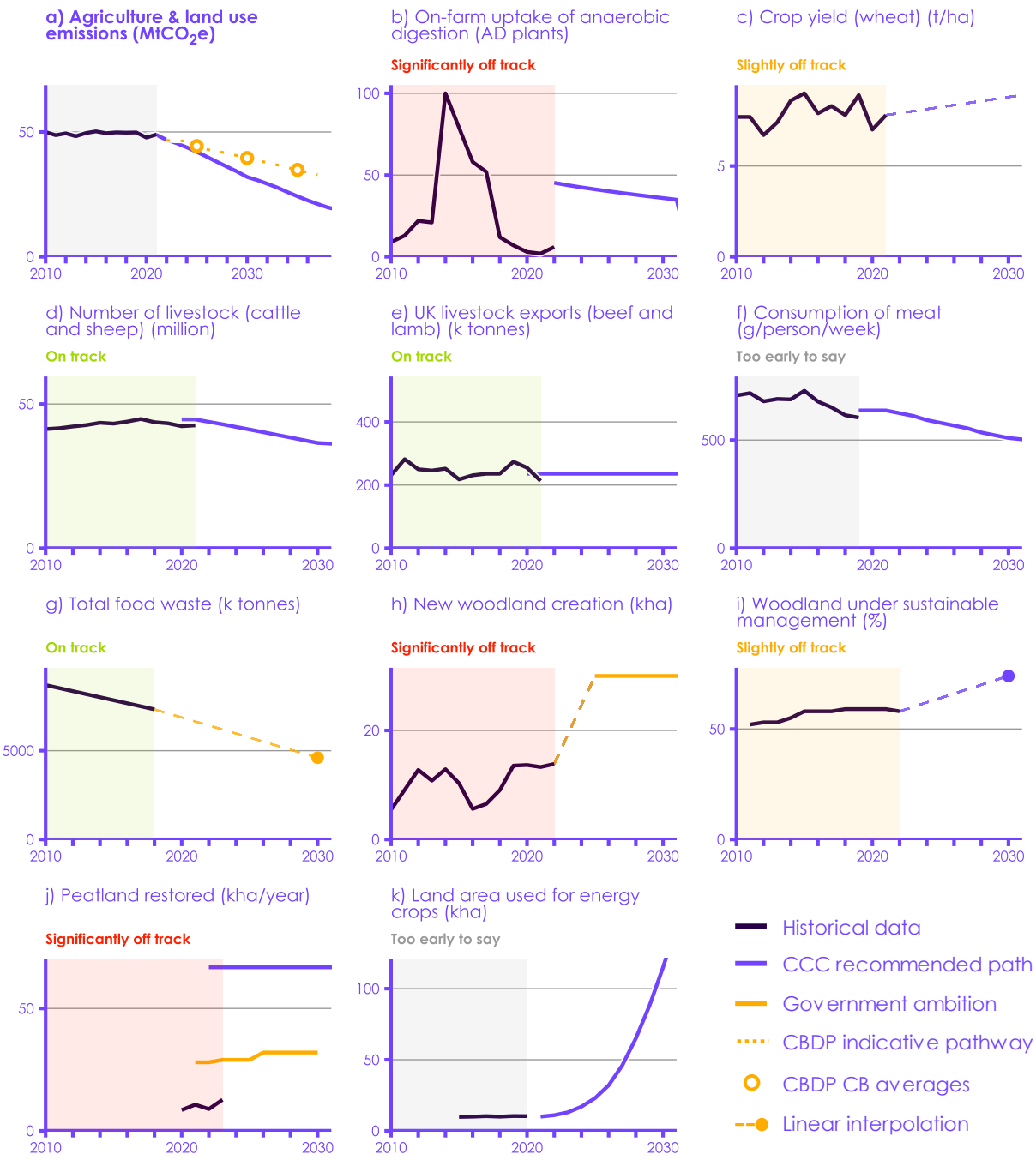
- Despite representing only 13% of UK peatland area, the use of peatland soils for crops and intensive grassland contributes 44% of the total emissions from peatlands (Figure 9.8). A methodology update to this year's GHG inventory introduced lower emission factors for wasted organic soils. This means emissions reported in this year's inventory are lower compared to the that published in 2022 when they contributed 58% of total emissions.

Biomass planting requires careful consideration to ensure it is undertaken in a sustainable manner to limit trade-offs with other land uses such as food production and nature recovery.

Energy crops. The area of perennial energy crops has remained relatively constant since 2013 at around 10,000 hectares (Figure 9.2k, England only). Over the course of the Net Zero transition, our modelling suggests we need to increasingly rely on sustainable domestic biomass planting with carbon capture and storage to produce clean energy, while limiting biomass imports.

* 'Sustainably managed' is defined by the Forestry Commission as woodland managed to the UK Forestry Standard that has a Woodland Management Plan or has been in receipt of a grant felling license in the previous 15 years. Woodland outside of this definition may also be considered as managed.

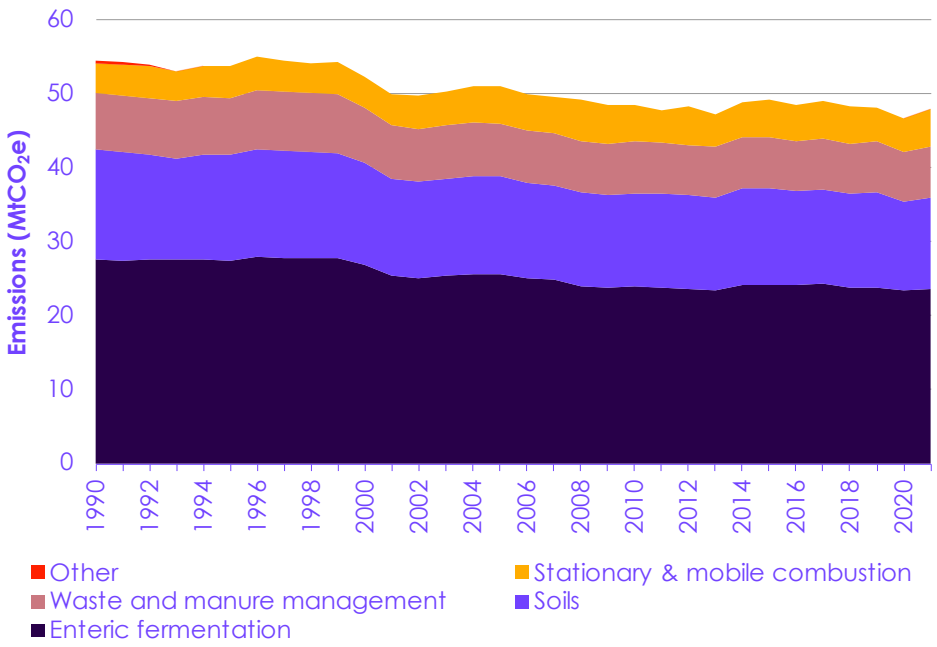
Figure 9.2 Key indicators for agriculture and land use



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path, and considering the wider contextual factors that may have a temporary impact (e.g., recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) Dashed lines indicate the linear rate of change that would be required to meet the target, whereas solid lines show modelled pathways. (3) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (4) We have adjusted the Government's published Carbon Budget Delivery Plan (CBDP) pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories. (5) The Government's emissions pathway includes only quantified plans from the CBDP. Unquantified plans may lead to further emissions reductions. (6) Figure f) reports total meat consumption. (6) Figure g) reflects household and supply chain food waste. (7) Figure j): Peatland restoration data are sourced directly from the UK administrations and their delivery programmes: Nature for Climate Peatland Grant Scheme (England), Peatland Action (Scotland)and the National Peatland Action Programme (Wales). Data for 2023 should be considered provisional. Data for peat restoration in Northern Ireland were not available.

Agricultural emissions increased in 2021 but have stayed relatively stable over the last decade.

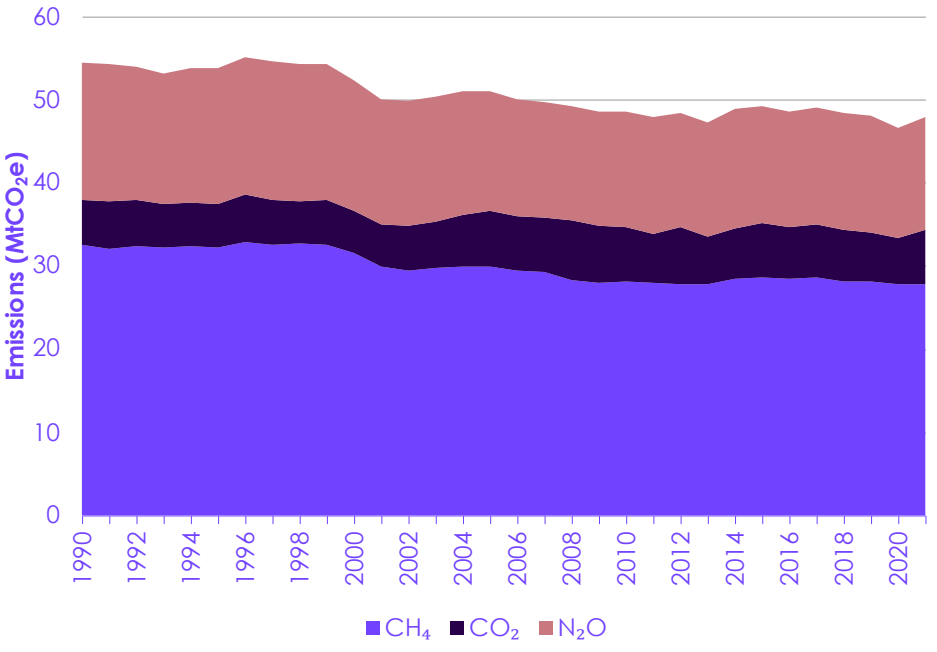
Figure 9.3 Agriculture emissions (1990 – 2021)



Source: BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*

Methane from enteric fermentation and livestock waste management dominates UK agricultural emissions and has not declined since 2009.

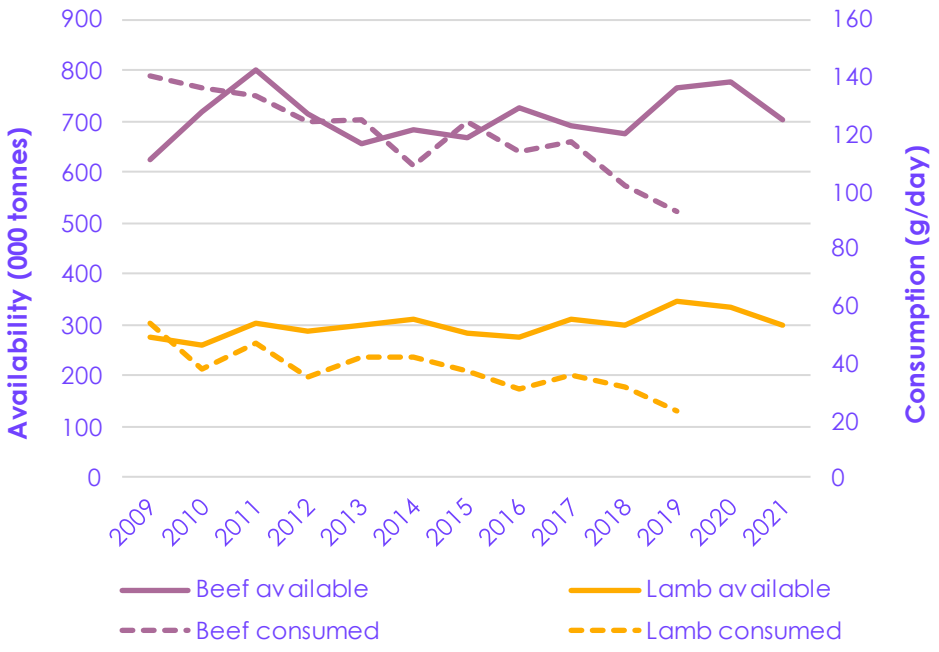
Figure 9.4 Agriculture emissions by greenhouse gas (1990 – 2021)



Source: BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*

The trend for reported consumption of beef and lamb has declined since 2009. However, available beef and lamb over the same period has remained broadly unchanged.

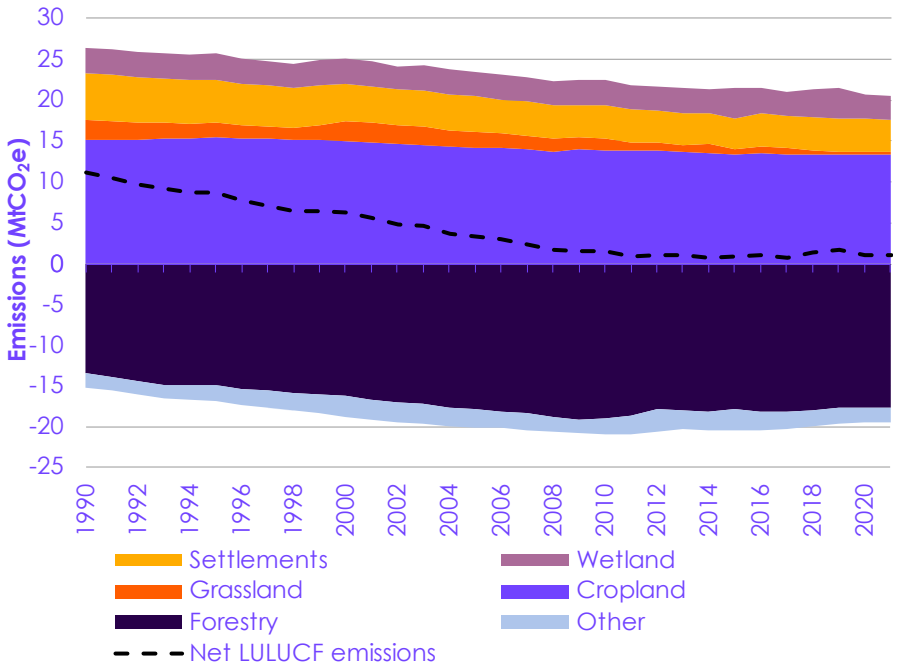
Figure 9.5 UK ruminant meat availability and consumption



Source: Defra (2022) *Agriculture in the UK*; PHE (2020) *NDNS: results from years 9 to 11 (2016 to 2017 and 2018 to 2019)*; CCC analysis.
Notes: Meat availability is calculated as UK production plus imports, minus exports. Consumption data are not available beyond 2019.

Land use emissions decreased slightly in 2021. The sink provided by the LULUCF sector has shown a general decline since 2010, due to a weakening forestry sink.

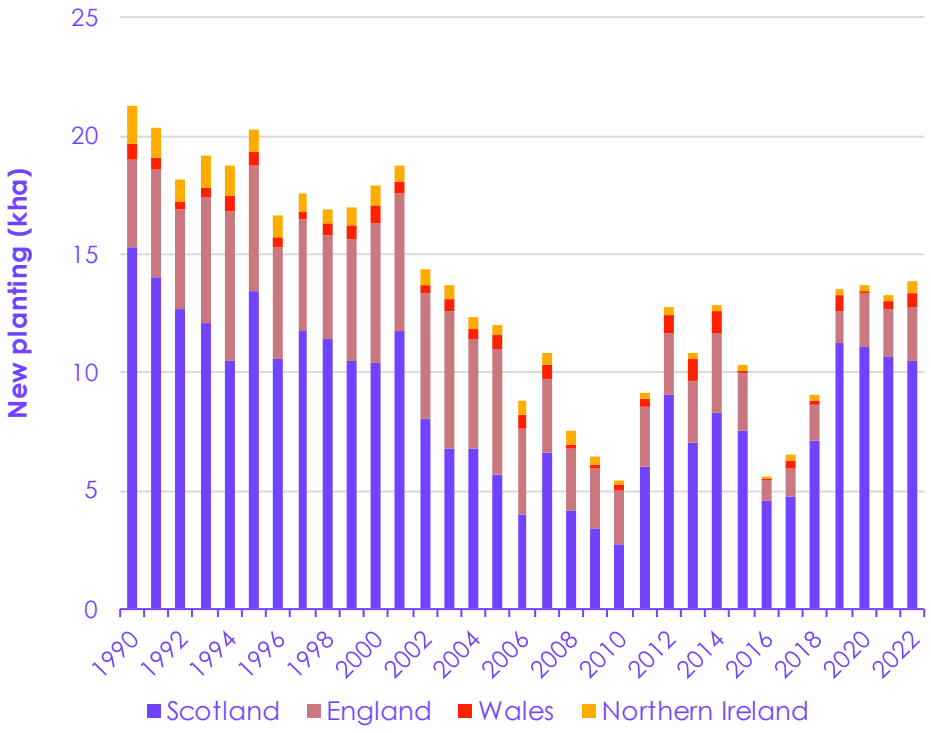
Figure 9.6 Land use emissions (1990-2021)



Source: BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*

Woodland creation has not significantly changed since 2019. Most new planting in the UK occurs in Scotland.

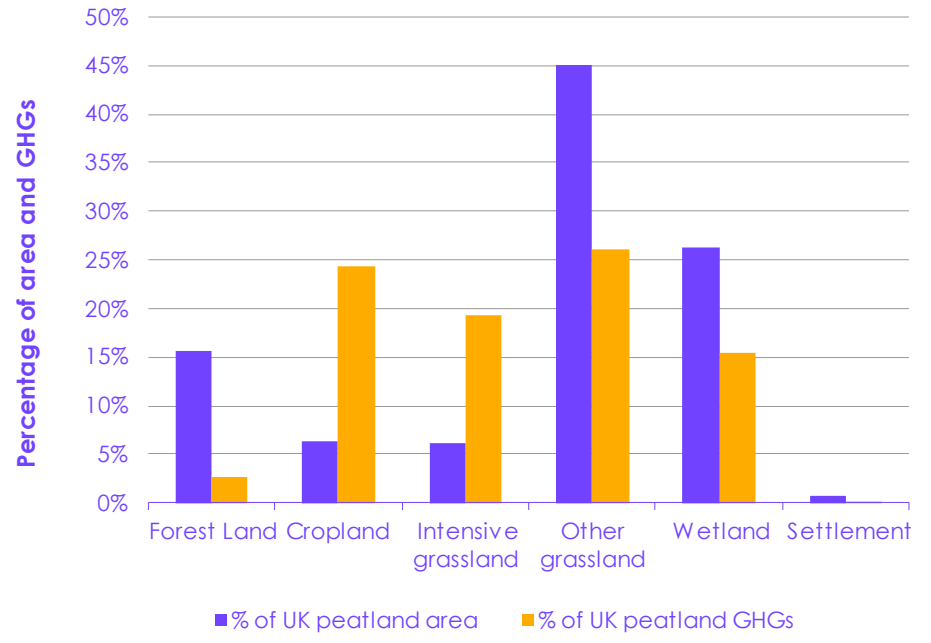
Figure 9.7 New tree planting area by UK region (1990 – 2022)



Source: Forest Research (2022) *Forestry statistics*; CCC analysis.

Agricultural use of peat soils represents a significant proportion of emissions from peatlands. Despite representing only 13% of UK peatland area, their productive use contributes 44% of the total emissions from peatlands.

Figure 9.8 Contribution of peatland GHG emissions to each LULUCF subsector (2021)



Source: Data provided by UKCEH; CCC analysis.

2. Policy assessment

All proposed policies set out in the CBDP for the agriculture and LULUCF sectors have been assessed to have risks or insufficient plans.

Policy progress has been largely lacking in most land and agricultural sub-sectors, with either risks or insufficient plans identified against the proposed policies in place to deliver the required emissions reduction by the Sixth Carbon Budget period (Figures 9.9a and 9.9b, Table 9.1 and 9.2). Our assessment is based on the criteria outlined in Annex 1, with Figures 9.9a and 9.9b presenting the policy assessment for each Carbon Budget and Tables 9.1 and 9.2 representing our overall assessment of land and agricultural policies from now through to 2037. Due to a lack of long-term policy commitments, we have assessed the risks increase through the 2030s, particularly in the land use sector.

The CBDP estimates emissions reductions of 14.7 $MtCO_2e$ through actions to reduce emissions in the agriculture and land-use sectors by 2035 compared to the baseline. This is 32% less abatement than was set out in the 2021 NZS. This reduction in ambition is predominantly accounted for by the land use sector, where abatement savings are now 45% less than they were in the NZS, while agriculture has seen a 11% fall in ambition (Figure 9.9).

Despite the significant reduction in ambition in the land use sector, projected land use emissions for the CBDP pathway are slightly lower than that published in the NZS due to methodology changes on how emissions are estimated in the land use GHG inventory. The methodology changes may be contributing a small amount to the reduction in emissions savings, but it is not clear how much.

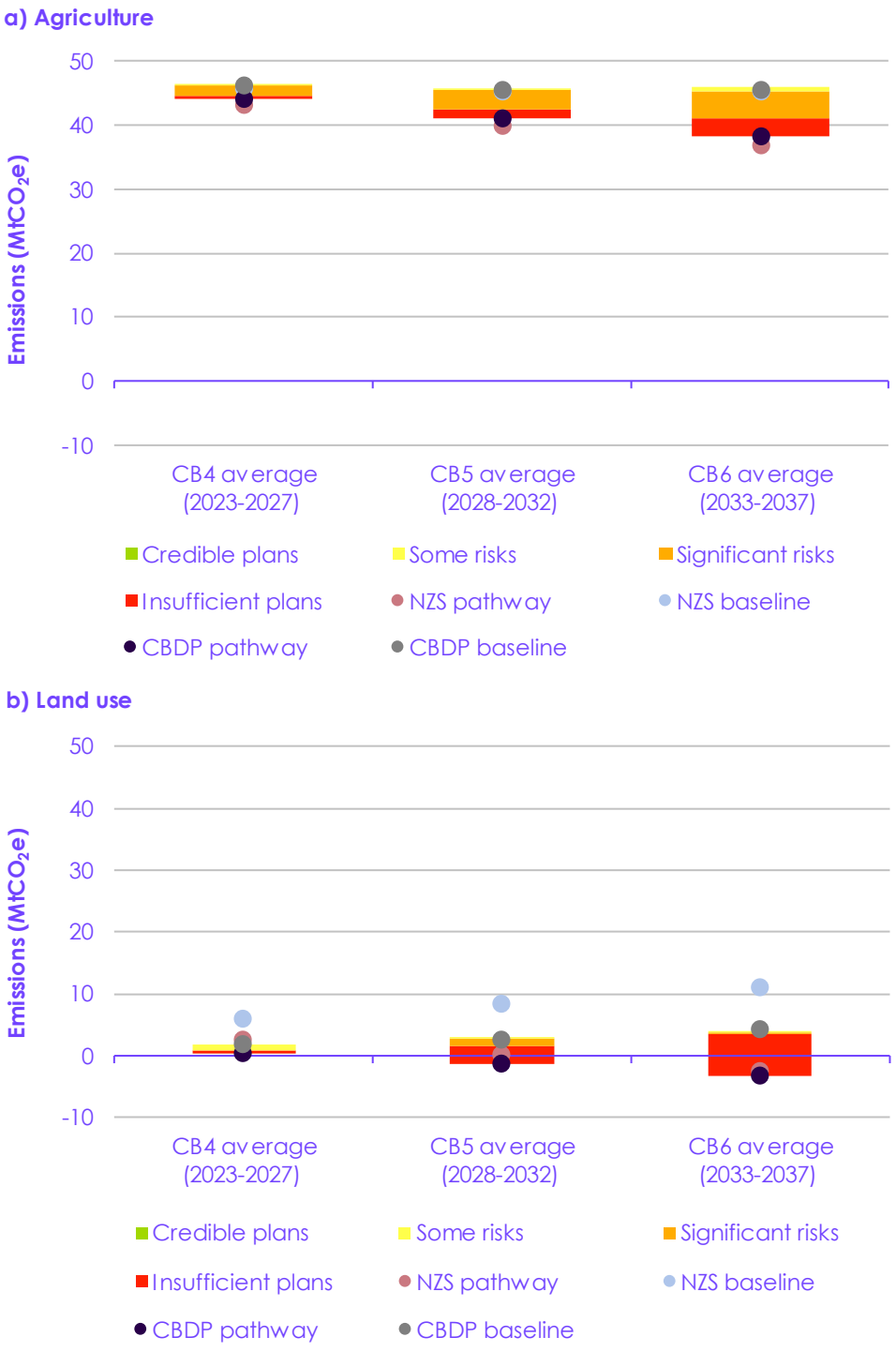
Tables 9.1 and 9.2 provide a summary of recent progress and what still needs to be addressed. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 9.1 and 9.2. Agriculture and land policy is largely devolved. Detailed recommendations specific to Scotland and Wales can be found in their respective progress reports.[5,6]

The policy assessment in this report focuses on measures to reduce emissions, but the agriculture and land sectors must also be well adapted to future climate impacts. In the CCC's recent report, Progress in adapting to climate change – 2023 Report to Parliament, we set out a number of recommendations in this area.

Recent policy announcements for post-CAP reform mean there is improvement in the near term. Risk and uncertainty increase in the 5th and 6th Carbon Budgets.

Land-use policy is currently short-term, with budgets focusing up to 2025 in England and Wales, 2030 for Scotland and continued uncertainty in Northern Ireland. There is need for greater detail on plans and policies beyond these periods.

Figure 9.9 Assessment of policies and plans for agriculture and land use



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The breakdown of emissions savings for Scotland, Wales and Northern Ireland are estimated, as the Government's published figures do not provide this level of detail. (3) We have adjusted the Government's published CBDP pathway and baseline for land use to account for methodological changes between the 1990-2019 and 1990-2020 inventories.

Table 9.1
Policy scorecard for agriculture

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Agriculture overall assessment	O	R	R	O	R
Agricultural productivity 42% of abatement over CB6 period	O	O	R	R	R

Progress:

- **England:** Defra offers competitive, capital grants under the Farming Investment Fund to support farmer investment in new technology and infrastructure, with benefits for productivity, environmental outcomes, water management and animal health and welfare.[7] A commitment to long-term funding has not yet been made, but the approach is expected to continue. Though this could have benefits for emissions abatement, it is not a requirement to apply for the fund.
- The Farming Futures R&D scheme, delivered via UKRI, funds research to benefit farmers in England.[8] In 2023, the theme is automation and robotics with the aim to increase productivity and address labour challenges in agriculture and horticulture.
- The Genetic Technology (Precision Breeding) Act passed into law in March 2023, with the aim to facilitate greater research and innovation in precision breeding and gene editing. This could seek to improve productivity and resilience of crops and livestock.
- Under Defra's Animal Health and Welfare Pathway, three years of funding is available for farms seeking a health and welfare review of eligible livestock (cattle, sheep, pigs).[9] Though the review could address productivity, this is farmer-led.
- Measures to improve yields via crop health improvements are available through the Sustainable Farming Incentive, Integrated Pest Management actions and the Farming Innovation Programme.
- **Scotland:** Scottish Government has launched grants targeting efficiency and innovation in agriculture. The Knowledge Transfer and Innovation Fund offers up to £200,000 to promote knowledge and skills transfer and innovation. The current funding round prioritises climate change and biodiversity outcomes.
- Scottish Government provides funding towards on-farm carbon audits, soil sampling and analysis, and animal health and welfare under the Preparing for Sustainable Farming grant to support the transition towards environmental conditionality. The Farming Advisory Service offers £1,200 per applicant of funding to access expert consultancy support to develop an Integrated Land Management Plan.
- **Wales:** Welsh Government offers competitive capital grants during 2023 for horticulture for existing businesses and those wishing to enter this industry eligible for support. The aim is to support diversification, improve efficiency and deliver sustainable local food production.

To be addressed:

- Most productivity measures in the CBDP are delivered via ELMs and associated funding, which is voluntary, often competitive and does not prioritise actions for climate over other objectives. There is a high risk that actions will not be delivered at the scale and pace required (recommendation R2023-065).
- Productivity measures could result in farmers increasing herd numbers, which could increase overall emissions unless further measures are used to mitigate additional emissions. A policy gap remains in ensuring that this is adequately addressed.

Low-carbon farming 58% of abatement over CB6 period	O	R	R	Y	O

Progress:

- **England.** Defra released Environmental Land Management (ELM)[10] policy detail and payment rates in February 2023. The Sustainable Farming Incentive (SFI) element aims to incentivise farmers to deliver agricultural best practice. Almost 3,000 SFI agreements have been issued by April 2023.
- The Environmental Improvement Plan (EIP) stated that Government will co-finance agricultural waste management and storage in the short-term but indicates the next step will be stronger regulatory measures.[3]
- Environmental permitting conditions will be extended to dairy-intensive beef farms from 2025, pending a forthcoming consultation, providing opportunities to reduce enteric emissions. Defra and the Environment Agency continue to work with farmers to identify the best available technologies.
- The CBDP set out the potential role of high-efficacy methane suppressing products in livestock feed plus ambition to mandate introducing to cattle feed when safe to do so.
- **Scotland.** In August 2022, Scottish Government launched a consultation on the content of the Agriculture Bill,[11] followed by the Agricultural Reform Route Map in early 2023,[12] providing detail of subsidy support framework. The Agri-Environment Climate Scheme (AECS) aims to bridge the gap between the CAP and future subsidy approaches in Scotland. There is commitment for future annual rounds of the scheme up to and including 2024.
- **Wales.** The Agriculture (Wales) Bill, introduced in September 2022, sets out a future framework for agricultural support based on sustainable land management objectives. Future Bills will set out the approach for funding incentives. Detail on the Sustainable Farming Scheme (SFS), due to start in 2025, was released in July 2022.[13] For scheme payment eligibility, farmers must carry out a range of 'universal' actions, including nutrient accounting, soil testing and protection, animal health improvement, semi-natural peatland restoration and a baseline obligation of 10% tree cover on-farm.
- **Northern Ireland** started to roll out the Soil Nutrient Health Scheme in 2022, a 4-year plan to baseline soil nutrient levels and estimate carbon stocks of agricultural soils.

To be addressed:

- The CBPD has a high dependence on technological approaches to deliver low-carbon policy measures, often in development or reliant on market for uptake at scale. UK Government should clearly set out its role in accelerating development and uptake of these actions (recommendations R2022-006, R2022-029 and R2023-065).
- All UK nations rely on farmers' voluntary uptake of low-carbon and land-use change measures to deliver GHG emission reduction. Detail is needed on how baseline land management rules (e.g. cross compliance) that offer mitigation benefits will transition to the post-CAP subsidy support packages. Defra and Scottish Government have indicated this will develop over 2023-2024 (recommendation R2023-101).
- The CBDP lacked policy measures to decarbonise agricultural vehicles and machinery. A strategy to address this is needed (recommendation R2022-250).
- Government has committed to develop a consistent, robust approach to on-farm monitoring, reporting and verification of carbon emissions, due to be delivered by 2024. This should include supporting farmers to interpret and take action to decarbonise based on the results (recommendation R2023-063).
- Government should set out the regulatory framework to reduce enteric methane emissions, specifically under proposals to extend environmental permitting to the dairy and intensive beef sectors and to mandate the addition of methane inhibiting additives to feed products for UK beef and dairy systems (recommendations R2023-061, R2023-062).
- With the Welsh Glastir scheme funding finishing at the end of 2023 and the SFS not due until 2025, Welsh Government should facilitate the transition and maintain incentives for land management actions (recommendation R2023-034).

Demand and consumption No quantified abatement in Government's pathway	O	R	R	R	R

Progress:

- **England:** The Department of Health and Social Care will lead on cross-departmental work to ensure health and climate are considered in all policy development, including food.[14]
- In the CBDP, the development of alternative proteins for humans is cited as a proposal that could deliver future unquantified emissions savings.[2] The CBDP also reiterated that the Government will be bringing in voluntary eco-labelling on foods.
- **Scotland:** Diets policy has progressed over the last year:
  - The launch of the Food Standards Scotland's campaign, Eat Well Your Way, focuses on the role of the individual to make healthy and sustainable choices but does not clearly set out the link between food choice and climate change.[15]
  - The Good Food Nation Bill, which passed in Parliament last year, requires relevant authorities to create 'Good Food Nation Plans' that must consider environmental outcomes related to the food system.[16]
- **Wales:** The Welsh Government is developing a strategy to promote a shift to a 'healthier and suitable diet'. Work is cross-departmental including health and agriculture and will aim to identify opportunities for new policies and/or interventions.
- A Food Bill was introduced into the Welsh Parliament last year aiming to establish a more sustainable food system in Wales, including healthier diets.[17] The Bill is still at an early stage and a consultation on its principles closed in January 2023.

To be addressed:

- **England:** Developing a market for alternative proteins requires addressing a range of barriers regarding investment, technology readiness, safety, consumer acceptability and regulatory. Policy is needed to encourage shifts to healthier, sustainable diets. Quantified abatement savings from diet change are absent from the CBDP (recommendations R2022-027, R2022-036).
- Government policy is still needed on reducing food waste across the entire food system, from farm to fork. This requires obtaining better baseline data on food that is wasted on-farm (recommendation R2022-037).
- **Scotland:** The Good Food Nation Bill does not explicitly mention climate change. A national plan to be delivered this year presents an opportunity to clearly signal a move towards healthy, low-carbon diets, set targets to drive action and monitor delivery and wider impacts on health, nature and climate.
- **Wales and Northern Ireland:** Not currently considering climate-focused policy on dietary choices.

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan. Percent abatement includes published abatement for England and proportional estimates of the emissions savings for Scotland, Wales and Northern Ireland based on the CCC Balanced Pathway. These are estimated as the Government's published figures to do not provide this level of detail. (3) The scores represent our assessment across the Fourth, Fifth and Sixth Carbon Budget periods. A breakdown of scores for each period can be found in Figure 9.9a.

Table 9.2
Policy scorecard for land use

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Land use sources – overall assessment	O	O	O	O	O
Land use sinks – overall assessment	Y	Y	O	O	O
Peatlands 53% of abatement over CB6 period	Y – until 2030 R – from 2030	Y – until 2030 R – from 2030	O	O	O

Progress:

- **UK:** Funding is in place to support peatland restoration, but delivery remains significantly off track. In 2022/23, 12,700 hectares were brought under restoration management - an increase of 3,800 hectares from the previous year. Once funding ends, agricultural subsidy schemes are likely to fund peatland restoration.
- The Peatland Code Version 2.0 was launched in March 2023.[18] Changes include alignment with the UK Greenhouse Gas Inventory (GHGI) and eligibility of shallower peat depths in some circumstances. The most significant change is including lowland peat habitats as permitted restoration projects. This allows lowland fen soils under agricultural use, which represent the highest emissions from peat, to lever private finance to support restoration.
- **England and Wales:** A ban on peat-related gardening products is proposed, starting with retail, then widening to professional horticulture.
- **England:** A Lowland Peat Taskforce was set up in 2021 to identify new approaches and more sustainable management for agriculture on lowland peatlands. The EIP includes a commitment from Defra to build on the recommendations of the Taskforce, yet to be released.
- Funding will address research and innovation needs on lowland agricultural peats. These include the Paludiculture Exploration Fund, allocating £5.6 million to addressing barriers to developing commercially viable lowland peat soils and £6.6 million to developing pilots to improve water management via local partnerships and infrastructure needs.[19]
- **Scotland:** Government introduced a Bill in March 2023 that extends licensing across all applications of muirburn* and restricting when burning can be used on peat soils to limited circumstances.[20] The CCC will track progress of the Bill. In February 2023, a consultation was launched on banning the sale of peat-related gardening products.[21]
- **Wales:** There is political commitment to ramp up from the current target of 600 – 800 ha of annual peatland restoration to 1,800 ha per year by 2030/31.[22] Welsh Government and NRW are increasing capacity in staffing, landowner engagement and contractor skills but funding commitments are yet to be formalised.

To be addressed:

- There remains a significant gap between delivery and the trajectory by the CCC Balanced Pathway. Incentives are needed to achieve restoration and sustainable management at

* Muirburn is burning used as a vegetation management tool, typically for livestock grazing needs and/or grouse moor management.

scale (recommendation R2022-010) beyond the timeframes of existing policy that address skills, contractor capacity and infrastructure (priority recommendation R2023-171). In England, this should be set out in the forthcoming Peatland Restoration Roadmap, due in 2024.

- Government should continue to work with the horticultural industry to develop viable alternatives to peat, phasing out professional peat use earlier than 2030 (recommendation R2022-021).
- Timeframes to end domestic and industrial peat extraction should be set and a mechanism introduced to ensure the extraction industries protect and restore the remaining peat resource (recommendation R2022-032).
- Extend the policy requiring a license for burning management to cover all protected peatlands, as a step towards limiting its use on all peat soils (recommendation R2023-191).
- Northern Ireland remains the only nation without a peat strategy. Steps should be taken to formalise the consultation on the 2021 – 2040 draft Peatland Strategy including identified actions to conserve and restore NI peat soils[23] (recommendation R2023-067).
- Restoration reporting is variable across each administration. Formal reporting of the new area under restoration was not available for this Progress Report so we report provisional estimates. Defra is developing a peatland restoration register, aligned to the UK GHGI and the reporting framework used in Scotland and Wales. This should be extended across the UK administrations for consistent, open access reporting (recommendation R2023-068).

Trees and woodland 10% of abatement over CB6 period	Y	Y – until 2025 O – beyond 2025	O	O	O

Progress: UK afforestation rates remain well below the CCC's Balanced Pathway and each country's own commitment, with levels reaching 13,850 hectares for 2022:

- **England:** A legally binding target has been set to increase tree canopy and woodland cover from 14.5% to 16.5% of total land area by 2050. This amounts to around 250,000 hectares of new planting (equivalent to around 10,000 hectares per year from 2025) to achieve a net increase of about 230,000 hectares (after allowing for loss of woodland) by 2050. Beyond 2025, there is a commitment that future woodland creation grants under ELMs will mirror the current England Woodland Creation Offer, ensuring continuity of offer.[3]
- More funding from the Nature for Climate Fund[24] has been made available:
  - A further £4 million this year to Defra's existing Woods into Management Forestry Innovation Fund (MFIF) and the Tree Production Innovation Fund will support more active management of existing woodlands and innovation of domestic tree planting stock. Some of the MFIF funding will also support increased use of domestic timber in the construction sector.
  - A second round of funding to support capital investment in equipment for tree and seed suppliers will reopen this year (Tree Production Capital Grant), while £1.2 million will fund activities to enhance the quality, quantity, and diversity of tree seed sources to 2024/25 (Seed Sourcing Grant).
  - The new Woodland Creation Accelerator Fund 2022 (£9.8 million) offers up to £150,000 per Local Authority to increase jobs and skills in tree planting/woodland creation. A Forestry Training Fund (£700,000) pays for short forestry-related training courses until March 2025 and will upskill farmers and land managers wanting to plant and manage trees.
- **Scotland:** Public funding, committed until 2024/25, supports the Government's target to increase tree planting rates to 18,000 hectares per year. Action is occurring to tackle barriers to upscaling planting, such as supporting the expansion of woodland on farmland and knowledge exchange via the Integrating Trees Network.[25]
- **Wales:** The Welsh Government's annual afforestation target remains at 2,000 hectares, although only 580 hectares was planted in 2021/22. Grant funding of £32 million has been committed between 2022/23 and 2024/25 across three schemes.[26] The Woodland Creation Planning Scheme has boosted grants to develop plans for new woodland creation. The new Woodland Creation Grant provides capital grants for planting and ongoing maintenance for the first 12 years after planting. Smaller areas of tree planting under two hectares are eligible for funding under the Small Grants scheme.

To be addressed:

- While public funding has been put in place to drive up woodland creation, planting rates fall far short of each country's target. Challenges remain on encouraging landowners and managers to take up the offer. A change in contractual terms which may prevent tenant farmers from planting on land can help, while supporting the scale-up of nursery capacity, and availability of skills and workers can address other non-financial barriers. This will also support a scale-up of private sector funding to deliver woodland creation (recommendations R2022-039, R2022-045, priority recommendation R2023-192).
- Budgets have not been set beyond 2024/25 for the Welsh Woodland Creation Planning and Grant schemes, while there is the risk that applications for the current round of funding may not be forthcoming, as interested parties await offers under the 2025 launch of the SFS. To avoid a potential hiatus in tree planting, the rates payable under the SFS should be made public and payment under the Woodland Creation Grant matched accordingly. Proposals to attract private sector investment into woodland creation need to be firmed up as soon as is practicable (priority recommendation R2023-192).

Agroforestry and hedgerows 6% of abatement over CB6 period	Y	Y	Y	O	Y

Progress:

- **England:** Under ELMs, the new hedgerow SFI standard will be launched in 2023. Defra set out a commitment for the new agri-environment schemes to create or restore 30,000 miles of hedgerows by 2037 and 45,000 miles by 2050, with the aim of returning total hedgerow lengths in England to 10% above the 1984 peak (360,000 miles).[3]
- The EIP highlighted the importance of agroforestry for Net Zero and resilient agriculture, starting ambition for more widespread silvoarable* management. An agroforestry standard is expected in 2024. No specific area target for agroforestry has been set†; instead, ambition for this measure is embedded in England's woodland and tree cover target.
- The Countryside Stewardship scheme, which will transition under ELM, currently provides incentives for hedgerow creation and management, in-field trees and agroforestry approaches such as orchards and wood pasture. A capital offer under Countryside Stewardship is expected in summer 2023 that will fund the establishment and maintenance of silvoarable and silvopastoral agroforestry systems.[10]
- **Scotland:** Forestry Scotland offers funding to support creating small-scale farm woodlands in sheep pasture. The AECS supports hedgerow creation and management plus small-scale tree planting and will offer funding until 2024. Scottish Government has not set a target for this and delivery is not reported, making its success difficult to track.
- **Wales:**
  - The Glastir small grants opened in early 2023 with £3 million in funding allocated for hedgerow creation.[27] Woodland Creation Grants include funding for agroforestry and five years of maintenance.[28] These grants are competitive.
  - From 2025, hedgerows and agroforestry will be funded in the new SFS, with applicants expected to keep their hedges higher and wider, with additional funding tiers to support expansion of farm woodland, new hedgerows and improved connectivity between sites. Payment rates are yet to be defined.

To be addressed:

- An SFI agroforestry standard is expected in 2024; further detail should be provided to support farmers to consider how best to embed this measure into their farm business (recommendation R2022-031).

* Silvoarable is where arable or horticultural cropping systems are integrated with a long-term tree crop. Silvopastoral management is where trees are integrated into grazing systems.

† Silvopasture approaches are assumed to contribute 1300 hectares each year to the woodland cover targets in England.

	• With the Glastir scheme due to finish at the end of 2023, there is currently no clear funding mechanism for hedgerows in Wales over 2024 – a year gap before the new SFS begins. Welsh Government should take steps to support delivery for hedgerows between the two schemes (recommendation R2023-034). • There has been no national survey of hedgerows since the Countryside Survey in 2007 and agroforestry areas will be captured in reporting for woodland and tree cover rather than their own dedicated target. Improved monitoring of these measures is required to track success of current policy interventions (recommendation R2023-070).
Energy crops and biomass 32% of abatement over CB6 period	○ ○ ○ ○ ○ **Progress:** • Although no planting targets have been set, the quantified abatement savings set out in the CBDP assumes that this could be delivered with an indicative 9,600 hectares of energy crops and short rotation forestry in 2030, rising to 15,000 hectares planted in 2035. • Payments under the ELM SFI will be made available to farmers wanting to grow miscanthus and short rotation coppice from 2025 under new standards (e.g. for soil) announced in January 2023. Payments rates under the SFI for perennial energy crops will be published later this year. **To be addressed:** • The UK Government is set to release a new Biomass Strategy in June 2023, which will consider, amongst other things, an assessment of future imported and UK feedstocks. The Strategy must ensure biomass used in the UK, whether grown domestically or imported from abroad, adheres to strict sustainability criteria, including no net loss of biodiversity (recommendation R2022-044). • Scotland's Bioenergy Action Plan is due to be published in 2023. This should set out an understanding of the impact and interaction between biomass demand and land use and agriculture in Scotland.[5]
Additional policy development relevant to the land and agriculture sectors	• **Land Use Framework:** The UK Government is committed to delivering a land use framework across England in 2023 but detail on this is yet to emerge.[29] We identify the publication of the framework as an urgent step that should be delivered this year (priority recommendation R2023-102). • **Northern Ireland:** The lack of a Northern Irish Executive severely limits development of their approach across the land and agriculture sectors. Northern Ireland's post-CAP policy framework is the least developed of the home nations and the country remains the only one without a dedicated peatland strategy. The recent CCC Advice Report to Northern Ireland on the country's carbon budget demonstrated the impact that a delay in land-use measures, in particular tree planting, will have on their emission targets.[30] • **Capacity:** Land-use actions such as peat restoration and woodland creation are impacted by capacity of land managers and contractors to deliver work on the ground. UK Government and the devolved administrations should take steps to ensure that skills and capacity of the workforce match ambition in these areas (recommendation R2023-103). • **Nature:** In 2022, the Landscape Recovery Scheme under ELM awarded funding to 22 projects covering 40,000 ha across England. Initially, 10 – 15 projects were expected to receive support, with the greater number of projects accepted reflecting the ambition for restoring natural ecosystems at scale within the agriculture and land use sectors.[10] The second round of funding will focus on Net Zero and nature recovery as priorities, with up to 25 projects to receive funding. – ELM is expected to underpin wider embedding of nature in the agricultural landscape. It includes an aim that 60 – 80% of farmers will participate, with nature-focussed approaches covering 10 – 15% of farms by 2030. • **Retained EU Law (REUL) Bill:** As a result of the UK leaving the European Union and needing to develop its own policies, the UK had previously rolled over existing EU policies, but the REUL Bill could allow the option to revoke policies the Government does not think are necessary. This poses a huge risk to environmental and climate issues if certain policies are ended without adequate replacements, parliamentary scrutiny or amendments.

- **Blue Carbon:** Defra has established a cross-administration group to progress the evidence base underpinning blue carbon (carbon sequestered and stored by managed marine and coastal ecosystems). The UK Blue Carbon Evidence Partnership is expected to release an evidence-needs statement in Spring 2023, followed by development of a roadmap for the inclusion of blue carbon in the UK GHG inventory (recommendation R2022-003).
- **Green Finance:** In March 2023, the Government released a Green Finance Strategy that detailed how it plans to ramp up funding for Net Zero and nature recovery.[31] This includes:
  - Exploring tax treatment of carbon markets such as tree planting and peatland restoration.
  - Setting a goal to mobilise at least £500 million of private finance per year into nature's recovery in England by 2027, rising to more than £1 billion per year by 2030. This funding will partly focus on nature-based carbon sequestration (recommendation R2023-100).
  - Running a consultation on including Scope 3 emissions in industry, which may include agriculture.
- **Tenancy barriers:** Tenant farmers in England will be able to apply for the SFI without requiring landlord consent. This was one of the recommendations made to Defra from last year's Rock Review, which considered how a more resilient tenanted sector could meet the challenges of climate change in addition to delivering sustainable food production and enhanced biodiversity.[32] Tenant farmers in Wales will be able to access new agricultural support schemes under proposals set out in the new Agriculture (Wales) Bill (recommendation R2022-023).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan. Percent abatement includes published abatement for England and proportional estimates of the emissions savings for Scotland, Wales and Northern Ireland based on the CCC Balanced Pathway. These are estimated as the Government's published figures to do not provide this level of detail. (3) The scores represent our assessment across the Fourth, Fifth and Sixth Carbon Budget periods. A breakdown of scores for each period can be found in Figure 9.9b.

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Chapter 10: Aviation

29 $MtCO_2e$, 7% of UK emissions in 2022

Introduction and key messages

Aviation emissions continue to be impacted by the COVID-19 pandemic and are likely to have also been affected by the rising cost of living in 2022. Estimated aviation emissions in 2022 were 29 $MtCO_2e$. This was up 95% from 2021, but still 25% below 2019 levels.

The longer-term historical trend in aviation shows a gradual increase in emissions due to rising demand for long-haul flights only partly being compensated for by improved efficiencies. Overall, CCC aviation indicators are not showing progress that can be attributed to policy implementation.

The UK Government published the Jet Zero Strategy in July 2022. The Strategy recommits to 70% passenger demand growth by 2050 on 2018 levels, relying heavily on technology to compensate for the increased emissions.[1,2] New commitments in the Strategy include having five UK Sustainable Aviation Fuel (SAF) plants under construction by 2025, accelerating research on non-CO_2 impacts and a commitment to provide direct support to countries that require assistance to implement the CORSIA offsetting scheme effectively. The Strategy carries considerable risks in relation to the aviation sector's contribution to emissions abatement for the Sixth Carbon Budget.

Our key messages are:

- **Reliance on nascent technology.** The Jet Zero Strategy approach is high risk due to its reliance on nascent technology – especially rapid SAF uptake and aircraft efficiency savings – over the period up to the Sixth Carbon Budget. The Government does not have a policy framework in place to ensure that emissions reductions in the aviation sector occur if these technologies are not delivered on time and at sufficient scale.

- **Demand management.** Demand management is the most effective way of reducing aviation CO_2 and non-CO_2 emissions. The Government has a range of options to manage demand, such as digital technologies, addressing private flying and providing lower-cost domestic rail travel. The Government should develop a suite of policy and technology options to address aviation demand.

- **Airport expansion.** The Committee's Sixth Carbon Budget Advice recommended no net expansion of UK airports to ensure aviation can achieve the required pathway for UK aviation emissions.[3] Since making this recommendation the Committee has noted that airports across the UK have increased their capacities and continue to develop capacity-expansion proposals. This is incompatible with the UK's Net Zero target unless aviation's carbon-intensity is outperforming the Government's pathway and can accommodate this additional demand. No airport expansions should proceed until a UK-wide capacity management framework is in place to annually assess and, if required, control sector CO_2 emissions and non-CO_2 effects. A framework should be developed by the Department for Transport in cooperation with the Welsh, Scottish and Northern Irish Governments over the next 12 months and should be operational by the end of 2024 at the latest.

- **SAF mandate.** The process to implement the Government's ambitious SAF mandate is delayed and dependent on an uncertain domestic and global feedstock supply. The Jet Zero Strategy sets the SAF mandate target at 10% SAF by 2030. The CCC's Balanced Pathway assumes 2% SAF uptake by 2030; our Widespread Innovation Pathway assumes a 3% share in 2030. Government must build in contingency and risk management into the SAF mandate to prepare for the possibility of constrained domestic and global SAF supply throughout the 2020s and 2030s.

- **Non-CO_2 effects.** Aviation non-CO_2 effects have a net warming effect on the climate but have high levels of uncertainty and exhibit regional and seasonal variation. The second SAF mandate consultation does not include a defined commitment on aviation non-CO_2 effects beyond developing an evidence base on its impacts. The Committee recommends Government commit to a minimum goal of no further additional warming after 2050 from non-CO_2 effects.

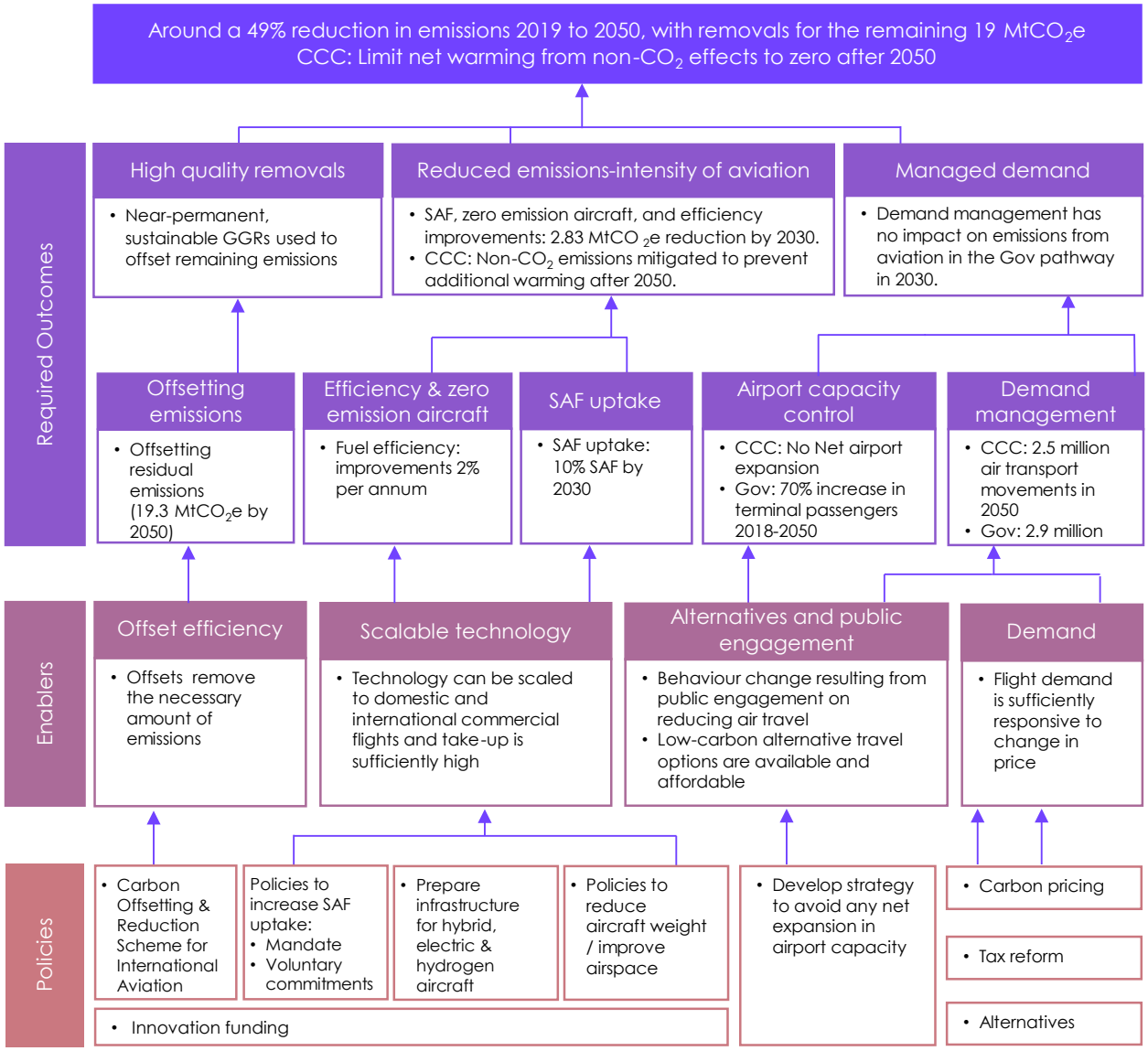
The UK's share of international aviation emissions is included in the UK's Net Zero target and, from 2033, will be included within carbon budgets. In 2025, our advice on the Seventh Carbon Budget will include recommendations on the level of the UK's 2035 Nationally Determined Contribution (NDC) and how international aviation and shipping emissions should feature in it (see Chapter 2 for more detail).

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 10.1 Monitoring map for aviation



Source: CCC analysis.
Notes: Numbers are from the Government's Jet Zero Strategy unless stated otherwise.

The CCC's monitoring map for aviation (Figure 10.1), sets out the policies, enablers and required outcomes for a successful transition. This report focuses on ten key indicators, with more indicators available in the supplementary materials. Our Monitoring Framework documents the indicators we track and our approach for assessing progress.

Due to the aviation sector's continued post-pandemic recovery, it is too early to say whether indicators are on track with the Government's Jet Zero Strategy pathway.

Emissions trends in the aviation sector are likely being driven by the continued recovery from the pandemic, with a possible contribution from the rising cost of living. Because of this, it is too early to say whether some indicators are on track (for instance, passenger-km per capita, terminal passengers, non-CO_2 effects). Overall, the indicators are not showing progress that can be attributed to aviation decarbonisation policy implementation.

Emissions. 2022 emissions data shows the aviation sector has not yet rebounded fully from the pandemic. Emissions in 2022 were 29 $MtCO_2e$. This is up 95% from 2021, but still 25% below 2019 levels. It is too early to say whether emissions are on track compared to the Government's Jet Zero Strategy (2022) pathway, which starts in 2023, and there remains uncertainty over future demand and emissions following the pandemic (Figure 10.2a).

- Aviation emissions trends are primarily driven by demand growth and efficiency savings. The longer-term historical trend in aviation emissions shows a gradual increase. This is due to rising demand for long-haul flights increasing emissions, while falling demand for domestic flights, higher plane loadings, a decrease in average flight distance and some efficiency improvements partially offset this increase.

In 2021 the carbon-intensity of aviation was significantly higher than 2019 levels due to low seat occupancy rates.

Carbon-intensity of aviation. The Jet Zero Strategy aims to reduce the CO_2 emitted per passenger-km of travel through increased fuel efficiency and SAF uptake. Due to lower seat occupancy rates, the carbon-intensity of aviation remains significantly higher than pre-pandemic levels.

- **Fuel consumption per passenger-km.** Data for 2021 show that fuel consumption per passenger-km more than doubled from 2019 levels, to 0.94 kWh per passenger-km in 2021 due to decreased seat occupancy (Figure 10.2b). The longer-term trend has seen a gradual decrease due to improvements in fuel efficiency.
  - 2022 data show that seat occupancy rates are likely returning to pre-pandemic levels (81%) as demand increases (Figure 10.2c). Between 2015-2019, seat occupancy rates were 84-86%.
- **Sustainable aviation fuel.** SAF is a nascent technology and industry. Uptake for 2022 was low at 0.22% of total aviation turbine fuel supply. The Government has committed to an ambitious 10% SAF uptake by 2030, compared to 2% in the CCC's Balanced Pathway (Figure 10.2d).
- **Non-CO_2 effects.** Due to the pandemic and associated lower demand, the non-CO_2 effects of aviation have decreased (Figure 10.2e and Figure 10.4).
- **Carbon offsets in the aviation sector.** The number of seat-kms flown by airlines associated with an offset increased to 32% in 2022 from 23% in 2021 (Figure 10.2f). For international flights it increased to 29% in 2022 from 18% in 2021, with the majority covered by corporate schemes (Figure 10.5). This indicator makes no judgement on the quality, additionality or sustainability of offsets and cannot be interpreted as the proportion of aviation emissions offset.

As well as post-pandemic recovery, the rising cost of living may also be impacting aviation demand.

Aviation demand. The Government's Jet Zero Strategy pathway projects aviation demand to increase by 70% by 2050 compared to 2018 levels. The CCC's Balanced Pathway recommends a 25% demand increase over the same period.

The post-pandemic recovery continues to impact aviation demand, with a possible contribution from the rising cost of living. In a Civil Aviation Authority (CAA) survey from October 2022 that asked respondents why they chose not to fly in the previous 12 months, the pandemic (32% of respondents) and rising cost of living (29% of respondents) were most frequently cited.[4] 40% of people plan to not fly or reduce the amount they fly over the next 12 months, with 19% of respondents answering that they will not fly due to living costs rises.

- **Terminal passengers and Air Transport Movements.** Terminal passengers have not rebounded to pre-pandemic levels. In 2022 there were 222 million terminal passengers, compared to 297 million in 2019 (Figure 10.2g). Air Transport Movements show a similar trend, reaching 1.7 million in 2022 compared to 2.3 million in 2019.

- **Public sentiment.** CAA survey data suggests that consumers increasingly consider the impact of flying on the environment when considering travelling by air, although this has decreased from 41% in 2021 to 37% in 2022 (Figure 10.2h). The survey data indicates this decrease is driven by higher-income consumers.

- **Type of travel.** In 2022, 6% of international aviation demand came from business travel (Figure 10.2i). The pre-pandemic share over the period 2009 to 2019 ranged between 9-13%.

- **Cost of aviation.** For both long- and short-haul air travel, the cost of business flights has decreased since 2009, while the cost for leisure and visiting family and friends has increased (Figure 10.6, 10.7). To incentivise alternative transport modes, prices of air travel ought to be more expensive relative to lower-emission modes.

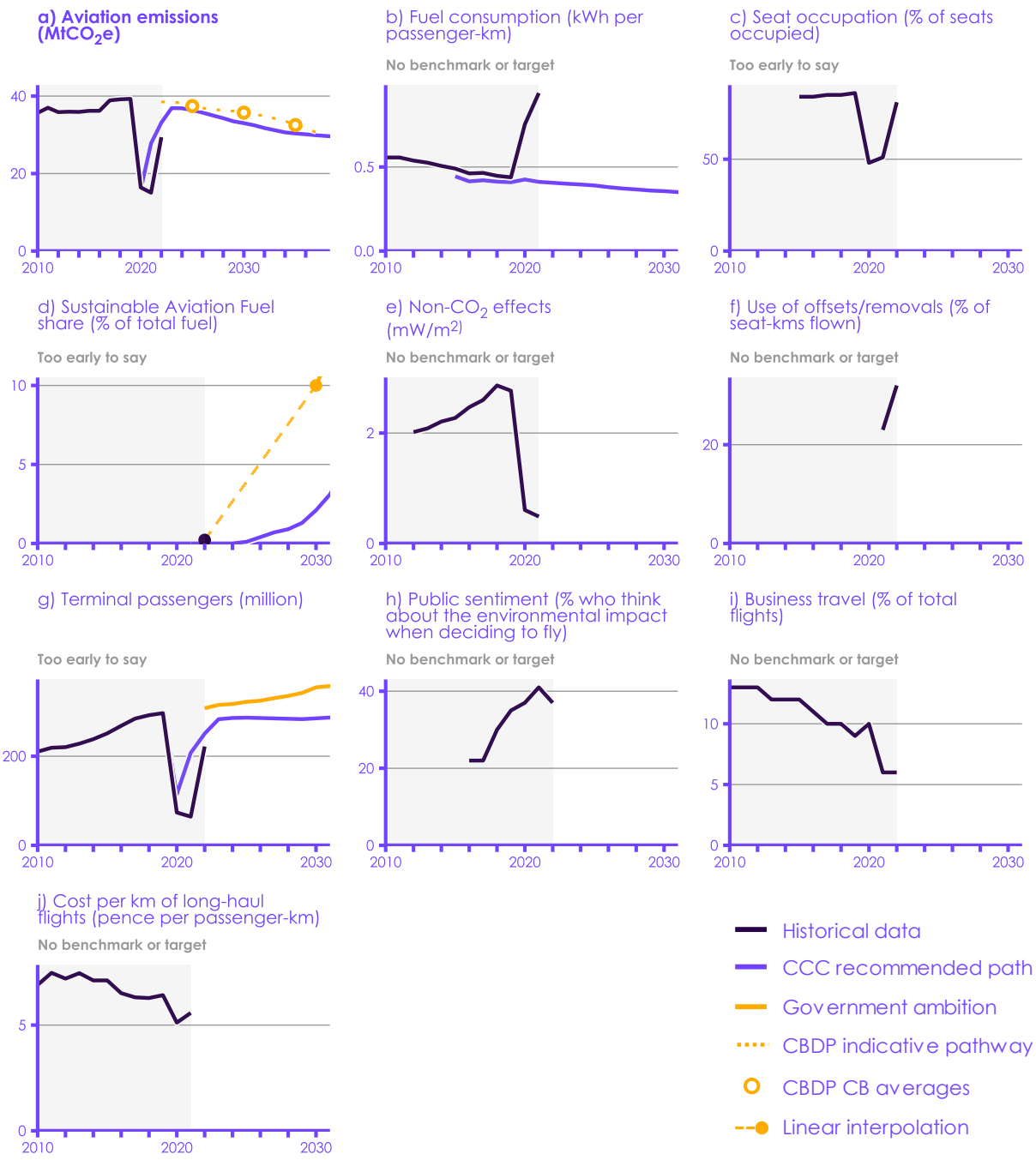
  - **Long-haul air travel.** The price per passenger-km of long-haul air travel has increased from 5.1 pence per km in 2020 to 5.6 in 2021. In 2019 prices were 6.4 p/km (Figure 10.6).

  - **Short-haul air travel.** The price per passenger-km of short-haul air travel increased above 2009 levels for the first time in 2021 (Figure 10.7). The trend between 2009-2020 showed decreasing prices (from 9.6 p/km in 2009 to 8.1 in 2020) due to improvements in aircraft efficiency in fuel consumption. The increase in 2021 to 10.2 p/km could reflect the impact of the energy and rising cost of living on the domestic aviation sector.

  - **Relative cost of rail travel.** The long-term price trend for rail travel shows a 32% increase on 2009 levels compared to a 10% decrease for short-haul business flights.

International comparisons. In 2021 the UK's per person emissions for international flights ranked 11th highest in the world, down from ninth in 2020 (Figure 10.8). Some countries are moving faster than the UK with policies to reduce their aviation emissions (see Box 10.2 for more information).

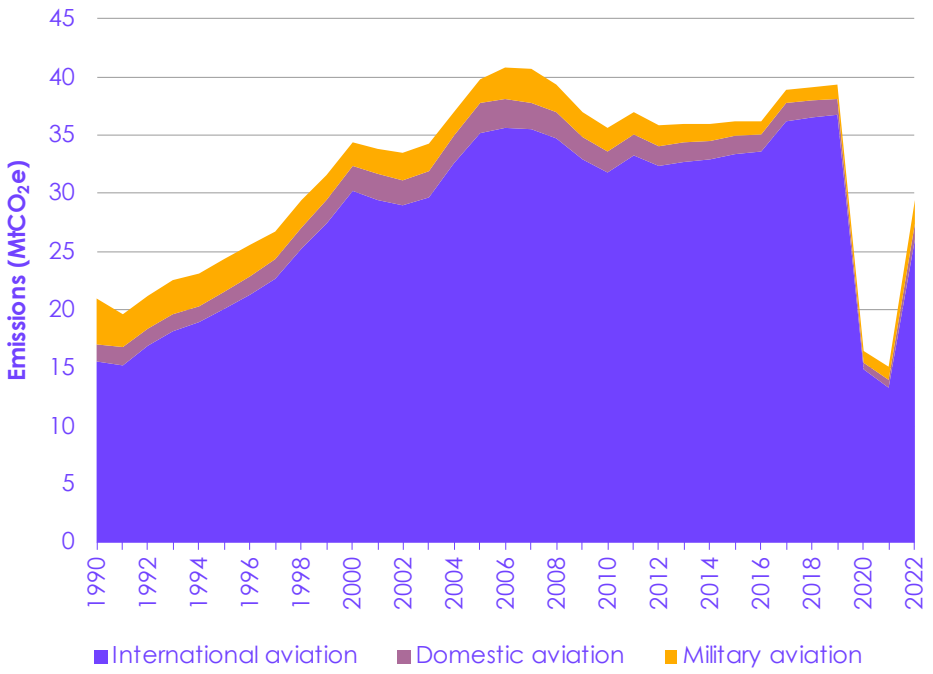
Figure 10.2 Key indicators for aviation



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path, and considering the wider contextual factors that may have a temporary impact (e.g., recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) Dashed lines indicate the linear rate of change that would be required to meet the target, whereas solid lines show modelled pathways. (3) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (4) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions.

In 2022, aviation emissions were 25% below 2019 levels.

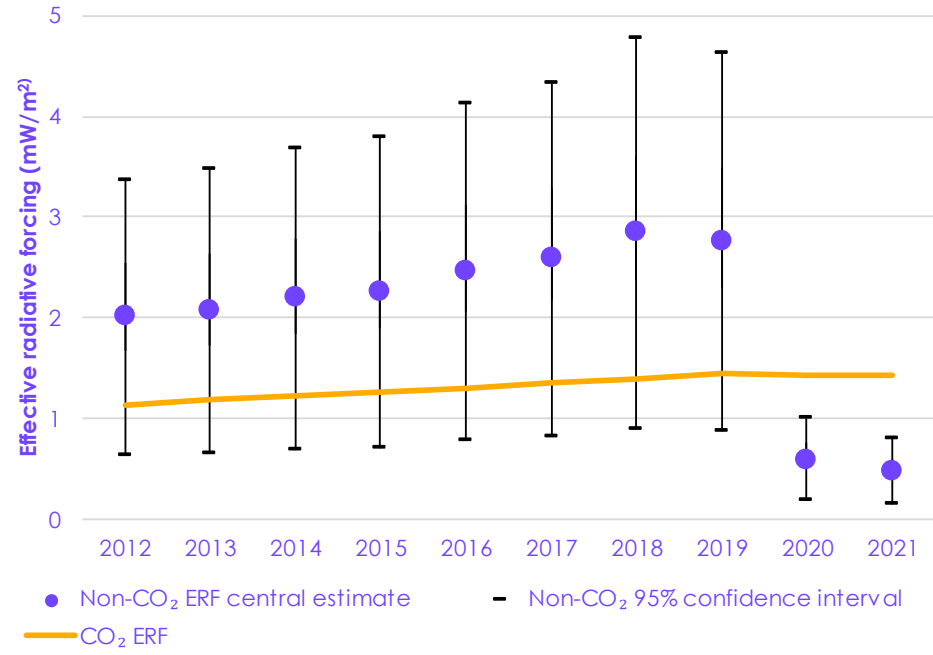
Figure 10.3 Aviation emissions since 1990



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*

Due to the pandemic and associated lower demand, the non-CO_2 effects of aviation have decreased.

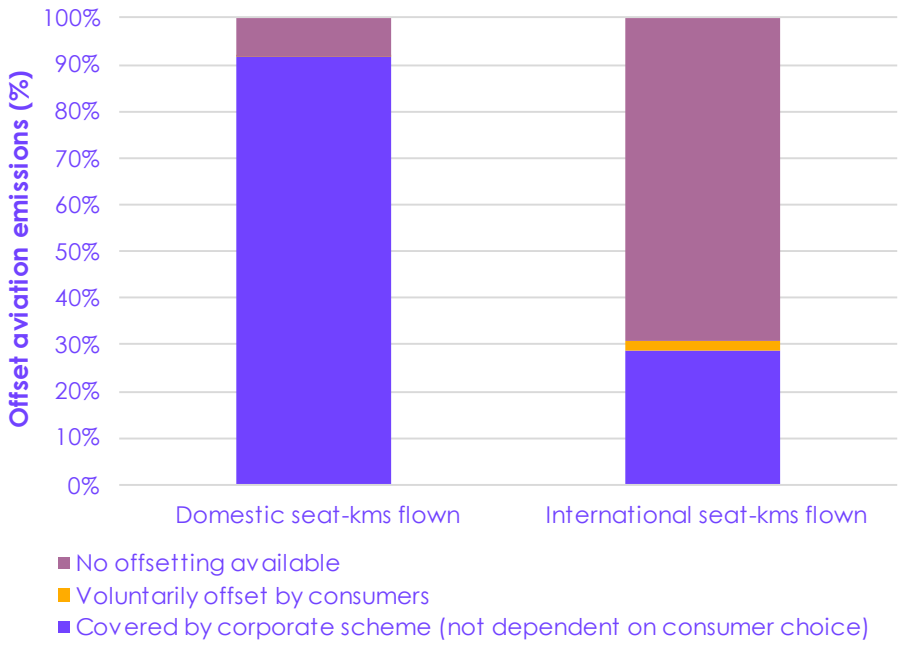
Figure 10.4 UK aviation CO_2 and non-CO_2 effects



Source: Non-CO_2: Lee, et al. (2021) *The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018,* Atmospheric Environment, Volume 244; ICAO (2012-2020) *The World of Air Transport*; CO_2: DESNZ (2023) *Provisional UK greenhouse gas (GHG) emissions national statistics 2022*; BEIS (2023) *Final UK GHG emissions national statistics: 1990 to 2021*; Smith, et al. (2018) *FAIR v1.3: A simple emissions-based impulse response and carbon cycle model, Geosci. Model Dev*; Millar, et al. (2017) *A modified impulse-response representation of the global near-surface air temperature and atmospheric concentration response to carbon dioxide emissions,* Atmos. Chem. Phys; CCC analysis.
Notes: Global estimates for 2018 have been scaled to total global passenger-kms for 2012-2021 and then further scaled for UK passenger-kms.

In 2022, 92% of UK domestic seat-kms and 29% of international seat-kms were covered by an offsetting scheme.

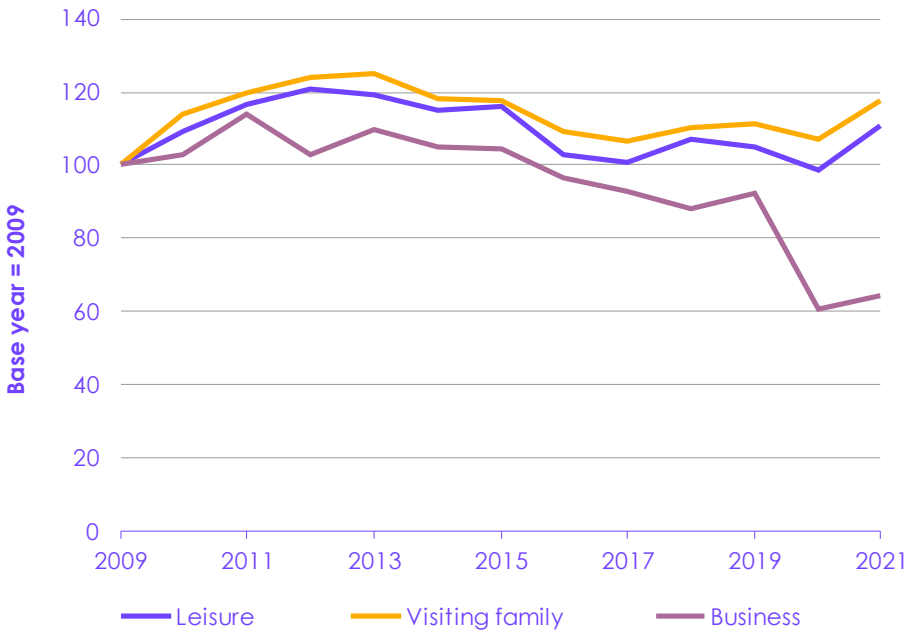
Figure 10.5 2022 UK corporate and voluntary aviation offsetting schemes



Source: Civil Aviation Authority (2019-2022) *UK Airline data, Table 03 All Services*; DfT (2023) *Seat-km & passenger-km flown to/from UK airports on passenger services, 2021 (unpublished)*; Berger, et al. (2022) *Willingness-to-pay for carbon dioxide offsets: Field evidence on revealed preference in the aviation industry*; CCC analysis of airline websites.[5,6,7,8,9,10,11,12,13,14,15]
Notes: Chart shows the purchase of offsets by airlines and makes no judgement on the quality, additionality, or sustainability of these offsets. The chart shows the percentage of flight kms with an offset attached, rather than the amount of aviation emissions that have been offset.

For both long- and short-haul air travel, the cost of business flights has decreased since 2009, while the cost for leisure and visiting family and friends has increased.

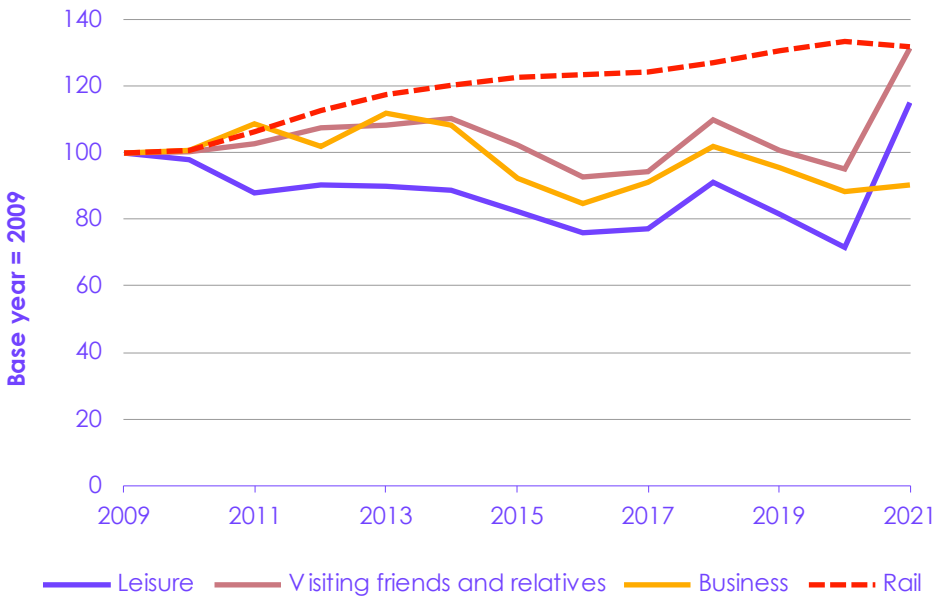
Figure 10.6 Trends in long-haul flight prices



Source: ONS (2021) *International Passenger Survey*; HMT (2021) *GDP Deflator*; CCC analysis.
Notes: Flight prices calculated from basket of ten most popular long-haul routes from the UK over time. Converted to real prices using the GDP deflator and shown as a price index. Prices are ticket price paid by consumers and therefore include all relevant taxes.

The long-term price trend for rail travel shows a 32% increase on 2009 levels compared to a 10% decrease for short-haul business flights.

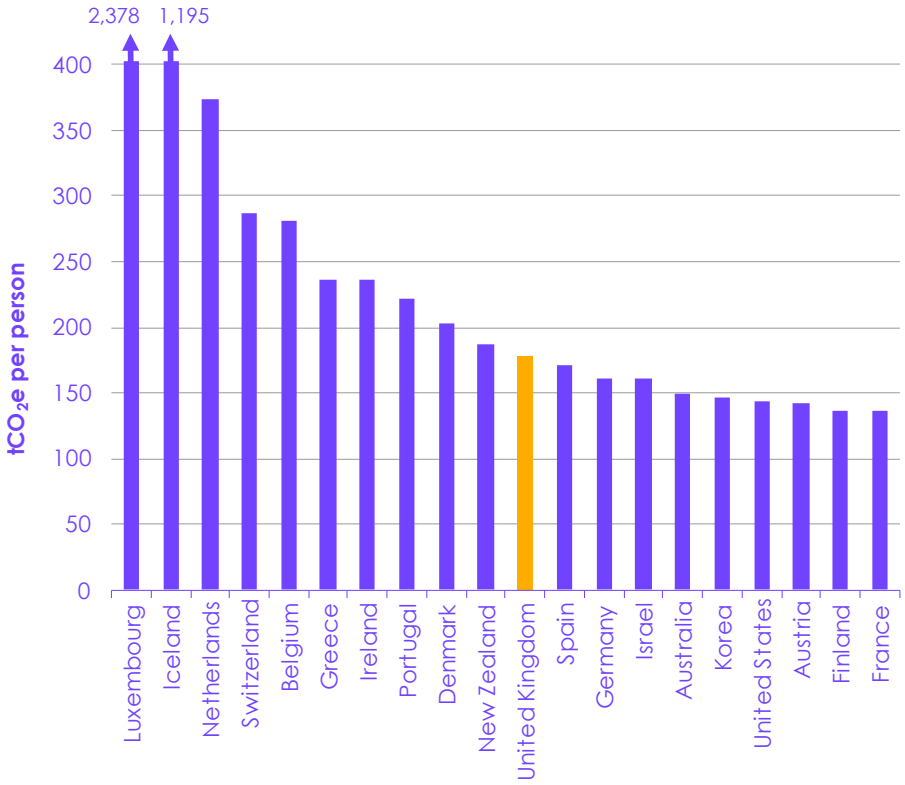
Figure 10.7 Trends in short-haul flight prices and rail



Source: ONS (2021) *International Passenger Survey*; HMT (2021) *GDP Deflator*; ORR (2022) *Office of Rail and Road Rail Fares Index*; CCC analysis.
Notes: Flight prices calculated from basket of ten most popular short-haul routes from the UK over time. Converted to real prices using the GDP deflator and shown as a price index. Prices are ticket price paid by consumers and therefore include all relevant taxes.

In 2021, the UK's per person emissions for international flights ranked 11th highest in the world, down from ninth in 2020.

Figure 10.8 OECD country ranking of international aviation emissions (2021)



Source: OECD (2022) *Air travel emissions*; United Nations (2022) *Population Estimates*; CCC analysis.

Box 10.1
CCC's recommendation on airport expansion

The Sixth Carbon Budget Balanced Pathway recommends that aviation demand can increase 25% on 2018 levels by 2050, which equates to 365 million passengers per year in 2050. The CCC's Sixth Carbon Advice also recommended no net expansion in airport capacity as existing aggregate capacity (370 million passengers) could accommodate such demand growth.

Net airport expansion should only proceed if the carbon-intensity of aviation is outperforming the Government's pathway and can accommodate this additional demand. Current Government policy is not delivering an outcome consistent with this. The Committee recommends that there should be no expansion of UK airport capacity until an airport capacity management framework is in place:

- Any additional airport capacity that would facilitate increased aviation demand should not take place unless corresponding reductions in capacity are made at other UK airports such that net UK airport capacity remains the same. Without a capacity-management framework, it must be assumed that any capacity increases at individual airports will lead to a permanently higher level of overall airport capacity.
- Two airport* expansions have been approved since 2018 in the absence of such a framework, which increases annual terminal passenger capacity by 9.3 million. Applications currently under consideration would translate to capacity for an additional 16.5 million terminal passengers. The potential Heathrow (assuming the Government's preferred option of the Heathrow Northwest Runway) and Gatwick Airport expansions would add a further 71.6 million terminal passengers if applications were resubmitted and approved.
- If all applications were approved, this would increase terminal passenger capacity by 97.4 million compared to 2018 levels, bringing total capacity to 467 million. The Jet Zero Strategy commits to a 70% increase in terminal passengers on 2018 levels, equating to 482 million passengers by 2050.
- A capacity-management framework would allow expansion decisions to be made in line with the aviation sector's decarbonisation pathway and in collaboration with the Welsh, Scottish and Northern Irish Governments. This framework should consider existing and planned capacity proposals.

Once a framework is in place, net airport capacity expansion should only take place if the carbon-intensity of the aviation sector is outperforming the Government's aviation emissions trajectory and can accommodate the additional demand.

Source: AEF analysis; CCC analysis of airline websites [16,17,18,19,20] ; UK Government (2017) *UK aviation forecasts 2017.*

* A total of four airport expansions have been approved since 2018, but two of these do not increase terminal passenger numbers.

Box 10.2
International comparisons of aviation decarbonisation policy

A number of countries and the EU are bringing forward internal policies to decarbonise the aviation sector. This box describes developments over the past year.

Demand

- **France.** The French Government's decision to ban domestic flights where there is an alternative train journey of less than two and a half hours has come into force.
- **Netherlands.** Schiphol Airport, which is majority owned by the Dutch Government, has proposed to ban private jet flights within certain time periods and night flights by the end of 2025. A Dutch court has initially ruled against the proposals for procedural reasons.

Technology

- **US.** In September 2022 the US Government published the SAF Grand Challenge Roadmap. The Roadmap re-confirms that the US is targeting 3 billion gallons per year of domestic SAF production by 2030 that achieve a minimum of a 50% reduction in lifecycle GHG emissions compared to conventional fuel and 100% of projected aviation jet fuel use, or 35 billion gallons of annual production, by 2050.
- **EU.** The ReFuelEU Aviation regulation, originally mandating minimum SAF blends of 5% in 2030 and 63% in 2050, is under political agreement between the EU Parliament and Council to aim for 70% SAF blend by 2050, promote hydrogen at EU airports and create an EU environmental impact labelling scheme for aircraft operators using SAF to enable consumer choice.

Source: BBC, *France bans short-haul flights to cut carbon emissions*; Euro News, *Schiphol airport's ban on night flights and private jets blocked by Dutch court*; US Department of Energy, *SAF Grand Challenge Roadmap*; European Council, *Council and Parliament agree to decarbonise the aviation sector*; European Commission, *European Green Deal: new law agreed to cut aviation emissions by promoting sustainable aviation fuels.*

While the Jet Zero Strategy has provided more policy certainty, risks remain unaddressed.

Policy progress has been partial in the aviation sector. The Jet Zero Strategy has provided more certainty on the Government's approach to aviation decarbonisation. However, risks remain unaddressed, particularly for securing SAF feedstock and SAF import supply, as well as planning for potential delays to nascent technology roll-out. The SAF mandate process is delayed, and insufficient policy has been brought forward to address demand management. The required emissions reduction for the Sixth Carbon Budget period is therefore at significant risk (Figure 10.9, Table 10.1). Our assessment is based on the criteria outlined in Annex 1.

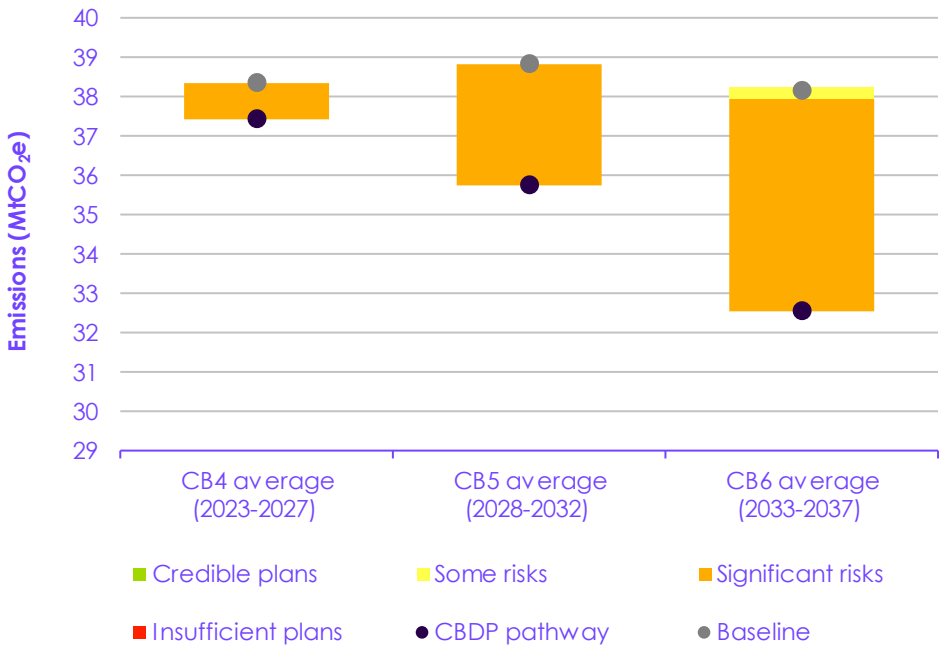
Table 10.1 summarises recent progress and what needs to be addressed. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 10.1.

The CCC's 2023 Adaptation Report makes recommendations to ensure the aviation sector is well adapted to future climate impacts.

The policy assessment in this report focuses on measures to reduce emissions, but the aviation sector must also be well adapted to future climate impacts. In the CCC's recent report: Progress in adapting to climate change – 2023 Report to Parliament, the Committee set out a number of recommendations in this area. These include extending Adaptation Reporting Power to cover local authority functions related to airports and establishing and monitoring a suite of transport indicators, including airports.

The required aviation emissions reductions for the Sixth Carbon Budget period are at significant risk.

Figure 10.9 Assessment of policies and plans for aviation



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; CCC analysis.
Notes: This assessment uses Government plans listed in Annex B, Tables 5 and 6 of the Carbon Budget Delivery Plan. See Annex 1 for the assessment criteria. Emissions from domestic, international and military aviation are included in the CCC's aviation sector.

Table 10.1
Policy scorecard for aviation

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Aviation overall assessment	O	O	O	O	O
Demand No quantified abatement in Government's pathway	R	R	R	O	R

Progress:

- Although delayed, the CAA published a Call for Evidence on the provision of environmental information to consumers when they are booking flights.[21]

To be addressed: The Jet Zero Strategy assumes a 70% increase in passenger demand on 2018 levels. The CCC's Balanced Pathway contains a 25% increase over the same period.

- The Government does not have an airport capacity strategy to manage demand if the aviation sector is not on track to achieve the Jet Zero emissions reduction pathway (priority recommendation R2023-037).
- The 2023 Spring Budget confirmed low domestic Air Passenger Duty rates for 2023-2024.[22] Emissions from flying are not reflected in the cost of flying; this could be addressed using fiscal policies, such as frequent flyer levies and taxation.
- There are a range of options to manage demand, such as digital technologies, addressing private flying and providing lower cost domestic rail travel, but Government has not developed sufficient demand-side policy to, for instance, adequately incentivise lower-carbon travel choices (recommendation R2022-057).
- The Jet Zero Strategy will be reviewed every five years. If the sector is not meeting the Jet Zero emissions reductions trajectory, Government will consider further measures. However, a review in the late-2020s would likely not provide enough time to implement mitigating measures if the Government is not on track to meet its pathway, particularly the 2030 SAF target. Given demand management is an effective way of reducing aviation CO_2 and non-CO_2 emissions, demand policies could be viewed as an alternative measure for course correction (recommendation R2023-116).
- The carbon intensity of, and demand for, different ticket types (e.g. business, first class, economy class), and demand for private flying is not currently tracked, making it difficult to understand how different demand management approaches could reduce the carbon-intensity of flying (recommendation R2023-117).
- During the pandemic, more people used technologies such as videoconferencing, which could have displaced some demand for business flying. Government has not announced any measures to encourage continued use of virtual technologies (recommendation R2022-058).

Sustainable Aviation Fuel 67% of abatement over CB6 period	Y	Y	O	O	O

Progress: The Government has committed to SAF contributing 10% of aviation fuel by 2030.[1] To achieve this target, progress has been made across several elements:

- The Jet Zero Strategy commits Government to having at least five SAF plants under construction by 2025. Five SAF projects have been awarded funding through the Advanced Fuel Fund.[23] University of Sheffield has been named the UK's first SAF clearing house, which will act as a central hub to coordinate SAF testing and certification.[24] Timely construction of these plants will be important for securing a domestic SAF supply.
- Although delayed, the Government has published its response to the first SAF mandate consultation, which has broadly defined eligible fuels and sustainability criteria, committed to

	a cap on Hydrotreated Esters and Fatty Acids feedstocks, confirmed that lifecycle emissions and feedstock origin will be reported on and established that companies will not be able to claim under both CORSIA and the SAF mandate to avoid double counting.[25] • A second SAF mandate consultation has been published, which consults on the level of carbon-intensity reduction for the scheme, SAF trajectories to 2040, the level of the HEFA cap and the Power-to-Liquid sub-target, amongst other parts of the mandate.[26] • The mandate will be delivered through secondary legislation via the Energy Act (2004) towards the end of 2024.[27] Given delays to the SAF mandate consultation process, Government must ensure the mandate is operational by 1 January 2025 (recommendation R2022-046). • The Government commissioned Philip New to conduct an independent evaluation of the conditions necessary to create a successful UK SAF industry.[28] The report concluded that the SAF mandate alone is insufficient to unlock the required investment in the UK largely due to dependence on debt finance and market and technology maturity. Other barriers identified include construction, feedstock supply and revenue certainty. **To be addressed:** The Jet Zero Strategy outlines a substantial role for SAF out to 2050 that relies on nascent technology and UK and global feedstock availability: • The Government suggested in the first SAF mandate consultation a 50% minimum GHG saving threshold. The second SAF mandate consultation is consulting on the minimum level of GHG savings for SAF, ranging from 40-60% relative to jet fuel. The minimum GHG emissions savings from SAF must achieve sufficient savings in line with the Government's aviation emissions reduction trajectory and increase over time at a rate that ensures high future emissions savings, while upholding stringent fuel eligibility standards (recommendation R2023-118). • The Government's approach to securing SAF supply will be informed by the upcoming Low Carbon Fuels Strategy and Biomass Strategy. The cost benefit analysis published with the second SAF mandate consultation acknowledges that there is high uncertainty regarding both domestic and global SAF feedstock supply, and that it is likely global feedstock supplies will be constrained out to 2050.[29] The approach to SAF must account for this risk and not be over-reliant on the buy-out mechanism* (recommendation R2023-119). • The second SAF consultation is not considering the potential role for high-quality GHG removals to reduce emissions up to 2030 (recommendation R2022-056).
Zero-emission aircraft 2% of abatement over CB6 period	Y | Y | O | O | O **Progress:** • Through the existing Aerospace Technology Institute Programme, Government and industry are investing £113 million in new hydrogen and all-electric flight technologies. **To be addressed:** • The Jet Zero Strategy reconfirms that Government is aiming to have zero emission routes connecting the UK by 2030 but does not outline how Government will support the roll-out of zero-emission aircraft beyond 2030 (recommendation R2023-120).
Offsets and removals 5% of abatement over CB6 period	O | O | O | O | O **Progress:** There has been no progress on offsets and removals policy specific to the aviation sector. See Chapter 14 for more detail on greenhouse gas removals. **To be addressed:** • Government has not confirmed its approach to the interaction between CORSIA and the UK ETS and is further consulting on this in the second SAF mandate consultation (recommendation R2022-048).

* The mandate includes a buy-out mechanism, whereby obligated parties will either discharge their obligations by redeeming certificates at the end of the obligation period or by paying to buy out of their obligations, or a combination of the two.

	• Government consulted on the UK ETS in 2022, the scope of which included the role of free allocation allowances in the aviation sector and incentivising SAF. The Government response to this consultation has not yet been published. • Airlines should ensure that their company-wide carbon offsetting schemes and voluntary schemes offered to consumers only invest in high-quality, long-lived offset schemes and provide regular, annual monitoring, reporting and verification on their use of offsets. A summary of the CCC's report on voluntary carbon markets and offsetting is in Chapter 15, Box 15.2. Once available, airlines should use high quality, permanent GHG removals instead of offsetting schemes. • Chapter 15 makes recommendations on how the Government can support businesses to make appropriate use of offsets (priority recommendation R2023-165).
Non-CO_2 effects No quantified abatement in Government's pathway	O | O | O | O | O **Progress:** • The Jet Zero Strategy commits to a work programme to develop consensus on non-CO_2 effects and methodologies for estimating them. **To be addressed:** • The second SAF mandate consultation does not include a defined commitment on non-CO_2 effects beyond developing an evidence base on its impacts (recommendation R2023-118). • Work to address non-CO_2 effects must be accelerated. A minimum 2050 target for non-CO_2 effects, such as no further additional warming after 2050, could help to provide direction to the Government's non-CO_2 effects work programme. (recommendation R2022-053)
Efficiencies 23% of abatement over CB6 period	O | O | Y | Y | O **Progress:** • Tankering is a practice whereby an aircraft carries more fuel than required to reduce or avoid refuelling at the destination airport. The second SAF mandate consultation is scoping a voluntary or mandatory mechanism for airlines to avoid tankering. • The Jet Zero Strategy also commits to avoiding unnecessary emissions from "ghost flights" that are empty or near empty when departing the UK. • Government set a goal for all English airport operations to be Net Zero by 2040 and released a Call for Evidence.[30] **To be addressed:** • The pathway for fuel efficiency improvements outlined in the Jet Zero Strategy involves a change to 2% annual growth from historic levels of 1.5%.[5] Considerable research and development and incentives for fleet renewal is required to achieve this, as well as high levels of international cooperation (recommendation R2022-050).
Cross-cutting	**Progress:** Progress was made across several cross-cutting elements in the past year, particularly at the international level. • The CCC welcomes the UK's role in fostering agreement at the 2022 International Civilian Aviation Organisation (ICAO) General Assembly for international aviation emissions to reach Net Zero CO_2 emissions by 2050. The UK should continue to advocate for global ambition through the ICAO and CORSIA scheme, including that all residual emissions in 2030 are covered by near-permanent, sustainable GHG removals (recommendation R2022-054). • The UK is a member of the International Aviation Climate Ambition Coalition. The Coalition was active during last year's ICAO Assembly, including submitting a working paper calling for a high ambition goal. The UK Government should continue to advocate for high international aviation ambition and encourage more transparency on the Coalition's activities and priorities.

	• The Jet Zero Strategy commits to ensuring an aviation workforce equipped with the right skills to deliver a decarbonised aviation sector, delivered through the Future Aviation Skills research programme. The Government should continue to monitor potential skill gaps and seek to address them (recommendation R2023-104). **To be addressed:** • Legislation has not yet been brought forward to include international aviation and shipping emissions within the scope of the Sixth Carbon Budget (recommendation R2023-121). **Risk due to international action: Medium.** • Aviation is an international sector with high dependency on international action to achieve global decarbonisation. The level of ambition, policy and work programmes of the ICAO and CORSIA must be negotiated and agreed by member countries. The ICAO target for 2050 gives more direction to international action, but the pathway to achieving international decarbonisation remains undefined and uncertain.

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan.

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Chapter 11: Shipping

12 $MtCO_2e$, 3% of UK emissions in 2022

Introduction and key messages

Shipping emissions have reduced slowly over recent years. They were 12.2 $MtCO_2e$ in 2022, up 1% from 2021 but still 12% below 2019 levels. The Government's Carbon Budget Delivery Plan pathway requires emissions from domestic shipping and the UK's share of international shipping to fall by around 22% by 2035 on 2019 levels.

Little has changed in the last year regarding policy for the shipping sector. In 2023, the Government must publish its response to the Course to Zero consultation and embed it in the updated Clean Maritime Plan (the environment route map of the Maritime 2050 Strategy).[1,2] The Government should also push for an ambitious 2050 Net Zero goal to be agreed at the International Maritime Organisation (IMO).

The UK's share of international shipping emissions is included in the Net Zero target and, from 2033, will be included within carbon budgets. Through advice on the Seventh Carbon Budget, we will recommend the level of the 2035 NDC and how international aviation and shipping emissions should be featured in it (Chapter 2).

Our key messages are:

- **The Government must produce policies in the next year.** Progress has been slow to establish a strategy for full decarbonisation. The Course to Zero consultation response and refreshed Clean Maritime Plan must be published in 2023.[1] In 2022, the Government established a UK Shipping Office for Reducing Emissions, which is providing funding for commitments such as the Clean Maritime Demonstration Competition and new UK research and innovation.[3,4] Separately, the Government announced the new Freight Innovation Fund which includes maritime freight.

- **The path to Net Zero.** Deep emissions reductions in shipping require a transition to zero-carbon fuels such as ammonia and hydrogen, and low-carbon fuels such as methanol. These are in development but, combined with slow shipping asset turnover, lead to a relatively back-ended emissions pathway. The Government has not published its response to the Course to Zero consultation or the Low Carbon Fuels Strategy.[1,5] Current uptake of zero-carbon fuels is essentially zero. E- and bio-methanol is being adopted by some parts of the sector but has feedstock and sustainability concerns and is not truly zero-carbon without carbon capture technology. Improved efficiency in operations across the sector is also required through technologies such as port-side robotics and AI for enhanced logistics.

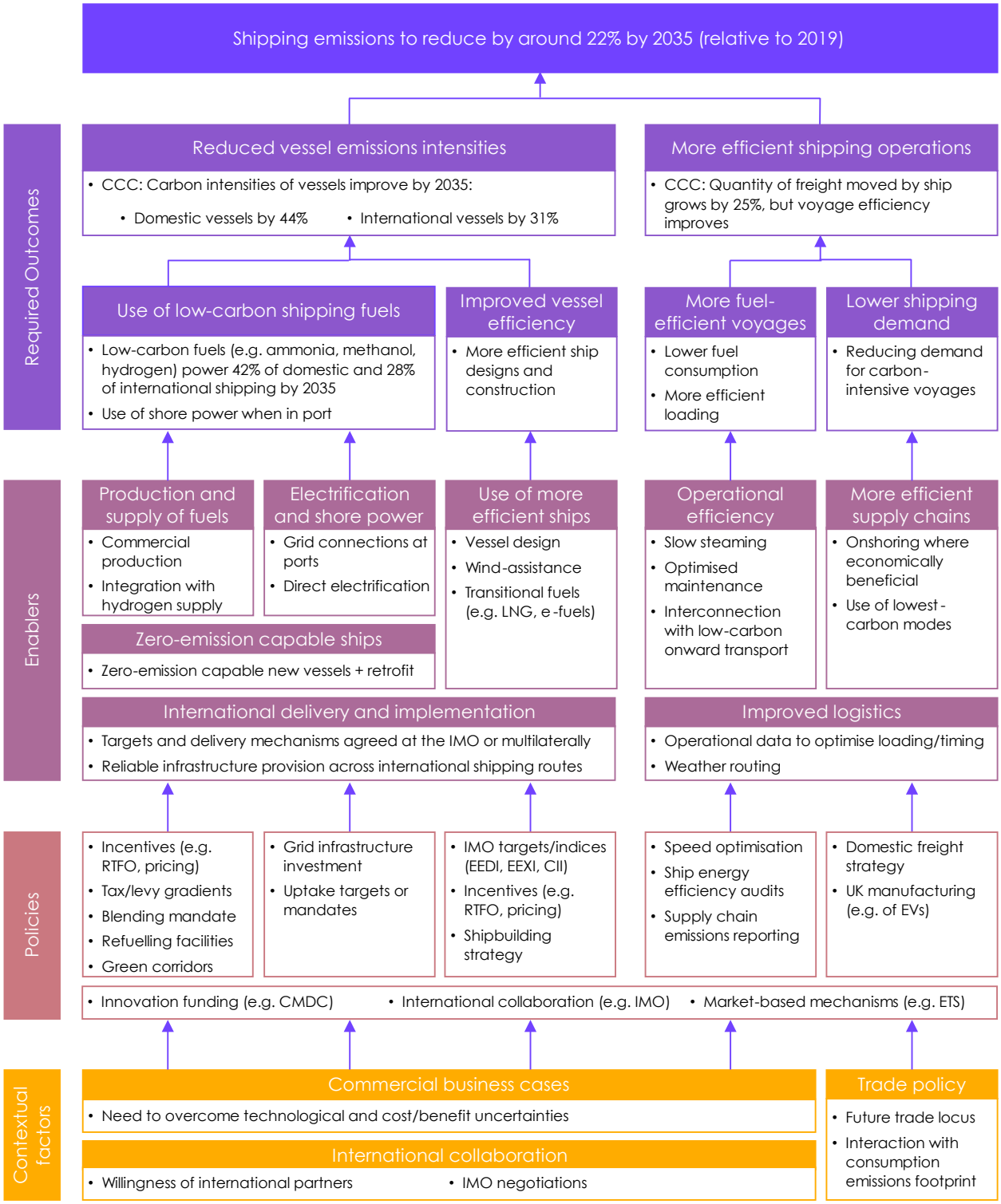
- **International action.** Effective international policy is essential to deliver reductions in global maritime emissions. The IMO meeting in July 2023 is an opportunity to agree a more ambitious GHG Strategy with revised resolutions to encourage member states to develop National Adaptation Plans (NAPs) and encourage voluntary cooperation between ports and the shipping sector to reduce emissions from ships.[6] The UK must continue to take a leadership role in pushing for adoption of an international Net Zero target for the sector. This target should minimise the use of offsetting to drive ambitious decarbonisation of vessels, fuels and operations.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 11.1 Monitoring map for shipping



Source: CCC analysis.
Notes: Numbers are from the Government's Carbon Budget Delivery Plan unless stated otherwise. CMDC: Clean Maritime Demonstration Competition.

The CCC's monitoring map for shipping (Figure 11.1) sets out the policies, enablers and required outcomes for a successful transition.

We plan to update our indicators to allow more granular monitoring of the enablers that will deliver shipping decarbonisation based on the approach set out in the Course to Zero consultation and updated Clean Maritime Plan. For now, we monitor a subset of six indicators. Progress this year on these indicators is shown in Figure 11.2.

It is too early to say whether shipping emissions are on track relative to the Government's pathway, but they remain lower than pre-pandemic levels.

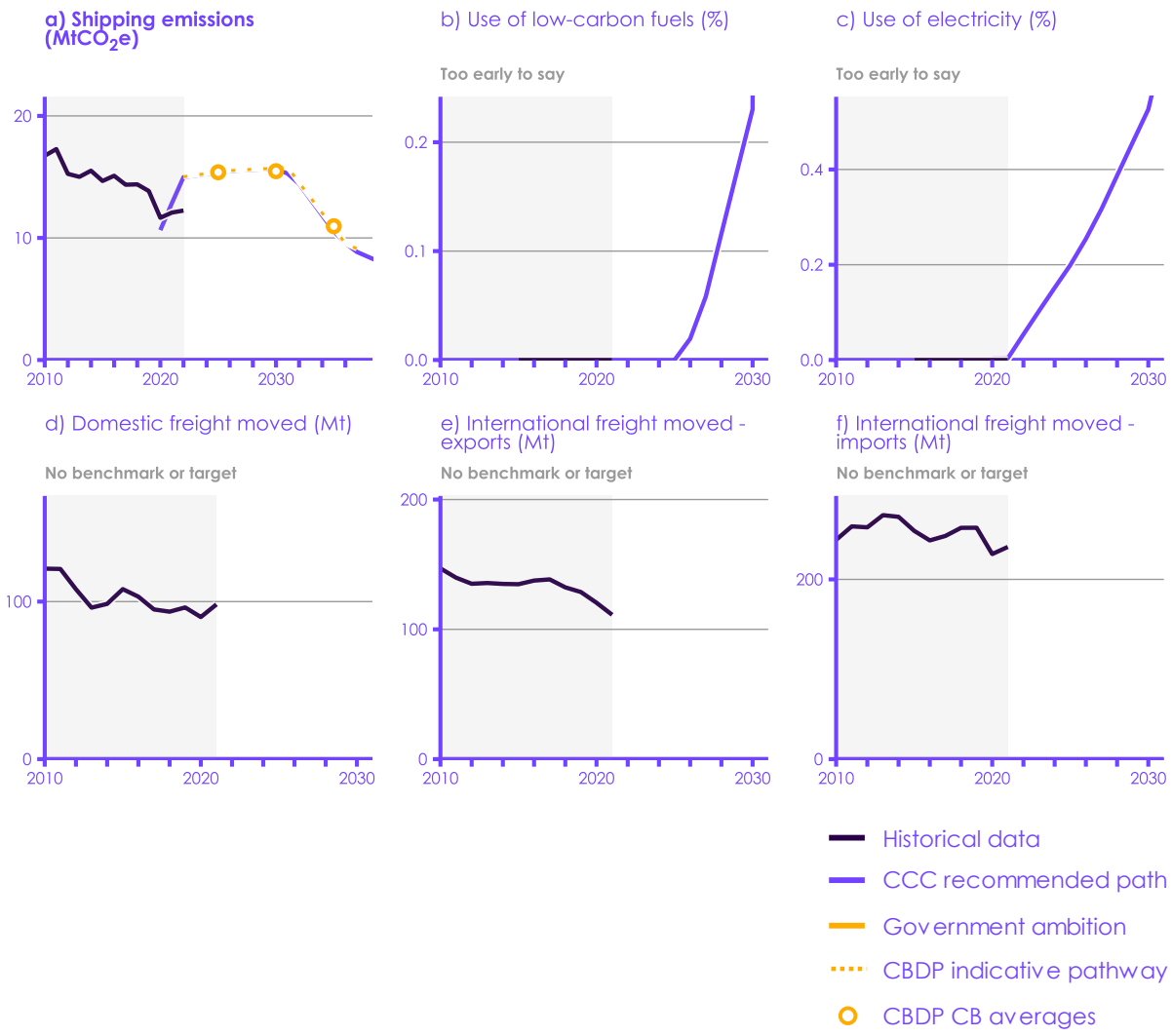
Emissions from shipping were 12 $MtCO_2e$ in 2022, a 1% increase on 2021 levels, but remaining 12% lower than pre-pandemic levels in 2019 (Figure 11.2a). 54% of emissions in this sector can be attributed to international shipping, 42% from domestic shipping and 4% from naval shipping (Figure 11.3). Shipping emissions were declining steadily from 2009-2019 but it is too early to say if emissions are on track relative to the Government's pathway.

Current uptake of low-carbon fuels is virtually zero but is expected to ramp up from 2025 alongside electrification of ports.

Low-carbon fuels and electrification. The current take-up of low-carbon fuels and electrification are virtually zero (Figures 11.2 b-c). They are not yet reported in regular publications but will need to be in the future. Although the initial take-up of low-carbon fuels is not expected to begin until 2025, electrification (especially of ports and the provision of shore-side power) should ramp up throughout the 2020s. It is too early to say whether this is on track.

Shipping demand. Over the past decade, shipping demand has decreased (Figure 11.2 d-f). This is due to a 1% annual average decrease in domestic shipping activity from 2012-2021 and decreases of 2% and 1% respectively in international exports and imports. There are no recommended pathways setting out the role for changes in shipping demand in the sector's decarbonisation pathway.

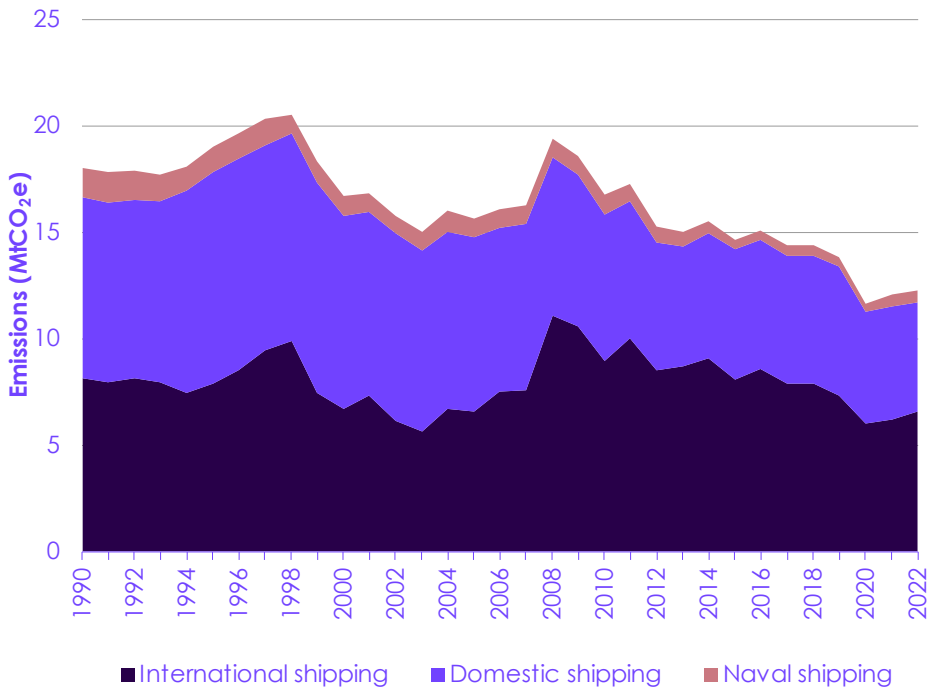
Figure 11.2 Key indicators for shipping



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path, and considering the wider contextual factors that may have a temporary impact (e.g., recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (3) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions.

Shipping emissions are steadily reducing. Despite a small increase last year, emissions remain below pre-pandemic levels.

Figure 11.3 Shipping emissions since 1990



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; DESNZ (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021.*

There are currently no credible policies in place to deliver the required emissions reduction by the Sixth Carbon Budget period.

Policy development has been insufficient in the shipping sector as, without an update to the Clean Maritime Plan, there are currently no credible policies in place to meet the required emissions reduction by the Sixth Carbon Budget period (Figure 11.4, Table 11.1). Our assessment is based on the criteria outlined in Annex 1.

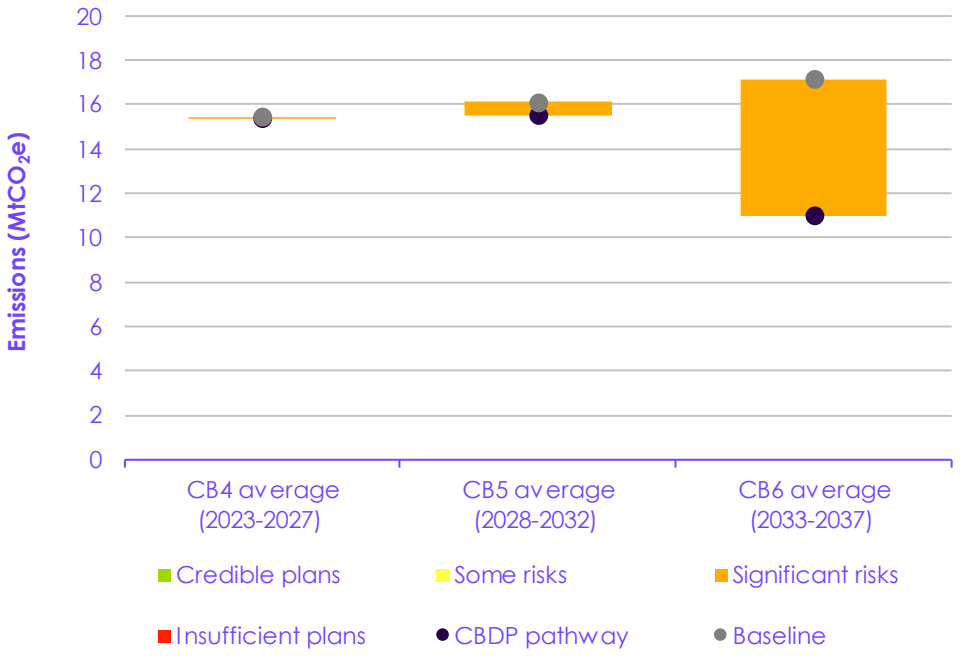
Table 11.1 summarises recent progress and what needs to be addressed. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 11.1.

The CCC's 2023 Adaptation Report makes recommendations to ensure the shipping sector is well adapted to future climate impacts.

The policy assessment in this report focuses on measures to reduce emissions, but the transport system must also be well adapted to future climate impacts. In the CCC's recent report: Progress in adapting to climate change – 2023 Report to Parliament, we set out a number of recommendations in this area. For ports, we recommend extending the next round of the Adaption Reporting Power (ARP4) to cover local authority functions related to ports and establishing and monitoring transport adaptation indicators for ports.

The required shipping emissions reductions for the Sixth Carbon Budget period are at significant risk.

Figure 11.4 Assessment of policies and plans for shipping



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan. See Annex 1 for the assessment criteria. (2) Emissions from domestic, international and naval shipping are included in the CCC's shipping sector.

Table 11.1
Policy scorecard for shipping

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Shipping overall assessment	O	Y	O	O	O
Low-carbon fuels No breakdown of abatement given in the Government's pathway	O	Y	O	O	O

Progress:

- In 2022, the Government consulted on a Course to Zero for the maritime sector to establish a strategy to reach the Government's ambition for Net Zero shipping by 2050 (at the latest) and scope the role of different alternative fuels.[1] The consultation aims to build on the Transport Decarbonisation Plan, published in July 2021, and will be embedded within an update to the Clean Maritime Plan.[7] The Clean Maritime Plan is due to be published in 2023.
- The UK Shipping Office for Reducing Emissions (UK-SHORE) announced winners of the second round of the Clean Maritime Demonstration Competition (CMDC), including projects establishing green shipping corridors in the UK and a feasibility study on hydrogen-powered ships.[4] A third round of the CMDC and several research and innovation investments collaborating with UKRI (from initial UK-SHORE funding) were also announced. A flagship Clean Maritime Research Hub competition was also announced from within UK-SHORE funding.[8]

To be addressed:

- There is no clear strategy for decarbonising the sector. Government has not yet published a response to the Course to Zero consultation or the Clean Maritime Plan, in which the Course to Zero should be embedded. The updated strategy should include a phase-out date for the sale of new non-zero-emission domestic vessels (recommendations R2022-268 and R2022-270).
- The 2019 Clean Maritime Plan noted expectations for building clean maritime clusters by 2025 and operating by 2035. The CCC's Sixth Carbon Budget analysis recommends that clean maritime clusters will be required to provide at least 2 TWh/year of zero-carbon fuels by 2030.[9] This should be in scope of the Clean Maritime Plan update (recommendations R2022-267 and R2023-135).
- The Carbon Budget Delivery Plan's deployment assumptions state that low-carbon fuels are to expand to 42% of total domestic shipping fuel use by 2035.[10] The Low-Carbon Fuels Strategy should set out the role of low- and zero-carbon fuels for the shipping sector in addition to the Government providing support and incentives to drive private-sector investment in low-carbon maritime fuels. For example, a better understanding is required on the viability of different low-carbon fuels such as the sustainability of supply and carbon emissions for methanol (recommendation R2023-135).

Efficiency, zero-emission vessels and electrification No breakdown of abatement given in Government's pathway	O	Y	O	O	O

Progress:

- The Government launched the Freight Innovation Fund as part of the 'Future of Freight' plan to help small- to medium-sized businesses develop more efficient solutions for freight (£7 million over three years). The first round of projects were selected in April, including AI and logistics solutions to improve operational efficiency in the sector.
- The Government published a summary of responses on the use of maritime shore power in the UK.
- Through UK-SHORE funding, £77 million was awarded for the Zero Emission Vessels and Infrastructure (ZEVI) competition. The project will collaborate with Innovate UK to provide

	match-funding support to clean maritime projects that have high technology readiness levels and are close to commercialisation. Funding will cover construction and setup of projects until March 2025. **To be addressed:** • Shore power infrastructure at major UK ports needs to be rolled out to support its uptake and enable widespread use. There is currently no plan to deliver this roll-out (recommendation R2022-266). • The Technology and Innovation in UK Maritime report committed to establishing a Centre for Smart Shipping (CSmart) to oversee and coordinate the Government's existing and future work on maritime technology and innovation, including in shipping operations. CSmart has not yet been established (recommendation R2023-134). • The Government has not published its response to the 2021 consultation on the future of transport regulation and maritime autonomy and remote operations. While this consultation did not directly consider emissions, the development of maritime autonomy and remote operations could impact efficiency across the sector. As such, joined-up thinking is required to ensure any new framework for autonomous vessels includes consideration of low-carbon shipping and maritime operations, for instance through CSmart (recommendation R2023-134).
Demand management No breakdown of abatement given in Government's pathway	R | O | O | O | O **Progress:** • The Freight Innovation Fund's first round includes the Orkney I-Port drone technology project. This will create an intermodal transport hub to improve island-to-island connectivity, using drones to make deliveries, conduct surveys and monitoring and reduce demand for ships. **To be addressed:** • The Government should publish its response to the proposed extension of the UK ETS to include domestic shipping. A clear strategy is required to minimise the risk of shipping activity being displaced to higher-carbon alternative modes (recommendations R2022-264 and R2022-265).
Cross-cutting	**Progress:** • The National Shipbuilding Taskforce has confirmed its membership as part of the refreshed National Shipbuilding Strategy.[11,12] The taskforce aims to understand skills shortages and provide insight into required new skills, particularly those relating to new and emerging technologies and zero-emission shipping. The Government should continue to support the sector in understanding any potential future skills gaps and work with industry to mitigate these through an action plan which is outlined as an outcome in the Taskforce's Terms of Reference (recommendation R2023-136). • Green shipping corridors are shipping routes that showcase low- and zero-emission fuels and technologies. Established at COP26, the Clydebank Declaration aims to drive the creation of green shipping corridors through international collaboration. Last year, as part of a number of new initiatives established through the Clydebank Declaration, a Green Shipping Corridor Taskforce was announced between the UK and US and an action plan for the Zero Emission Shipping Mission was co-led by the UK, Denmark, Norway and US. The Government should continue to collaborate internationally in a diversity of fora (recommendation R2022-271). • The IMO announced the Future Fuels and Technology for Low- and Zero-Carbon Shipping Project, which has been implemented with funding support from the Republic of Korea. Expected to run until 2025, the project aims to provide an assessment of the state of availability and readiness of low- and zero-carbon ship technology and marine fuels, to inform member states as they work towards the revision of the IMO GHG Strategy. • The EU has agreed to include shipping emissions in the EU ETS (through the Fit for 55 package). • An agreement was reached on Fuel EU Maritime, a new EU regulation ensuring the GHG intensity of fuels used in the bloc's shipping sector will gradually decrease to 80% of the starting intensity in 2050, with additional incentives offered for the use of green e-fuels until 2035. • Another EU provisional agreement (March 2023) outlined obligations for container and passenger ships to use onshore power supply for all electricity needs while moored at the

quayside in major EU ports by 2030 and the rest of EU ports by 2035, unless zero-emission technology is already in use.

- In April 2023, the IMO hosted the second joint working group meeting between the Maritime Safety Committee (MSC), Legal Committee (LEG) and Facilitation Committee (FAL). This meeting scoped addressing common high-priority safety, legal and facilitation issues regarding Maritime Autonomous Surface Ships (MASS). The UK Government, alongside their own ambitions for a new regulatory framework for emerging autonomous technologies, should push for consideration of low-emission technologies for international MASS.

To be addressed:

- The July 2023 IMO meeting is a crucial opportunity for the IMO to agree a global Net Zero by 2050 target. The new GHG strategy should include credible decarbonisation mechanisms (such as fuel standards and carbon levies) to deliver this and minimise the use of offsetting to drive ambitious decarbonisation of vessels, fuels and operations. (recommendation R2022-263).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: See Annex 1 for the assessment criteria.

Endnotes

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Chapter 12: Waste

25 $MtCO_2e$, 6% of UK emissions in 2021

Introduction and key messages

The continued growth in the use of Energy from Waste (EfW) plants is undermining efforts to reduce emissions within the waste sector. Incoming reforms to recycling collections and packaging should improve recycling rates and divert waste from EfW and landfill, but stronger signals and policies to limit further EfW growth, divert biodegradable waste from landfill and prioritise waste prevention, are needed. This is largely unchanged from our 2022 assessment as we continue to wait for key waste policies to be implemented.

Our key messages are:

- **Energy from Waste.** EfW emissions are already higher than the Government's Carbon Budget Delivery Plan (CBDP) anticipates and EfW capacity is set to increase in the coming years.[1] A comprehensive systems approach to control and reduce EfW emissions is urgently needed, including a moratorium on additional EfW capacity until a review of capacity needs has been completed.

- **Recycling.** Improving England and Scotland's stalled recycling rates is key to reducing dependence on EfW and landfill – implementation of planned reforms to recycling and packaging must not be delayed.

- **Landfill.** The Government has indicated that additional policies will be needed to meet the aim of preventing biodegradable waste from going to landfill, still the largest source of emissions in the sector. Clarity on these policies is needed urgently.

- **Wastewater.** Emissions from wastewater are increasing and while progress has been made in clarifying how Ofwat will assess water companies' performance in reducing emissions, there is a risk that water companies will not prioritise decarbonisation.

- **Carbon capture and storage.** Good progress has been made in developing plans to support the first EfW facilities to install carbon capture technology as part of the industrial carbon capture and storage (CCS) cluster programme – but a more strategic approach to decarbonising the fleet is needed.

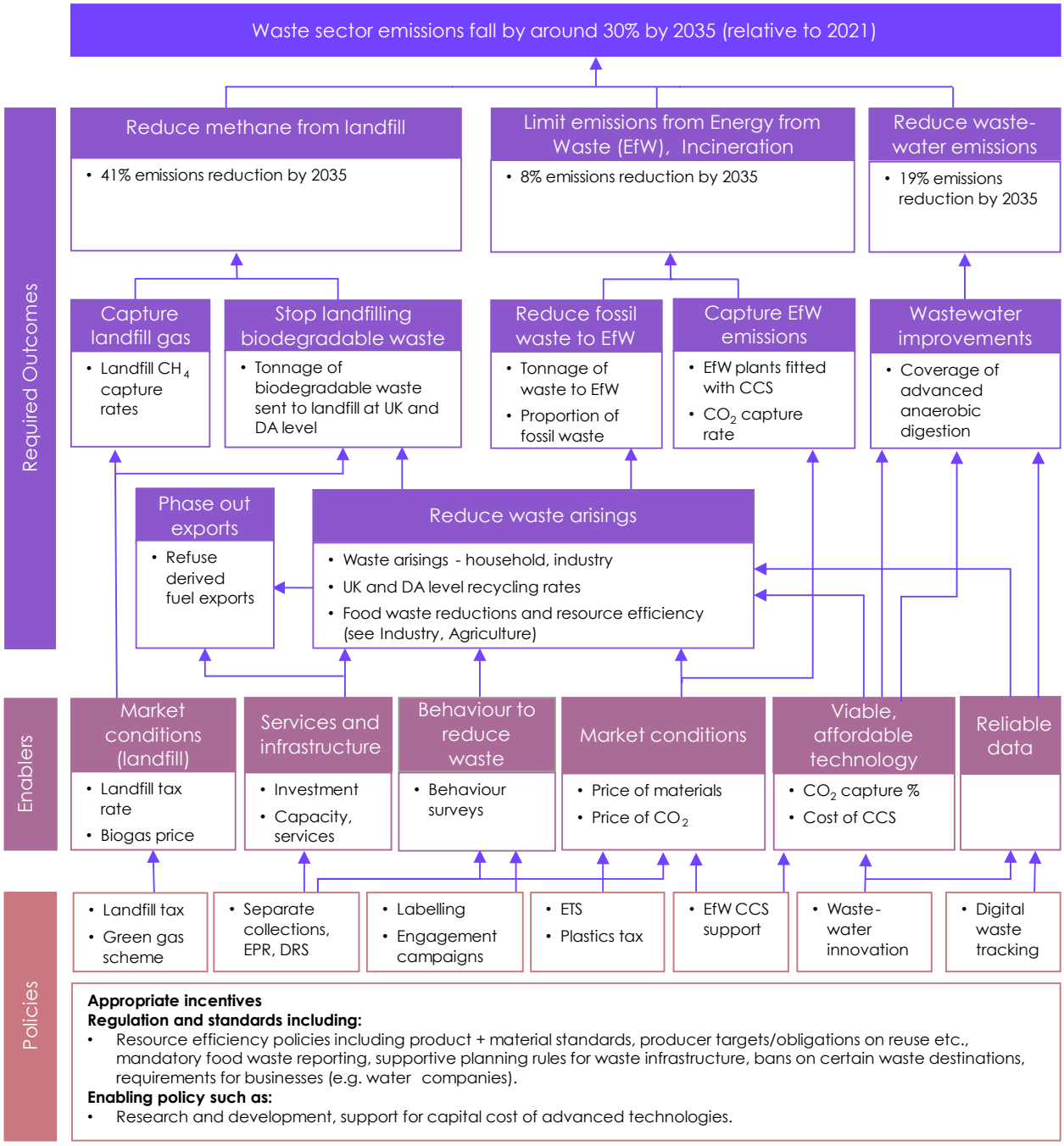
- **Overall strategy.** More generally, greater strategic coordination of plans to decarbonise the waste sector is needed, including much greater emphasis on waste prevention, clarity on future residual waste capacity needs, the suitability of incentives and interactions with other sectors such as waste as a feedstock for Sustainable Aviation Fuels.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

Figure 12.1 Monitoring map for waste



Source: CCC analysis.
Notes: Numbers are from the Government's Carbon Budget Delivery Plan unless stated otherwise. CCS = Carbon capture and storage; EPR = Extended Producer Responsibility; DRS = Deposit Return Scheme; ETS = Emissions Trading Scheme.

The CCC's monitoring map for waste (Figure 12.1), sets out the policies, enablers and required outcomes for a successful transition. This report focuses on ten key indicators, with more indicators available in the supplementary materials. Our Monitoring Framework documents the indicators we track and our approach for assessing progress. Most of our indicators draw on official statistics on UK waste management, which have not been updated in time for this report, although we have included current data on EfW capacity.

Emissions from the waste sector remained stable from 2020 to 2021 (Figure 12.2a), at 25 $MtCO_2e$ per year.

Falling emissions from landfill are being compensated by rising emissions from EfW.

- This masks the continued trend of falling emissions from landfill being compensated by rising emissions from EfW (Figure 12.3).

- Other waste emissions, which include emissions from composting (household and non-household) and anaerobic digestion of biological waste, have also been rising in recent years.

Landfill emissions reduced by 5% between 2020 and 2021, in line with trends in recent years, reflecting the continued reduction in the amount of waste being sent to landfill (Figure 12.2b). The rate of landfill emission reductions is broadly in line with the CBDP but at current rates the Government is off track to achieve its aim of preventing biodegradable waste from being sent to landfill by 2028 (Figure 12.2c).

Energy from Waste emissions grew by 5% from 2020 to 2021, in line with continued increases in the use of incineration, mostly EfW, to process residual waste (Figure 12.2d).

EfW capacity has increased since 2014 and is predicted to continue to grow, indicating a further increase in emissions from EfW.

- EfW capacity has increased from 8 Mt/year in 2014 to 23 Mt/year in 2022 (Figure 12.2e, Figure 12.5). The latest assessment from the consultancy Tolvik suggests a further 18% growth in EfW capacity by 2027, based on plants currently under construction.[2] This indicates emissions from EfW are likely to increase further – beyond the levels assumed in the Government's CBDP out to 2035.

- EfW emissions need to reduce by on average 0.6% each year to be aligned to the Governments CBDP – suggesting emissions are well off track.

Reducing plastic waste is a key factor in reducing emissions from EfW plants, but evidence suggests not enough progress is being made.

- The volume of plastic packaging waste arising increased by 11% between 2017 and 2021 (Figure 12.2f), while the proportion of plastic packaging recycled has remained at around 45%.[3]

- Around 46% of plastic packaging was exported for recycling in 2021 and 2022 but doubts have been raised as to the extent this recycling can be assured.[4]

Waste reduction has not notably improved in recent years, with slight increases in household and commercial waste, according to the most recent data.

Waste from households has remained relatively constant in the last ten years while there has been an increase in commercial and industrial waste.

- Waste from households, prior to treatment or recycling, has remained relatively constant in the last ten years. However, a 2% increase was seen between 2019 and 2020 (Figure 12.2g). Waste from commercial sources increased in the five years prior to the pandemic (Figure 12.2h).

- These trends need to be reversed to reduce emissions from landfill and Energy from Waste – the CCC's pathway assumes a gradual decline in waste arisings over the next decade.

Recycling rates have also made little progress at a UK-wide level,* at 44% in 2020 (Figure 12.2i), but progress differs significantly by nation (Figure 12.4):

Wales's recycling rate has stalled in recent years, while the other UK nations are off track to meet their respective recycling targets.

- Wales has had consistently higher recycling rates than the rest of the UK, although the recycling rate has stalled in recent years at 56% in 2020 and further policies are likely to be needed to meet its 2025 target of 70%.[5]

- England and Scotland are both significantly off track to meet their respective recycling targets of 65%† by 2035 for England and 70% by 2025 for Scotland.[6,7] Recycling rates for England and Scotland were 43% and 41% respectively in 2020, 13% and 15% lower in England and Scotland than in Wales, with no improvement seen in recent years.

- Since 2015 Northern Ireland's recycling rates have increased by 7% to 49% in 2020, but are still slightly off track to meet the Circular Economy Package Policy's 65% municipal waste recycling target by 2035, with an interim target of 60% by 2030.[8]

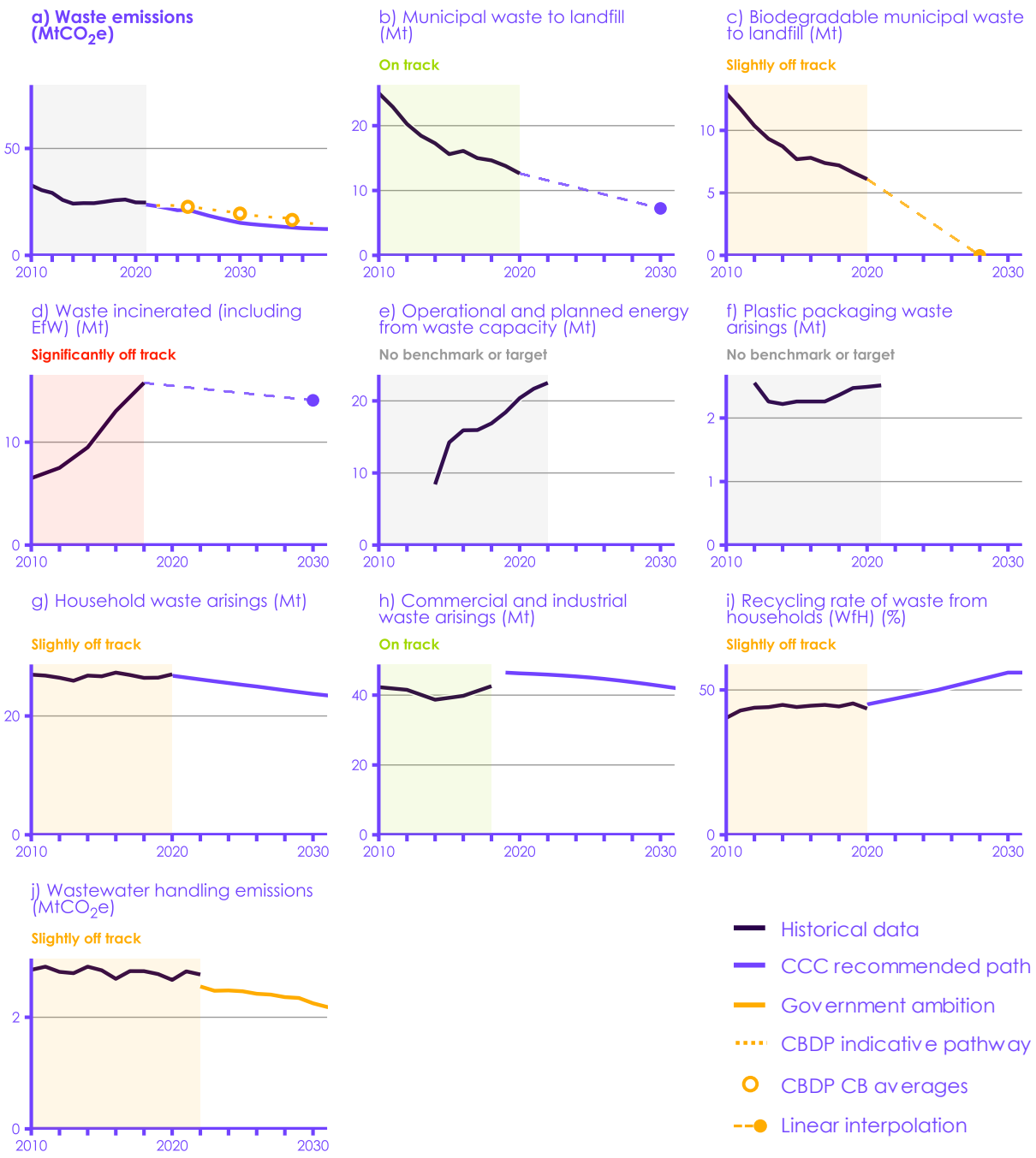
Wastewater emissions increased between 2020 and 2021, reversing two years of declining emissions.

Wastewater emissions grew by 6% year-on-year to 2021 – reversing two consecutive years of declining emissions, leaving the Government off track in delivering the 2% annual emissions reductions required on average to 2035.

* When referring to 'recycling rate' this is comparable across the devolved administrations. When referring to the devolved administrations targets, the methodologies for determining these are subtly different in each country.

† 65% recycling rate by 2035 is the target for municipal solid waste, packaging has a separate recycling rate target of 75% by 2030.

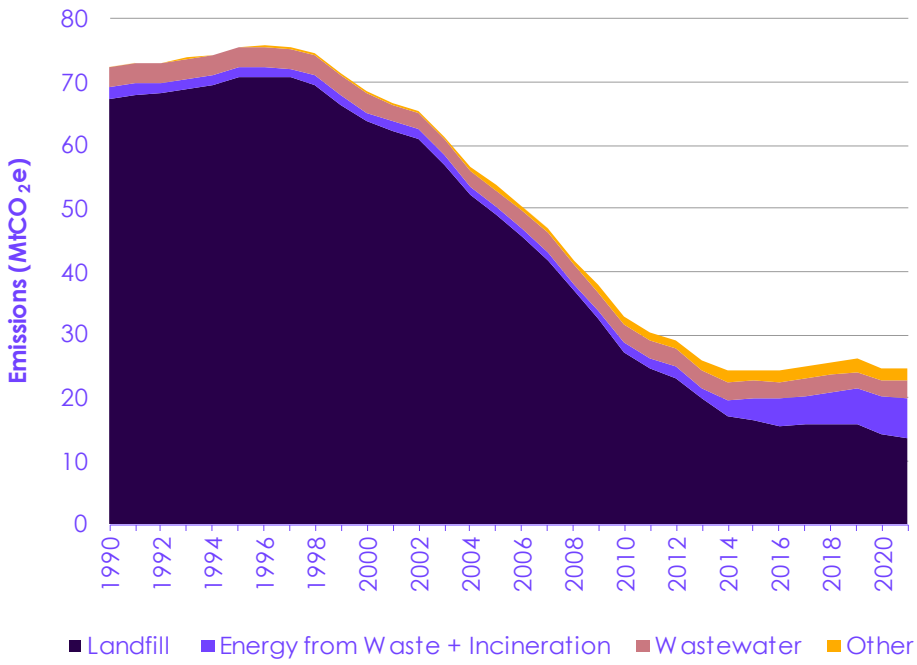
Figure 12.2 Key indicators for waste



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path, and considering the wider contextual factors that may have a temporary impact (e.g., recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (3) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions. (4) Waste from Household is the agreed definition for comparison of recycling rates across nations of the UK.

Emissions from the waste sector remained stable between 2020 and 2021, masking a decrease in landfill emissions and an increase in emissions from EfW.

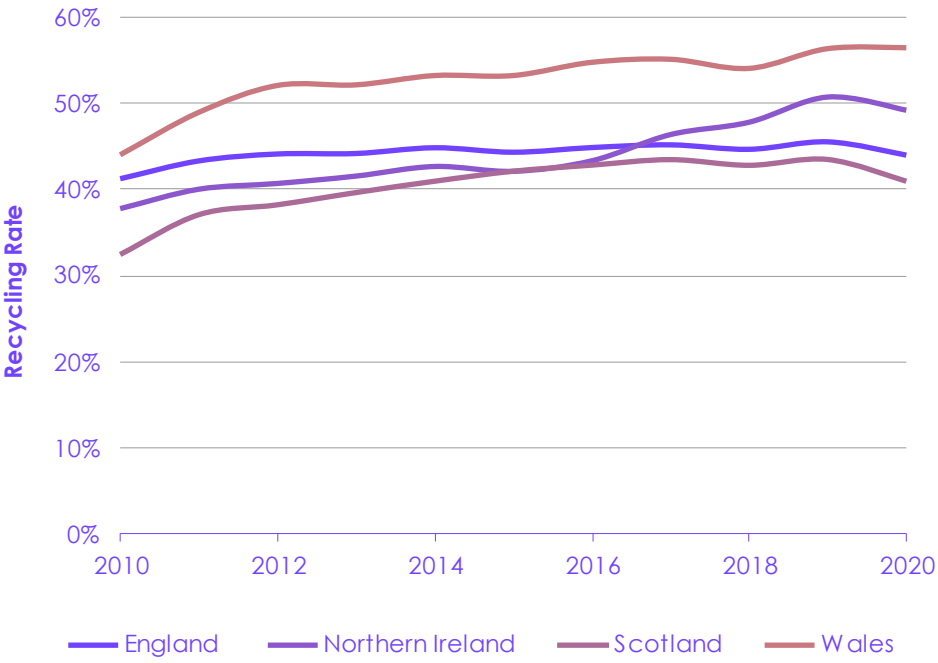
Figure 12.3 Waste emissions (1990-2021)



Source: DESNZ (2023) *Provisional UK greenhouse gas emissions national statistics 2022*; BEIS (2023) *Final UK greenhouse gas emissions national statistics: 1990 to 2021*.
Notes: Other waste emissions include emissions from composting (household and non-household) and anaerobic digestion of biological waste.

Wales has had a consistently higher recycling rate than the rest of the UK. The recycling rates in all nations have stalled or decreased between 2019 and 2020.

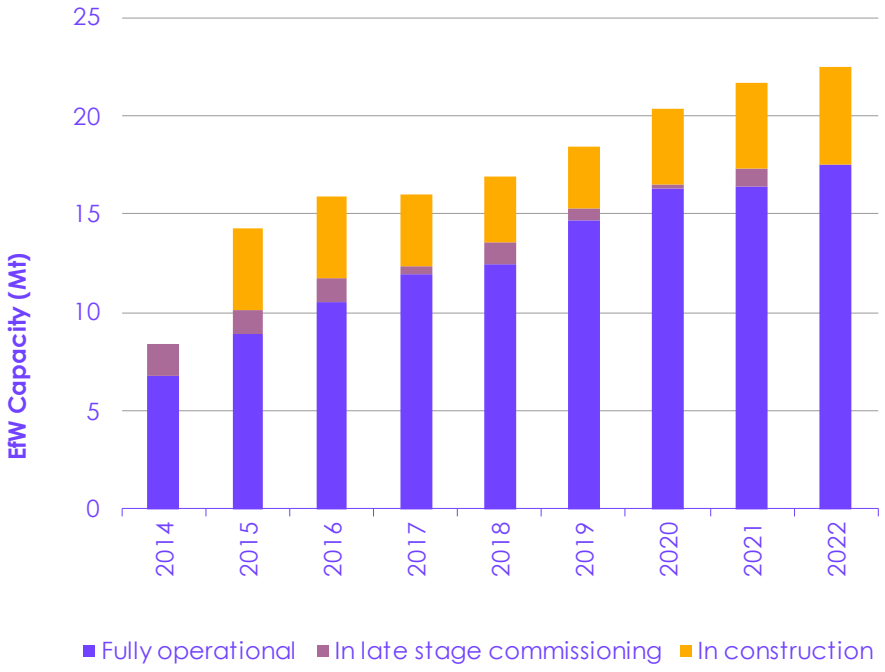
Figure 12.4 Household recycling rates across the UK



Source: Defra (2022) *UK Statistics on Waste Data*.
Notes: Recycling rates shown on the 'Waste from Households' basis, the agreed definition for comparison of recycling rates across nations of the UK.

Energy from Waste capacity has increased since 2014 with further capacity in construction.

Figure 12.5 UK Energy from Waste capacity (2014 – 2022)



Source: Tolvik Consulting (2023) *UK Energy from Waste Statistics - 2022*; Tolvik Consulting (2022) *UK Energy from Waste Statistics – 2021*; Tolvik Consulting (2019) *UK Energy from Waste Statistics - 2018*.
Notes: Energy from Waste capacity in construction is not available for 2014, Energy from Waste capacity in late stage commissioning is not available for 2022.

2. Policy assessment

Major reforms to the waste sector are expected in the coming years but a more strategic, whole-systems approach is needed.

Policy progress has been insufficient in the waste sector, with significant risk around policies planned to reduce emissions in line with the Government's pathway over the Sixth Carbon Budget period (Figure 12.6, Table 12.1) – largely unchanged from our assessment last year. Our assessment is based on the criteria outlined in Annex 1. Major reforms to the waste sector are expected to be introduced in the coming years but a more strategic, whole-systems approach is needed with greater emphasis on improving waste reduction and reuse and domestic recycling in order to reduce reliance on EfW and prevent biodegradable waste from entering landfill.

A moratorium on additional EfW capacity should be introduced until a review of required residual waste treatment capacity has been completed.

Emissions from EfW continue to rise and a stronger approach is needed to prevent further increases in emissions. Previous analysis suggested that a waste energy recovery capacity of 13 Mt would likely be sufficient to meet waste ambitions by 2035.[9] Capacity in 2022 has already surpassed this, with further increases predicted.[2] Therefore, a moratorium on additional EfW capacity should be introduced until a review of required residual waste treatment capacity has been completed.

Table 12.1 provides a summary of recent progress and what still needs to be addressed. The detailed recommendations for this sector are in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 12.1. The policy assessment in this report focuses on measures to reduce emissions, but the waste sector must also be well adapted to future climate impacts. Wastewater infrastructure is projected to be at increasing risk of surface water flooding due to climate change, and solid waste and wastewater sites are also at risk due to their reliance on other infrastructure such as electricity, gas and transport routes. We assessed progress in adaptation in our recent report: Progress in adapting to climate change – 2023 Report to Parliament.

There are significant risks that planned policies on recycling and packaging reforms will not deliver the intended abatement in time.

Figure 12.6 Assessment of policies and plans for waste

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan. See Annex 1 for the assessment criteria. (2) Energy from waste (EfW) emissions are included in the CCC's waste sector.

Table 12.1
Policy scorecard for waste

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Waste overall assessment	O	Y	O	O	O
Cross-cutting issues	**Progress:** • The UK and devolved governments continue to develop plans to introduce their Collection and Packaging Reforms, including Extended Producer Responsibility for Packaging, a Deposit Return Scheme and binary recycling labelling.[10,11] These reforms will be central to improving recycling rates, and in turn reducing emissions from both landfill and EfW. • The Government has formally set a target to reduce residual waste in England by 50% by 2042 compared to 2019 levels, but a target to improve resource efficiency is lacking.[12] **To be addressed:** • It is important that the Government avoids any further delay to implementing Extended Producer Responsibility, Deposit Return Scheme and consistent collections (overdue), so that Local Authorities and the waste industry can prepare for implementation (recommendations R2022-320, R2022-321). To ensure these reforms are effective, they must be implemented in a coordinated way and designed so that funds raised from the scheme are directed towards recycling and waste prevention activities. • A much more strategic approach to delivering decarbonisation of the waste sector, alongside meeting recycling and waste reduction aims is needed. The Government has promised to publish an addendum to the Resources and Waste Strategy focused on decarbonisation. The Government must use this as an opportunity to clarify how the range of policies and incentives being introduced across the sector will be sufficient to drive down EfW emissions and eliminate biodegradable waste to landfill (recommendations R2022-302, R2022-314, R2022-319). • We are yet to see an assessment of future residual waste capacity needs and options to end the export of waste and recycling (recommendation R2022-311) or the final Waste Prevention Programme (recommendation R2022-320), both of which will be important inputs to the sector's decarbonisation plan. • The Government has suggested it will not holistically review the incentives regime across the waste sector as we recommended last year (recommendation R2022-310) – although it is reviewing the Landfill Tax regime and considering including EfW plants within the UK Emissions Trading Scheme (UK ETS). • Efforts to improve waste management are largely concentrated on recycling, and greater focus is needed to improve reuse, repair and resource efficiency to avoid waste. Government should set resource efficiency targets to drive emissions abatement from resource efficiency (recommendation R2022-262).				
Landfill 87% of abatement over CB6 period	O	Y	O	Y	O
	Progress: • Defra launched a call for evidence to support development of a plan to achieve the aim of preventing biodegradable waste streams from entering landfill from 2028.[13] It is also developing detailed plans for the allocation of the £295 million of capital funding announced in the Net Zero Strategy to support Local Authorities to implement food waste collections in order to reduce biodegradable waste inputs to landfill.[14] The Government consulted in 2022 on plans to improve food waste reporting by large businesses in England.[15]				

	• Defra has said it is working with the Environment Agency to investigate the potential for improved methane capture at landfill sites and to improve measurement systems and methods, but it did not commit to setting an ambition to capture a proportion of methane produced and provided no timeline for when their work would be completed.[14] **To be addressed:** • A firmer commitment to the aim to prevent biodegradable waste from entering landfill by 2025 would send a strong signal to the sector to make the necessary preparations (recommendation R2022-308). • Clarity on how the £295 million in capital funding for food waste collections will be made available to Local Authorities is urgently needed so they can make the necessary investments (recommendation R2022-305). • Likewise, a target to capture a proportion of landfill methane (possibly on an individual site basis) would encourage greater action from operators (recommendation R2022-313), while additional incentives may also be needed. • Proposed requirements for large businesses to report on their food waste must be introduced on a mandatory, rather than voluntary basis (recommendation R2022-307).
Energy from Waste 0% of abatement over CB6 period	R | Y | O | O | R **Progress:** • Details on the proposed business model to support an initial phase of industrial CCS projects were published in December 2022, including for eligible EfW plants.[16] Two EfW plants have been selected to move into negotiations. A consultation on changes to Decarbonisation Readiness requirements include expanding coverage to EfW plants and sets out draft feasibility tests for CCS readiness. • The waste collection and packaging reforms – including consistent recycling collections and Extended Producer Responsibility – should help to increase the proportion of plastics diverted from EfW and in doing so reduce emissions. The Government has brought in restrictions on certain single-use plastic items – with further items to be banned later this year.[17] **To be addressed:** • The Government should continue to progress work on the carbon capture business models at pace and continue to support EfW plants to participate in future phases (recommendation R2022-304). • The continued rise in EfW use and expected capacity increases over the coming years mean that a stronger, whole-systems approach is needed to prevent EfW emissions growing further (alongside improvements to recycling and prevention) including reporting EfW emissions as a separate source (recommendation R2023-012). We call for Government to explain how expected increases in EfW emissions are consistent with its emissions pathway, confirm plans to include EfW within the UK ETS and suggest a moratorium be placed on additional EfW capacity until an assessment of residual waste treatment capacity is completed (priority recommendation R2023-073). • Draft proposals to mandate increased use for Sustainable Aviation Fuels over the coming years signal the important role of residual waste as a feedstock, which could have implications for future EfW capacity requirements. This cross-sectoral interdependency requires decisive direction and coordination from the Government.
Wastewater 13% of abatement over CB6 period	O | O | O | R | O **Progress:** • The Government's approach is to leave water companies to implement decarbonisation solutions, and its main mechanism for doing so is through Ofwat reviewing companies' business plans, setting operational greenhouse gas performance commitments, and providing limited competitive funding to support decarbonisation measures.

	• Ofwat's Price Review 2024 draft methodology includes two common operational emissions performance commitments and sets out a Net Zero challenge bidding competition to provide additional funding to water companies to develop low-carbon technologies.[18] **To be addressed:** • Water companies are under significant pressure to deliver on a range of priorities while keeping bills to a minimum. There is a risk that companies are unable to prioritise decarbonisation alongside delivery of other objectives, such as water resource management, flood risk management and reducing pollution. Government must keep performance under review and be prepared to step in if progress is not being made (recommendation R2023-074).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan. (3) Potential inclusion of EfW in the UK ETS is listed as a decarbonisation policy in the Government's CBDP, but there is no quantified abatement from this or other EfW policies in the plan.

Endnotes

[1] Department for Energy Security and Net Zero (DESNZ) (2023) *Carbon Budget Delivery Plan,* https://www.gov.uk/government/publications/carbon-budget-delivery-plan.

[2] Tolvik Consulting (2023) *UK Energy from Waste Statistics – 2022*, https://www.tolvik.com/published-reports/view/uk-energy-from-waste-statistics-2022/.

[3] Department for Environment, Food and Rural Affairs (Defra) (2022) *UK Statistics on Waste,* https://www.gov.uk/government/statistics/uk-waste-data.

[4] Environment Agency (2023) *National Packaging Database,* https://npwd.environment-agency.gov.uk/public/publicsummarydata.aspx.

[5] Welsh Government (2021) *Beyond Recycling,* https://www.gov.wales/beyond-recycling-0.

[6] Defra (2018) *Our Resources: A Strategy for England,* https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england.

[7] Scottish Government (2020) *Securing a Green Recovery on a Path to Net Zero: Climate Change Plan 2018-2032 – update*, https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/documents/.

[8] Defra (2020) *Circular Economy Package Policy Statement,* https://www.gov.uk/government/publications/circular-economy-package-policy-statement.

[9] Defra (2018) *Our Waste, Our Resources: A Strategy for England Evidence Annex,* https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england.

[10] Defra (2023) *Packaging data: what to collect for extended producer responsibility,* https://www.gov.uk/guidance/how-to-collect-your-packaging-data-for-extended-producer-responsibility.

[11] Defra (2023) *Deposit Return Scheme for drinks containers moves a step closer,* https://www.gov.uk/government/news/deposit-return-scheme-for-drinks-containers-moves-a-step-closer.

[12] Defra (2023) *Environmental Improvement Plan 2023,* https://www.gov.uk/government/publications/environmental-improvement-plan.

[13] Defra (2023) *Call for Evidence: Near elimination of biodegradable waste disposal in landfill from 2028*, https://consult.defra.gov.uk/waste-and-recycling/cfe-near-elimination-bio-waste-to-landfill/.

[14] DESNZ (2023) *Responding to the Climate Change Committee's (CCC) Annual Progress Report 2022 Recommendations*, https://www.gov.uk/government/publications/committee-on-climate-change-2022-progress-report-government-response.

[15] Defra (2022) *Improved food waste reporting by large food businesses in England,* https://www.gov.uk/government/consultations/improved-food-waste-reporting-by-large-food-businesses-in-england.

[16] Department for Business, Energy and Industrial Strategy (BEIS) (2022) *Industrial Carbon Capture business models summary,* https://www.gov.uk/government/publications/carbon-capture-usage-and-storage-ccus-business-models.

[17] Defra (2023) *Far-reaching ban on single-use plastics in England,* https://www.gov.uk/government/news/far-reaching-ban-on-single-use-plastics-in-england.

[18] The Water Services Regulation Authority (Ofwat) (2022) *Consulting on our Methodology for PR24,* https://www.ofwat.gov.uk/regulated-companies/price-review/2024-price-review/pr24-draft-methodology/.

11 $MtCO_2e$, 2% of UK emissions in 2021

Introduction and key messages

Fluorinated gases (F-gases) are potent greenhouse gases used in a range of applications including refrigeration, air conditioning, heat pumps and medical inhalers. The Government aims to reduce F-gas emissions to less than 3.4 $MtCO_2e$ by 2035, from 11 Mt in 2021, with most of the planned reduction coming from the UK F-gas Regulation. This regulation mandates a large reduction in the consumption of most hydrofluorocarbons (HFCs) by 2030, bans the use of F-gases in certain applications and mandates various emission reduction measures.

Our key messages are:

Emission trends.

- F-gas emissions have fallen over the last few years but are still higher than levels in the early 2000s.
- There is also a risk that emissions may increase with the roll-out of heat pumps, which currently use mostly F-gas refrigerants.
- Of the Government's planned emissions reduction by 2035, 90% will be via the existing UK F-gas Regulation, if successfully enforced.

Review of the F-gas Regulation.

- The Government has committed to reviewing its F gas Regulation. We continue to recommend that the review of future regulation matches or exceeds the increase in ambition expected in forthcoming EU F-gas Regulation.
- There is still no clear legislative timeline for the expected extension of F-gas Regulation policy of an 85% phasedown of hydrofluorocarbon (HFC) consumption by 2036 relative to 2011-2013.

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress
2. Policy assessment

1. Emissions and indicators of progress

Emissions from F-gases decreased by 6% in 2021 to 11 $MtCO_2e$. Prior to this, F-gas emissions declined by around 5% per year since 2017.

In this section we show progress against four key indicators for decarbonising the F-gas sector. Our Monitoring Framework documents the indicators we track and our approach for assessing progress.

Emissions from F-gases decreased by 6% in 2021 to 11 $MtCO_2e$ (Figure 13.1a).

- Prior to this, F-gas emissions declined by around 5% per year from 2017 to 2020, as the 2015 F-gas Regulation took effect (Figure 13.1a). Despite this, emissions remain higher today than in the early 2000s and only 26% lower than 1990 levels.

- Most heat pumps use F-gas refrigerants, which could become a significant source of F-gas emissions as heat pumps get rolled out across the UK, unless the Government takes action to ensure that they shift to using non-F-gas refrigerants (e.g. propane, CO_2).

Hydrofluorocarbons (HFCs). The consumption of HFCs must decrease to 15% of 2015 levels by 2035 to meet the Government's pathway. The F-gas Regulations are the main lever to reduce this. It is currently too early to say whether the reduction rate is on target (Figure 13.1b).

Inhalers are also a source of F-gas emissions in the UK. The CCC recommends that all inhalers should be Metered Dose Inhalers (MDI) with a global warming potential of 200 or less, or should be replaced by non-metred dose inhalers (for example, dry powder inhalers), by the mid-2020s.

Figure 13.1 Key indicators for F-gases

Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.

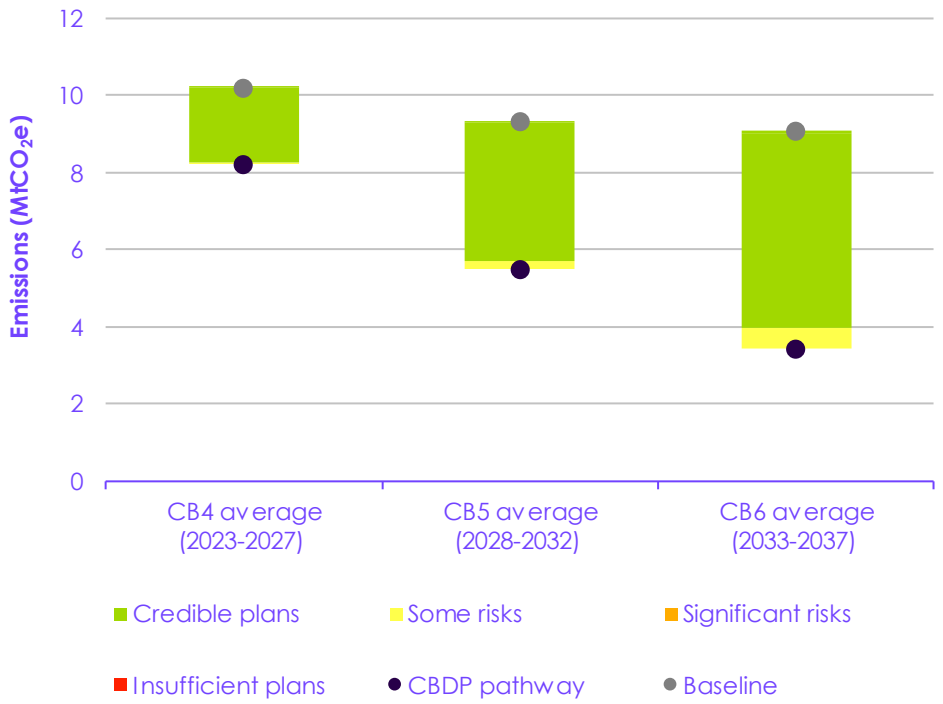
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path, and considering the wider contextual factors that may have a temporary impact (e.g., recovery from COVID-19). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (2) Dashed lines indicate the linear rate of change that would be required to meet the target, whereas solid lines show modelled pathways. (3) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions. (4) We have adjusted our Balanced Pathway to account for changes in the UK's emissions inventory methodology. (5) A low-carbon inhaler is defined as either a non-metered dose inhaler (MDI) inhaler, or an MDI inhaler using propellants with a Global Warming Potential below 200 times that of CO_2.

Policy progress has been sufficient in this sector, with credible policies in place to meet most of the required emissions reduction by the UK's Nationally Determined Contribution (NDC) and Sixth Carbon Budget period (Figure 13.2, Table 13.1). Our assessment is based on the criteria outlined in Annex 1.

In Table 13.1 a summary of recent progress and what still needs to be addressed is given. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 13.1.

Policy progress has been sufficient in this sector, with credible policies in place to meet most of the required emissions reduction by the NDC and Sixth Carbon Budget period.

Figure 13.2 Assessment of policies and plans for F-gases



Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2023) *Energy and emissions projections: 2021 to 2040*; CCC analysis.
Notes: (1) This assessment uses Government plans listed in Annex B, tables 5 & 6 of the Carbon Budget Delivery Plan (CBDP). See Annex 1 for the assessment criteria. (2) The baseline is an adjustment to the Government's CBDP baseline, with the impact of some policies removed so that they can be assessed (Table 4 in the CBDP).

Table 13.1
Policy scorecard for F-gases

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
F-gases overall assessment	G	G	G	G	G
Existing F-gas regulation 90% of abatement over CB6 period	G	G	G	G	G
	Progress: The regulatory mechanism has credible clear timelines to deliver the reduction of HFCs. • UK, Scottish and Welsh Governments are reviewing the F-gas Regulation.[1] This is being done in two stages. The first stage was completed in December 2022, with the publication of an assessment report. The report looked primarily at the impact of the current regulation and current market circumstances. **To be addressed:** Last year we recommended (recommendation R2022-212) that if any increases in EU F-gas ambition were to occur, there would be a need to review UK regulations with a view to matching or exceeding EU standards. • In March 2022, the European Parliament referred to the Committee on the Environment, Public Health and Food Safety which proposed to strengthen requirements in place on the market products containing F-gases.[2] • In light of this, the anticipated second stage consultation for future F-gas Regulation will need to identify changes for regulation in the UK.				
85% phasedown of HFC consumption by 2036 relative to 2011-2013 1% of abatement over CB6 period	Y	Y	Y	O	Y
	Progress: This policy is an extension of the existing 79% phasedown target in the F-gas Regulation, so can use the same delivery mechanism. • No funding or financial incentives are necessary, and the enablers and barriers should be the same as for the existing phasedown target. **To be addressed:** • It is unclear when this regulation will be put into legislation (recommendation R2022-213). • There is also a risk that emissions may increase with the roll-out of heat pumps, which currently use mostly F-gas refrigerants (recommendation R2022-216).				
Reduction of MDI prescriptions in England 9% of abatement over CB6 period	Y	Y	Y	O	Y
	Progress: No progress. **To be addressed:** • Assessments should be published of the impact of planned actions (including prescriptions which use lower GHG treatments for asthma patients) and timelines for future policies. Set targets to end the use of Metered Dose Inhalers (MDIs) for all patients where possible (recommendation R2022-215).				

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan.

Endnotes

[1] Defra (2022) *F gas regulation in Great Britain Assessment report,* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1126230/F_gas_regulation_in_Great_Britain.pdf.

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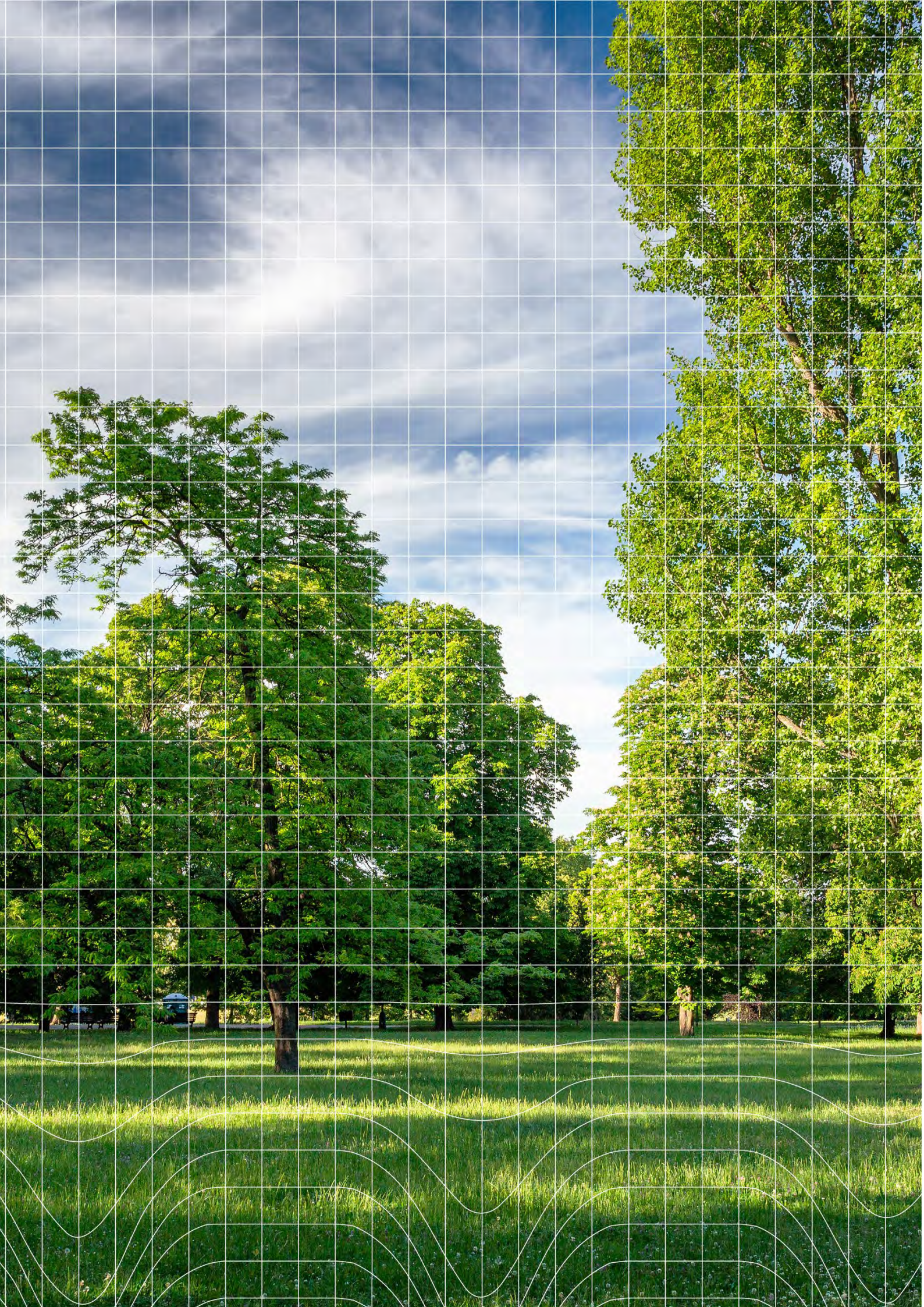


Chapter 14: CCS & engineered removals

0MtCO$_2$ in UK removals in 2022

Introduction and key messages

No carbon capture and storage (CCS) or engineered removals projects are currently operating in the UK, yet these industries are expected to scale up rapidly from the late 2020s and play a crucial role in meeting future carbon budgets from the Fifth Carbon Budget onwards and the 2030 Nationally Determined Contribution (NDC). CCS will need to play a role in many sectors' decarbonisation. As well as underpinning removals technologies – engineered removals – such as Bioenergy with Carbon Capture and Storage (BECCS) and Direct Air Capture with Carbon Storage (DACCS), CCS is needed to enable emissions reductions in sectors including industry, electricity generation and fuel supply.

The Government has made progress on CCS this year. Headline policy developments include the announcement of projects to progress to negotiations for the first two CCS clusters, the launch of the process for choosing the next two clusters and the commitment of up to £20 billion of funding. These developments are necessary and welcome but were preceded by delays in programme development and do not address all the gaps in CCS-related policy. Some of these gaps are in the policy and guidance supporting engineered removals. Engineered removals play a significant role in the Carbon Budget Delivery Plan pathways in the 2030s, with the Fifth and Sixth Carbon Budgets expected to deliver 6.4 $MtCO_2$ and 23.4 $MtCO_2$ of removals a year on average.[1]

The Government has committed to sensible steps to put the UK on the path to becoming a viable place for engineered removals projects from the late-2020s, but action to support these intentions is overdue. If these delays continue, there is substantial risk of the Government failing to meet its 2030 ambition of 5 $MtCO_2$/year of engineered removals, which would have a knock-on impact on its ability to meet the UK's 2030 NDC. These risks were stated in our 2022 UK Progress Report but have become more urgent, as we are a year closer to 2030 and the landscape for engineered removals remains broadly unchanged.

Our key messages are:

- **Policy progress on CCS.** The Government has announced eight projects to progress negotiations for the first two CCS clusters and it has launched the process for choosing the next two clusters. The Government has committed up to £20 billion of funding to support the development of CCUS over the next 20 years. This is welcome, but there remain some risks to delivering these technologies at the scale and speed required. The UK's first carbon storage licensing round has been launched, receiving 26 bids.

- **Remaining gaps for CCS.** The Government's broader CCS programme is behind schedule and detail is light on the timelines for selection and support of the second pair of clusters. Details of the up to £20 billion spending commitment for CCUS have not been released. There is still no detailed plan or policy framework for CO_2 transport from dispersed sites and the Transport and Storage Regulatory Investment business model has not yet been finalised.

- **Engineered removals and CCS clusters.** Both BECCS and DACCS rely on access to the UK's CCS network to function. However, no engineered removals projects are being taken forward in Track 1 of the CCUS cluster programme. Clarity is required around how engineered removals projects will integrate with these clusters.

- **Funding mechanisms for engineered removals.** Due to high capital and operating costs, together with technology and construction risks associated with novel technologies, engineered removals will require Government support in their early stages of deployment. Clarity on the form that this support will take is now overdue. The Government's response to its Power BECCS Business Models consultation in March 2023 shows progress, but a response to the Engineered Removals Business Models consultation is needed this year to ensure other approaches are able to progress.[2,3]

- **Guidance on Monitoring, Reporting and Verification (MRV) and biomass sustainability**. Stringent MRV and high quality standards for biomass used for BECCS are crucial in ensuring that the intended volumes of removals from engineered removals projects are delivered and managed in a safe, sustainable and transparent way. The Government must address biomass sustainability and plans for growing domestic biomass supply in the overdue Biomass Strategy and work with other countries to produce comprehensive guidance on MRV over the next year. Progress in these areas is key to securing public acceptability of large-scale engineered removals in the UK.

- **Public engagement.** Many people will be unfamiliar with the technologies used for engineered removals. The Government must both engage and educate on the role that engineered removals are likely to play in future decarbonisation to avoid both negative public perception in future years and public overreliance on removals.

- **Coordination across devolved administrations.** Improved coordination is needed between the UK Government and devolved administrations to address how engineered removals in the UK contribute to constituent nations' emissions reduction targets. The UK Government should also work with devolved administrations to build a comprehensive understanding of the potential for deployment of engineered removals across the UK, combining and building on individual nations' assessments, and enable access to the most promising CCS resources (such as appropriate geologies for storage) in each part of the UK.

- **Alternative arrangements.** The Government is aiming for a significant scale-up in CCS and engineered removals this decade. Despite this ambition, action in these areas has been delayed, leaving little space for unforeseen delays or complications in project delivery for technologies that are as yet untested at scale in the UK. Delays or shortfalls this decade will have implications for meeting the UK's 2030 NDC. Unlike other sectors, engineered removals does not have multiple routes to securing its intended contribution to the 2030 NDC, and large-scale projects operating this decade are the sector's only way forward. Therefore, as well as addressing specific policy gaps for engineered removals, the Government should identify alternative options in other sectors that could be targeted for additional effort this decade if delays and complications mean that removals are not able to reach 5 $MtCO_2$/year by 2030 (see Chapter 3).

In the rest of this chapter, we discuss progress in two sections:

1. Emissions and indicators of progress

2. Policy assessment

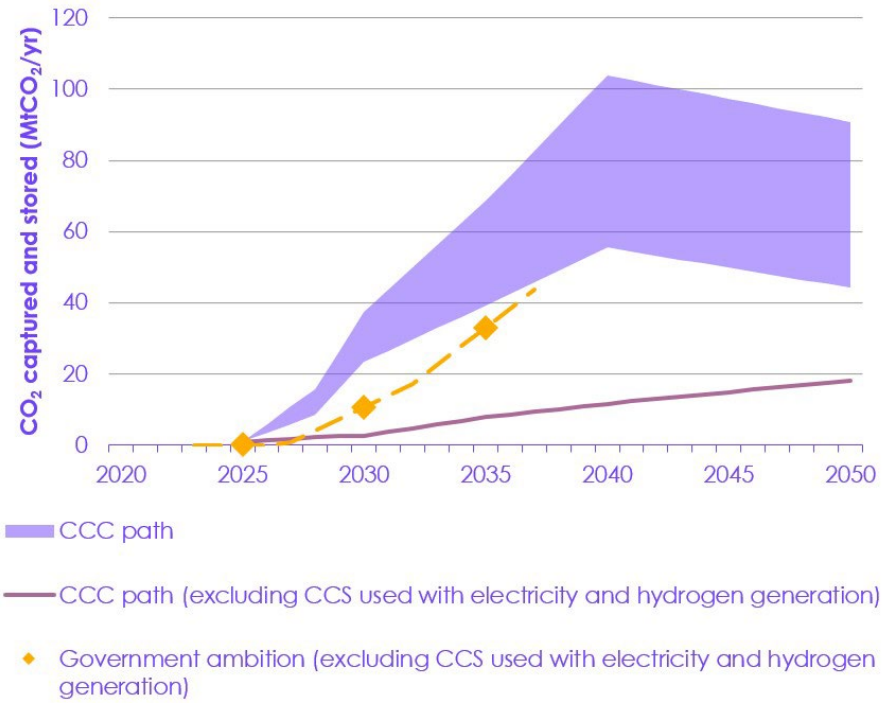
In this section we compare Government ambition with CCC pathways for CCS and show progress against four key indicators for deployment of engineered removals. Our Monitoring Framework documents the indicators we track and our approach for assessing progress.

No CCS has yet been undertaken, and this needs to start ramping up in the next few years.

CCS ambition. So far, no CO_2 has been captured and stored, but this should start to ramp up in the next few years. The CCC's recommended pathway has higher ambition than the UK Government for the amount of CO_2 captured and stored in the UK across all sectors, but this is due to the UK Government not publishing its expected need for CCS in decarbonising electricity supply. The Government's ambition for industry CCS and engineered removals is much higher than that of the CCC path (Figure 14.1).

The Government's target for industry CCS and engineered removals is much higher than that of the CCC path.

Figure 14.1 CCC and UK Government pathways for CCS



Source: Climate Change Committee (2023) *Delivering a reliable decarbonised power system*; HM Government (2023) *Carbon Budget Delivery Plan.*
Notes: (1) The range in the CCC recommended pathway is due to uncertainty in the amount of CCS in the electricity generation sector. (2) The UK Government has only provided average values over each carbon budget period. (2) Dashed lines indicate the linear rate of change that would be required to meet the target, whereas solid lines show modelled pathways. (3) We assume that all the Fourth Carbon Budget CCS happens in 2027 as we do not expect any CCS to occur before that year. There has not yet been any CO_2 captured and stored in the UK.

There are no engineered removals projects currently operating in the UK.

Engineered removals. There is currently no contribution from engineered removals to overall UK emissions, with a ramp-up expected to start in the late 2020s. Engineered removals begin with BECCS (Figure 14.2b) with DACCS not contributing at scale (above 0.001 $MtCO_2$/year) until 2040 (Figure 14.2c).

- The Government's engineered removals pathway does not distinguish between BECCS and DACCS. Underpinning developments in CCS

infrastructure are behind schedule, with the original aim of CO_2 storage beginning in 2025 now unlikely to be realised before 2027.

Global DACCS deployment is expected to ramp up this decade.

- Globally, DACCS is expected to ramp up in the 2020s (Figure 14.2d). The scale-up of DACCS in other countries can aid UK deployment both through reductions in technology cost and through shared lessons from early experiences in designing, building and operating this novel technology. While no new DACCS facilities have commenced operation in the past year, a small number of large-scale projects have been announced and construction has begun on projects in Iceland and Texas.[4,5] Project proposals and grant bids have also been developed in the US in response to subsidies made available through the Inflation Reduction Act (Box 14.1).

Government efforts to incentivise the domestic production of timber are needed to keep Wood in Construction indicators on track.

Wood in Construction (WiC). Timber in construction can both sequester carbon in buildings and displace the use of high-embodied carbon products such as steel and concrete. The CCC recommends that emissions from WiC need to reach -0.2 $MtCO_2$ by 2030 (Figure 14.2e). By the same time, the market share of timber frame housing in new builds should reach 28% (Figure 14.2f). The market share is currently on track with respect to the CCC's pathway. Government efforts to incentivise the domestic production of timber that can be used for construction will be needed to keep this indicator on track. We cannot currently measure the overall removals from WiC, but some of the emissions impact is counted within the agriculture and land-use sector (Chapter 9).

Box 14.1
Incentives for greenhouse gas removals in the Inflation Reduction Act

The Inflation Reduction Act was passed in the US in August 2022, bringing into effect a wide range of decarbonisation incentives for both consumers and businesses. See Chapter 2 for further details.

The Act established strong incentives for removals using direct air capture (DAC) in the US:

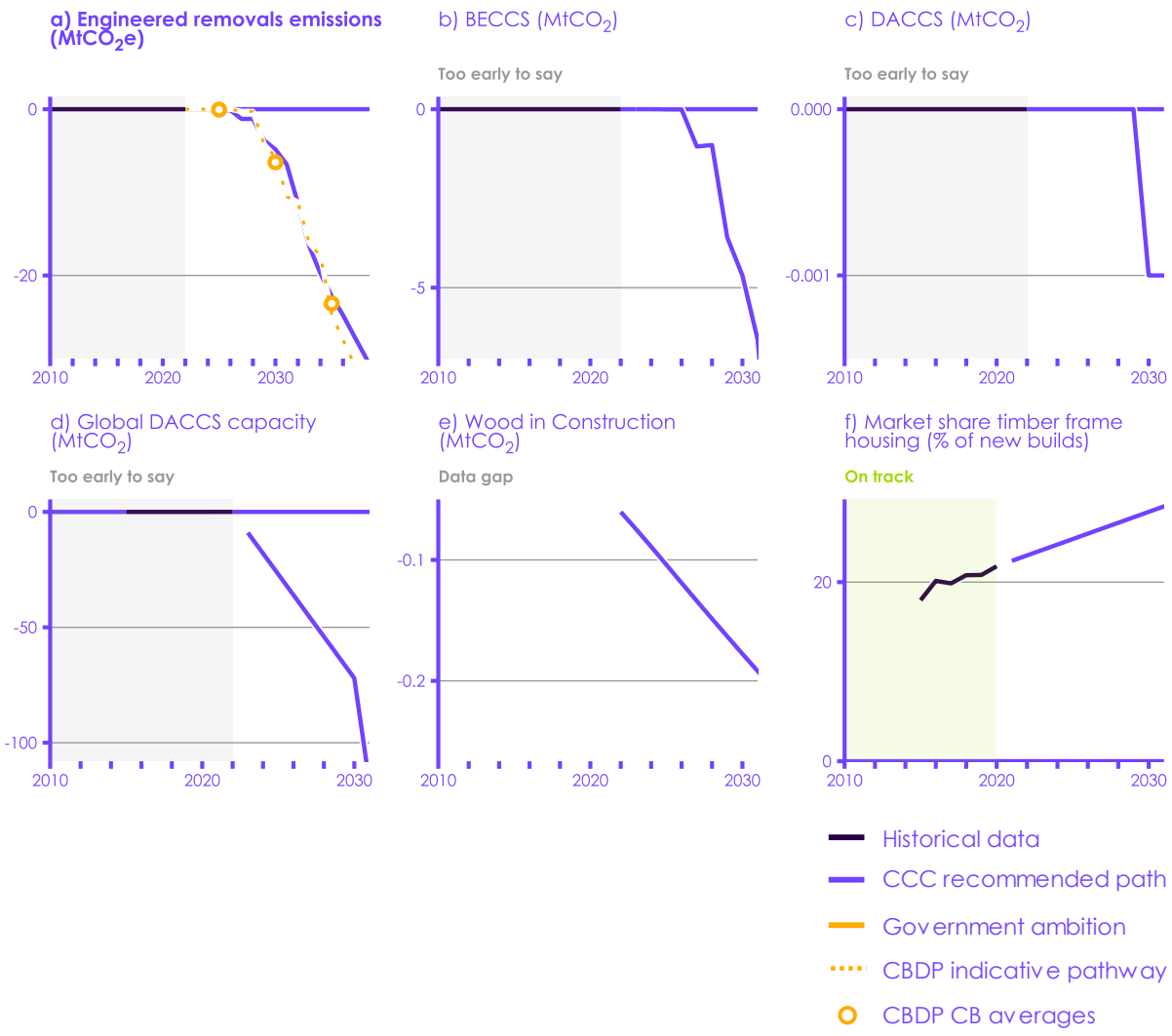
- **Expansion of the Section 45Q tax credit.** The Act expands and enhances a tax credit for carbon removal, establishing payments of $180/t for CO_2 removals using DACCS and $130/t for CO_2 captured using DAC and used to improve other processes (for example, the production of synthetic fuels and plastics and Enhanced Oil Recovery). The credit can be received for up to five years or twelve years for corporate projects and non-profit projects respectively.
- **Making tax credits easier to claim.** This credit is now available to DAC facilities capturing at least 1000 tCO_2/year, down from the previous threshold of 100,000 tCO_2/year. The tax credits can be received as direct payments and are transferable to tax-paying third parties.

These expanded incentives for direct air capture build on provisions in the Bipartisan Infrastructure Law that established multiple pots of funding for carbon sequestration and engineered removals, including $3.5 billion of support for four Regional Direct Air Capture Hubs that aim to capture 1 $MtCO_2$/year each.

The incentives offered through the US Inflation Reduction Act and Bipartisan Infrastructure Law are expected to stimulate the nascent direct air capture industry, supporting smaller projects to scale up and making the US an attractive site for future DACCS projects. There are also incentives available for BECCS, with projects involving industry and power CCS now able to benefit from the $85 t/$CO_2$ tax credit for the capture and storage of CO_2. For further exploration of competition impacts of international climate and energy policy, see Chapter 2.

Source: World Resources Institute (2022) *Carbon Removal in the Bipartisan Infrastructure Law and the Inflation Reduction Act*; US Department of Energy (2022) *Biden Administration Launches $3.5 Billion Program To Capture Carbon Pollution From The Air*; Clean Air Taskforce (2022) *Carbon Capture Provisions in the Inflation Reduction Act of 2022*.

Figure 14.2 Key indicators for engineered removals



Source: Refer to the Monitoring Framework, available on our website, for full documentation on the CCC's indicators, including historical data sources and data gaps.
Notes: (1) Sectoral emissions pathways are indicative only, they are not viewed by the CCC as sectoral targets. An indicator is on track if it is going in the right direction at an appropriate rate. This is determined by comparing the historical data to Government ambition or the CCC's recommended path and considering the wider contextual factors that may have a temporary impact (e.g., recovery from the COVID-19 pandemic). Government ambition is an umbrella term encompassing stated targets, projections, and modelling assumptions – and does not necessarily represent a formal commitment from the Government. (3) The Government's emissions pathway includes only quantified plans from the Carbon Budget Delivery Plan. Unquantified plans may lead to further emissions reductions.

2. Policy assessment

A summary and assessment of recent progress and what still needs to be addressed is given in this section. Our assessment is based on the criteria outlined in Annex 1. The detailed recommendations for this sector are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within the tables below.

The Government's announcements on funding and cluster development demonstrate a continued commitment to developing CCS in the UK, but significant risks remain on delivery at the promised scale and timeline.

Progress has been made on CCS over the last year. The announcements made on funding and cluster development this year demonstrate a continued commitment to developing CCS in the UK and represent progress against last year. However, significant risks remain over whether CCS will be delivered at the scale and timeline needed for the Government's targets and pathways (Table 14.1).

The Committee's assessment is less positive for engineered removals. Policy progress has been insufficient, with no credible policies in place to meet the required emissions reduction by the Sixth Carbon Budget period (Figure 14.3, Table 14.2).

Although the Government has signalled its overall intention for funding and regulating engineered removals, it has stalled on the development and delivery of detailed policies to support these aims. This has compressed timelines for potential projects to the extent that there may now be insufficient time for new BECCS and DACCS projects to go through development, engineering, construction and testing and begin operating by 2030. Given these timing issues, the Committee's view is that there are insufficient plans to meet the entirety of the Government's 2030 5 $MtCO_2$/year removals target. Detailed policies and plans in these areas now need to be announced and implemented during this year to reduce the risk to meeting the 2030 target and avoid impacting the Government's ability to achieve its 2030 NDC.

The need for Government clarity on engineered removals is now more urgent, with any further delays posing fundamental risks to the Government's ability to meet their 2030 5 $MtCO_2$/year ambition.

Our assessment of the Government's plans for engineered removals has worsened over the past year. We are one year closer to 2030, when the Government is relying on 5 $MtCO_2$/year of removals being in operation to meet its NDC, and little action has been taken. Given the proximity of this deadline, recommended steps on funding and guidance must be taken as soon as possible to avoid the Government timing out on its own targets.

The policy assessment in this report focuses on measures to reduce emissions, but the infrastructure for engineered removals must also be well adapted to future climate impacts. In the CCC's recent report - Progress in adapting to climate change – 2023 Report to Parliament – we set out a number of recommendations in this area.

Policy progress on engineered removals is insufficient, with no credible policies in place to meet the required emissions reduction by the Sixth Carbon Budget period.

Figure 14.3 Assessment of policies and plans for engineered removals

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; CCC analysis.
Notes: This assessment uses Government plans listed in Annex B, Tables 5 & 6 of the Carbon Budget Delivery Plan. See Annex 1 for the assessment criteria.

Table 14.1
Policy scorecard for CCS

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
CCS overall assessment	O	Y	Y	Y	O

Progress:

Some progress has been made in the past year for CCS and the Government's plans set out a vision for how the sector will support the UK's Net Zero ambitions.

- A suite of CCS business models is being developed, tailored to different parts of the CCS sector. Primary legislative measures to enable the carbon capture business models were introduced through the Energy Security Bill.
- The Government has announced eight projects to progress to negotiations to form the first two CCS clusters in Track 1 of the CCUS Cluster Sequencing Programme and intends to launch a process to enable further expansion of those clusters later in 2023.
- The process for confirming the next two clusters in Track 2 was launched in March 2023.
- Up to £20 billion of mostly new funding to support early development of CCUS over the next 20 years was committed in the 2023 Spring Budget.

- The UK's first carbon storage licensing round was launched and finalised, offering 20 licences to store carbon dioxide in offshore areas around the UK.[6]

To be addressed:

- Risks remain because the various funding and business models are not yet proven, so their methods of delivery may face issues.
- There is a lack of clarity around the cluster sequencing process – this reduces investor confidence.
- One contributing factor to this is around timelines. The Government has been clear about end-dates (i.e. when they want projects to start capturing and storing) but not about when processes will be launched and expanded or when funding is likely to be delivered. The publication of targets and end-dates should not be regarded as an acceptable substitute for action towards meeting those targets. There is also uncertainty on timings for clusters that have not already been given provisional support.
- There is additional timing uncertainty and risk arising from the fact that the programme is behind schedule. The aim is for CCS from the power sector to begin in 2025, and from industry in 2027. Given the time needed for CCS project development and construction, it is now unlikely that carbon storage will start before 2027 at the earliest.[7] Specific delays to be addressed are:
  - Details of the £20 billion spending commitment for CCUS have not been released. This should be done, including how early the money will be released and how the funds will be spent and allocated to different types of CCS (recommendation R2023-081).
  - The Government has not said when the second pair of clusters (Track 2) will be selected and become eligible for support.
  - The Government has not published a detailed timeline on each stage of the process of CCS development (recommendation R2023-091).
- There are several other sources of uncertainty:
  - There are no plans for CCS outside of clusters.
  - Applicants for Track 2 have been asked to demonstrate that their systems will be able to connect to non-pipeline transport in the future. However, there is still no detailed plan or policy framework for CO_2 transport from dispersed sites or for incentivising carbon capture and use (recommendation R2022-261).
- The Transport and Storage Regulatory Investment business model has not yet been finalised or delivered, with the last update being in January 2022 (recommendation R2022-254).
- The lack of integration of engineered removals into Government CCS policy developments puts its 2030 ambition for removals at risk. There are currently no operating funding routes for engineered removals, which are expected to rely on CCS and need to be deployed this decade. Proposals for the Power BECCS business model have not yet been finalised or delivered (recommendation R2023-106) and no proposals have been announced for the wider engineered removals business model (priority recommendation R2022-207). The Government has not provided clarity on whether engineered removals projects will be permitted to bid into the expansion of Track 1 clusters (recommendation R2023-107).

Table 14.2
Policy scorecard for engineered removals

Sub-sector	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Overall assessment	Y	O	O	R	O
BECCS No breakdown of abatement given in the Government's pathway	Y	O	O	R until 2030 O after 2030	O
DACCS No breakdown of abatement given in the Government's pathway	Y	O	Y	R until 2030 O after 2030	O

Progress:

The Government published:

- A consultation on business models for engineered removals in July 2022.
- A response to their consultation on business models for power BECCS in March 2023, committing to setting up a 'dual Contracts for Difference' approach for power BECCS projects.

The Government announced:

- The projects selected for the second phase of the £70 million Direct Air Capture and Greenhouse Gas Removals competition. This programme aims to identify scalable removals technologies through funding pilots and demonstrators.

To be addressed:

- Funding
  - The Government will need to develop details of the power BECCS business model, and a process for applications should be launched in 2023. This will need to ensure that the power BECCS business model is compatible with other mechanisms, such as the future GGR business models, the UK ETS and any biomass standards set out in the upcoming Biomass Strategy (recommendation R2023-106).
  - The Government has not yet produced a response detailing which of the options in their GGR business models consultation will be taken forwards. There is an urgent need for clarity on the delivery method, volume and timing of funding support for technologies like DACCS to progress their timely deployment and retain optionality for the engineered removals approaches that will contribute to the Government meeting its 2030 5 $MtCO_2$/year target (priority recommendation R2022-207).
- Carbon Capture and Storage
  - There is a need for Government to set out a clear strategy for how engineered removals projects will access CCS networks in the UK, especially if they are not part of a selected cluster. No engineered removals projects are being taken forward in Track 1 of the Cluster Sequencing process (recommendation R2023-107).

- Public acceptability
  - The public acceptability of engineered removals must be addressed, with particular focus on the potential large-scale use of BECCS in the UK. Engineered removals technologies will be unfamiliar to many and engagement is needed to avoid the public either misunderstanding the risks involved or overestimating the size of the role BECCS and DACCS will play in reaching Net Zero (recommendation R2023-108).
  - In addition to this engagement, the Government must establish stringent guidance on biomass sustainability and MRV to have credibility with the public on their ability to manage the use of these technologies to achieve near-permanent removals.
- Resource use
  - Guidance on biomass sustainability is overdue. The Biomass Strategy must be published in 2023 and set out a hierarchy for the best use of biomass, plans for growing domestic supplies of sustainable biomass and recommendations for sustainability standards for both domestic and imported biomass (recommendation R2022-222)
  - Large-scale deployment of DACCS is expected to have significant energy requirements. As the Government plans for a future decarbonised power system, the potential demand for low-carbon electricity for DACCS should be integrated into system projections.
- Industry clarity
  - The Government needs to respond to the recommendations of the 2021 Task & Finish Group report on MRV, setting out proposals or principles that have been coordinated with international partners to avoid divergence between countries (recommendation R2022-209).
  - The Government must set out a clearer timeline for funding and guidance on engineered removals if the UK is to remain a competitive site for deployment.
- Coordination with Scotland, Wales and Northern Ireland
  - Engineered removals are expected to play a role in achieving both UK-wide and devolved administration emissions reduction targets. However, early deployment of engineered removals could see projects concentrated in a small number of sites in one part of the UK for the late 2020s and early 2030s. To resolve this issue, the UK Government should work with the devolved administrations to consider whether removals in one part of the UK could contribute towards the emissions reduction in another nation at early stages of deployment. In considering this, they should explore the legal, financial and governance-related arrangements that would be needed to facilitate such transfers (recommendation R2022-211).
- Alternative arrangements
  - There are currently considerable risks that may impact the Government's ability to meet its 5 $MtCO_2$/year engineered removals ambition. These risks are detailed in this table. Failure to achieve this removals ambition would affect the Government's ability to meet its 2030 NDC. While the most important steps towards mitigating these risks lie in addressing the policy gap in this sector, the Government should also explore alternative arrangements, identifying areas where additional effort can be taken by 2030 if engineered removals projects do not commence operations in time (priority recommendation R2022-119).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: (1) See Annex 1 for the assessment criteria. (2) Percentage abatement figures refer to numbers from the quantified plans in the Carbon Budget Delivery Plan.

Endnotes

[1] Department for Energy Security and Net Zero (2023) *Carbon Budget Delivery Plan*, https://www.gov.uk/government/publications/carbon-budget-delivery-plan.

[2] Department for Energy Security and Net Zero (2023) *Power bioenergy carbon capture and storage consultation: government response,* https://www.gov.uk/government/consultations/business-model-for-power-bioenergy-with-carbon-capture-and-storage-power-beccs.

[3] Department for Business, Energy and Industrial Strategy (2022) *Business Models for Engineered Greenhouse Gas Removals: A consultation on accelerating investment in engineered carbon removals*, https://www.gov.uk/government/consultations/greenhouse-gas-removals-ggr-business-models.

[4] Climeworks (2022) *Climeworks takes another major step on its road to building gigaton DAC capacity,* https://climeworks.com/news/climeworks-announces-groundbreaking-on-mammoth.

[5] Occidental (2022) *Occidental, 1PointFive to Begin Construction of World's Largest Direct Air Capture Plant in the Texas Permian Basin*, https://www.oxy.com/news/news-releases/occidental-1pointfive-to-begin-construction-of-worlds-largest-direct-air-capture-plant-in-the-texas-permian-basin/.

[6] North Sea Transition Authority (2023) *Huge net zero boost as 20 carbon storage licences offered for award,* https://www.nstauthority.co.uk/news-publications/news/2023/huge-net-zero-boost-as-20-carbon-storage-licences-offered-for-award/.

[7] Global CCS Institute (2020) *Scaling up the CCS market to deliver net-zero emissions,* https://www.globalccsinstitute.com/wp-content/uploads/2020/04/Thought-Leadership-Scaling-up-the-CCS-Market-to-Deliver-Net-Zero-Emissions-Digital-6.pdf.

Chapter 15: Cross-cutting enablers

Introduction and key messages

The Net Zero transition will involve all of society and will rely on actions from many actors including individuals – through the choices they make and their engagement with climate policy; businesses – through shaping options available to consumers and reducing their own emissions; and financial institutions – by shaping business incentives and funds. The transition will impact on different groups in society in different ways, with a shift in the nature of jobs and individual lifestyles depending on characteristics such as income and location.

Across all these aspects of society, Government can shape the wider environment in which these actors operate, to ensure their actions actively align with, and don't slow, progress to Net Zero. They can also take steps to ensure the costs and benefits associated with the transition are fairly distributed. Effective governance structures and mechanisms are vital to coordinate and lead the delivery of Net Zero, which requires action in all sectors of the economy. They should ensure that relevant actors work together constructively and understand the contributions for which they are responsible.

In this chapter we assess progress in this regard, assessing the extent to which Government policy is supporting these various aspects of society to align their actions to Net Zero, and ensuring the transition is a fair and inclusive one and that effective governance structures are in place. In the coming year we will develop bespoke analysis and reports on some of the themes touched on in this chapter, so our assessment of progress and recommendations in this report are kept at a high-level.

Our key messages are:

- **Public engagement and green choices.** Despite some positive steps to advise the public on energy use in the last year, a coherent public engagement strategy on climate action is long overdue. There is a lack of prominence of climate issues in Government communications, risking signalling to businesses and the public that climate change is not a priority. However, increased concern about climate change and relatively high knowledge about Net Zero provide a potentially favourable context for engaging with the public. People should be empowered to make green choices through clearer information and Government leadership, and by policies which make green choices easy, attractive and affordable. Deliberative processes should be considered for navigating challenging policy decisions, building on the insights and lessons from the UK Climate Assembly.

- **Net Zero plans and actions of businesses.** Approximately two-thirds of UK emissions can be attributed to UK business 'Scope 1' (i.e. direct) emissions. The majority of these emissions are attributable to large companies, which are increasingly committing to Net Zero and reporting their activities. Despite some good examples of UK businesses taking strong action on Net Zero, the claims of some large firms have been found to lack credibility. There has been some good progress in developing a framework to strengthen UK corporate action on Net Zero, mainly through development of a draft transition plan standard and new rules designed to clamp down on greenwashing. Collaboration with business has been enhanced by the establishment of the Net Zero Council but much greater focus on supporting Small and Medium Enterprises (SMEs) is needed. Government should also consider reinstating the Business Champion (or equivalent) to avoid losing momentum.

- **Private sector investment and finance.** The updated Green Finance Strategy updated on a range of actions that will strengthen the UK's green finance architecture, including regulation of Environmental, Social, and Governance (ESG) ratings and plans to introduce an internationally aligned Green Taxonomy. However, neither the Strategy nor Investment Roadmaps published to date go far enough in setting out how the investment needed to deliver Net Zero will be secured, and a mechanism to track this is yet to be established. The private sector continues to call for stronger signals, incentives and better access to finance to unlock the scale of investment needed to deliver Net Zero and keep pace with competitors in the global race to develop green industries. Government should set out its priorities for developing emerging Net Zero industries and technologies in the UK and use the Autumn Statement to put in place strong signals to stimulate their development and deployment.

- **Innovation.** There has been insufficient progress in support for innovation in the last year. The Government must greatly accelerate this, including creating a demand-pull for new technologies through ambitious deployment policies as was successful for offshore wind. It should publish an evidence-based roadmap of the development of new technologies needed for Net Zero and develop an effective mechanism for supporting early-stage start-ups working in this area. This is important for keeping up with government support packages in the USA and the EU.

- **A Net Zero workforce.** A skilled workforce is a critical component of the Net Zero transition. While progress is being made in specific areas, a lack of clear strategy means that overall change is slow and fragmented. Across the board, long-term certainty around sector demand and investment incentives will be needed. Beyond this, for sectors that will need to grow rapidly, targeted policies will be needed to ensure this skilled workforce is in place. For sectors that may see job losses, targeted interventions to ensure workers and their communities have attractive alternatives will be needed. In its Net Zero and Nature Workforce Action Plan due in 2024, Government should set out in detail how it will work with devolved administrations, local authorities, businesses, trade bodies and organisations responsible for accrediting courses and qualifications to address these priorities.

- **Fair funding and affordability.** This year the Government provided necessary support to households on energy costs, however their response to the rising cost of energy missed a key opportunity to provide matching support for energy efficiency measures (see Chapter 5). In addition, wider system incentives are not set up to distribute and manage the costs of Net Zero for households and businesses in a fair and efficient way. The Government should publish a review of taxes and incentives impacting the Net Zero transition and outline the climate impacts of government budgets and spending decisions. The cost of switching to low-carbon technologies should be reduced, in part by rebalancing electricity and gas prices, following a commitment to outline an approach to this by the end of the financial year.

- **Governance.** The establishment of the new Department for Energy Security and Net Zero means there is now a central department with a specific remit to oversee the delivery of Net Zero. Responsibility for managing interdependencies and coordinating delivery must be embedded in its objectives, backed up by sufficient authority. Effective coordination and clear alignment of key decision-making frameworks with the required outcomes are essential, and this needs to extend to the Government's

interactions with devolved administrations, local government and the wider system. Structures such as the Inter-Ministerial Group, the Jet Zero Council and the Local Net Zero Forum have been established for this purpose, but must now become more effective in agreeing clear roles and responsibilities and managing shared outcomes.

In the rest of this chapter, we discuss progress in two sections:

1. Indicators of progress
2. Policy assessment

Due to limited data and the qualitative nature of some issues, in this section we summarise a small number of formal indicators and augment these with wider evidence.

Important aspects of the role of cross-cutting enablers are difficult to track due to insufficient data and the more qualitative nature of some of the issues. In this section we summarise formal indicators of progress and augment this with wider evidence of the status of cross-cutting enablers.

The indicators of progress show a mixed picture, highlighting that further policy intervention is needed. This finding is consistent with our assessment of policies and plans (section 15.2).

(a) Public engagement and green choices

We will develop further analysis on the role of people in the Net Zero transition in the next year. In the meantime, we present the following high-level indicators of progress.

There is rising public concern about climate change and people are relatively knowledgeable about the concept of Net Zero.

Public concern and awareness. Public concern about climate change has generally seen an increase since 2012, with 82% of people surveyed in 2022 concerned about climate change, compared to 65% in 2012.[1,2] People are also relatively knowledgeable about the concept of Net Zero, with 75% of people surveyed saying that they know either a little, a fair amount or a lot about Net Zero.

Personal action to reduce climate impacts. In 2022 most people (around 98%) reported doing at least one climate-positive behaviour in their everyday life, with two of the most commonly reported actions being recycling and reducing food waste (Figure 15.1). However, when asked about climate impact, most respondents identified other presented behaviours (such as choosing to walk or cycle instead of using a car) as having the biggest impact on tackling climate change (Figure 15.1).[3]

There is relatively low trust in Government communications about climate change.

Communications and public engagement processes around climate change. Trust in the UK Government to provide accurate information about climate change was relatively low in 2022, at 48%. Of the sources asked about, the most trusted source was scientists working at universities (86%), and the least trusted source was social media (15%).

Public support for climate policies varies, with higher support for regulating and taxing companies and subsidies and lower support for lifestyle changes and bans.

Support for policies on climate change. There is limited data available on support for current or planned Government policies around tackling climate change.

- A 2021 poll assessed a wide spectrum of policy options (some of which are not supported by Government or the CCC). The poll showed that policies aimed at enhancing the natural environment* received the highest public support (over 85%). Regulating† and taxing companies, household subsidies and investment in the UK also received high support (over 80%). On the other hand, policies aimed at changes to individual behaviours and lifestyle (e.g. policies that increase the cost of using a private car or aviation) were generally supported by less than half of respondents, with the exception of a Frequent Flyer Levy, which received 60% support. Outright bans (e.g.

* This included planting more trees in the UK's green spaces and protecting and restoring natural ecosystems.

† This included regulations on packaging and single use plastic.

banning the sale of meat and dairy products or all leisure air travel) received the least public support (below 20%).[4]

- Support for traffic reduction schemes ranged from 43% support for the introduction of more congestion zones and 53%* support for Low Traffic Neighbourhoods in the UK in 2021, to 62% support for 15-minute neighbourhoods in 2023.[5,6] A 2020 survey of residents in four Low Traffic Neighbourhoods showed that six in ten respondents supported their local scheme.[7]

A relatively low number of people intend to purchase heat pumps or electric vehicles.

Attitudes to specific green technologies and low-carbon choices.

- Self-reported knowledge about air-source heat pumps remained relatively high in 2022 (Figure 15.2). However, the proportion of respondents who said they were 'very likely' or 'fairly likely' to replace their heating system with a heat pump next time they need to change it remained relatively low at 15% (although 28% of respondents indicated this is not applicable, as it is not their decision).

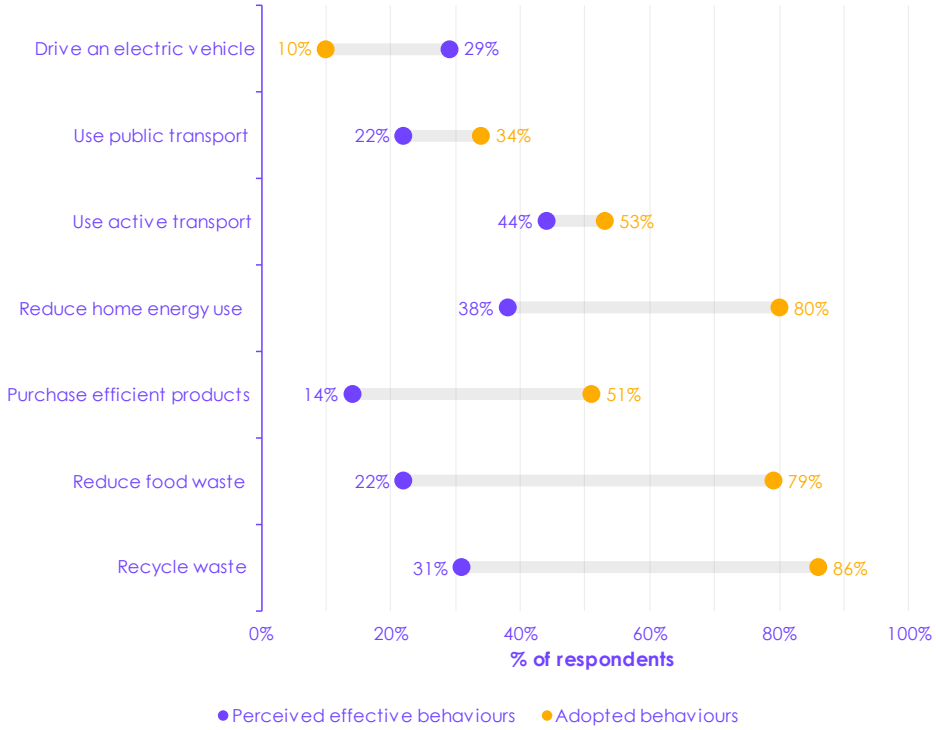
- Self-reported knowledge of electric vehicles also continued to be high in 2022 (Figure 15.2). However, intent to purchase or lease an electric vehicle as their next vehicle remains relatively low at 19% of respondents who planned to buy, lease or replace a vehicle. The most common advantages of electric vehicles people point to when prompted are environmental benefits (80%), reduced road tax (56%), being less noisy (51%) and cheaper to run or maintain (43%). The most common disadvantages people point to when prompted are not enough charging points (74%), purchase costs (74%), that less distance can be travelled on one charge (68%) and the time taken to recharge (62%).[8]

- Chapter 5 discusses low-carbon heating and Chapter 4 discusses electric vehicles in more detail. Chapter 10 includes an indicator on public attitudes to flying, which considers the extent to which consumers think about the impact of flying on the environment when considering air travel, and Chapter 9 discusses indicators on public meat consumption, highlighting that reported UK meat consumption has reduced since 2015.

* The support drops to 36% if the Low Traffic Neighbourhood policy meant that respondents themselves were not able to drive in certain areas.

There is disparity between climate actions people see as impactful and those they report adopting.

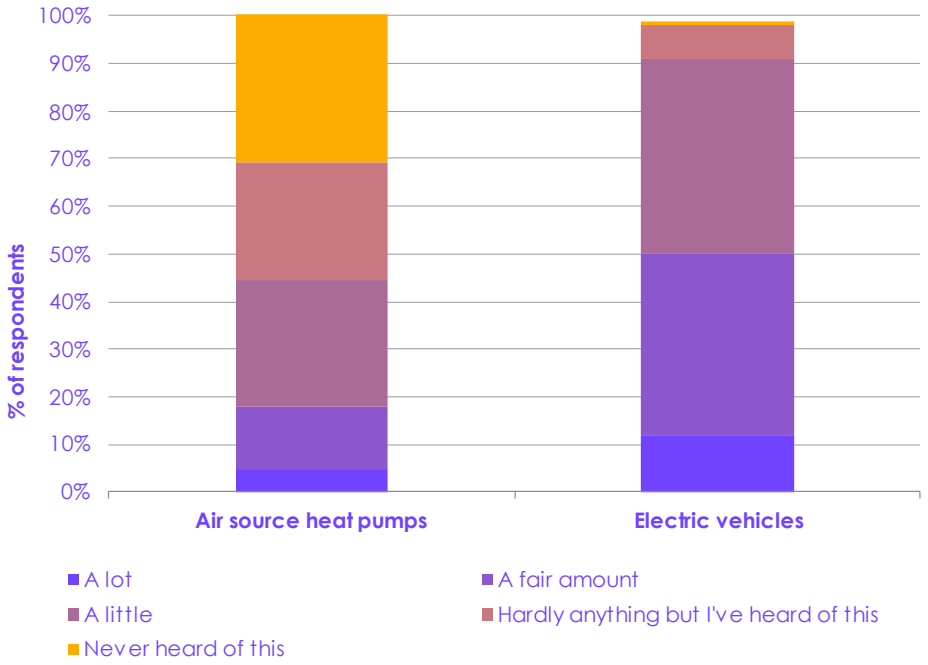
Figure 15.1 Behaviours perceived as effective and behaviours that are adopted



Source: BEIS (2022) *Public Attitude Tracker (PAT), Summer 2022.*
Notes: (1) Survey question for adopted behaviours: 'Thinking now about your everyday life, do you do any of these things? Please select all that apply.' This question is asked without any reference to these behaviours being climate positive. (2) Survey question for perceived effective behaviours: 'If most people in the UK did the following, which three of these do you think would have the biggest impact on tackling climate change in the UK? Please select up to three responses.' Not included here are the following response options, as they are not response options in the adopted behaviours survey question: 'Install low-carbon heating systems at home (e.g., heat pump)', 'Install insulation/draught proofing at home'. (3) Descriptions of behaviours are shortened in the graph. The full description of behaviours varies slightly between the two survey questions and can be found in the original source. (4) Behaviours that are typically assessed in the literature to have higher mitigation potential are displayed higher up on the y-axis and behaviours typically assessed to have lower mitigation potential lower down on the y-axis.[9] However, this should only be taken as an indication, as the actual mitigation potential depends on the extent and interpretation of the behaviour (e.g. reducing home energy use could be interpreted as very different behaviours: installing energy efficiency measures or switching off lights) and factors such as embedded emissions of additionally required infrastructure may not be accounted for.

There is relatively high self-reported knowledge and awareness of heat pumps and electric vehicles.

Figure 15.2 Knowledge and awareness of air source heat pumps and electric vehicles



Source: BEIS (2022) *Public Attitudes Tracker (PAT), Winter 2022*; Department for Transport (2022) *Transport Technology Tracker; wave 9.*
Notes: (1) Survey question for knowledge and awareness of air source heat pumps: 'How much would you say you know about the following low-carbon heating systems? Air source heat pumps'. (2) Survey question for knowledge and awareness of electric vehicles: 'Before today, how much, if anything, would you say you knew about electric cars or vans?'. (3) Electric vehicle responses do not add up to 100% as the survey question included a 'don't know' response option. (4) Response options for the heat pump question are displayed. Some response options for the electric vehicles question vary slightly: 'A great deal', 'A fair amount', 'Just a little', 'Heard of, know nothing about them', 'Never heard of them'.

(b) Business and finance

In the next year we will publish a monitoring framework for business action. In the meantime, we present the following high-level assessment of progress. We do not yet have indicators for progress in finance.

About two-thirds of UK emissions are from 'Scope1' business emissions.

Emissions. About two-thirds of UK emissions are from 'Scope 1' (i.e. direct) emissions through business activities (including energy supply and manufacturing), with the remaining third of UK emissions produced largely by private vehicles and residential buildings.

- Emissions from 'Scope 1' business activities increased by 3% between 2020 and 2021, as economic activity recovered following the easing of pandemic restrictions in summer 2021 (Figure 15.3).*
- Emissions from commercial buildings and travel grew by just under 10% as people returned to their normal places of work and business travel and supply chain transport increased.

* We use 'final' emissions data for 2021 rather than provisional emissions for 2022 because these more accurately account for non-CO_2 emissions from business activities. We will review how we attribute business related emissions as part of our forthcoming report on the role of business.

Corporate Net Zero targets. Large UK companies continue to make Net Zero pledges under the Science Based Targets Initiative (SBTi), which covers three-fifths of the current FTSE100 (Figure 15.4).

Third-party assessments of large companies have found despite ambitions, actions to reduce emissions and transform business practices are falling short.

Reported corporate action. While UK companies are among the most transparent, several recent third-party assessments of corporate climate disclosures at a global level have found that while the stated ambition from larger companies is encouraging, the substance of companies' reported actions to reduce emissions is falling short of what is needed to deliver the Paris Agreement.

- A report by CDP assessing European company disclosures found that while more UK companies report their activities than any other country, 'less than 5% of companies across Europe show the advanced transition readiness required to achieve the Paris goal'.[10]

- An assessment of 24 multinational companies' climate disclosures by New Climate Institute for Carbon Market Watch found that most companies' climate strategies are 'mired by ambiguous commitments, offsetting plans that lack credibility and emission scope exclusions'.[11]

- Analysis commissioned by the CCC looking at the extent of emissions reduction targets in the UK's industry sector found that if manufacturing companies met their targets, it would result in a reduction in emissions equivalent to 32% of the reduction in the CCC Balanced Pathway by 2030, falling to 19% by 2050 (see Chapter 6).

Despite strong appetite, smaller companies are struggling to engage effectively in Net Zero due to a lack of capacity and finance.

SME Net Zero engagement. SMEs show a high level of awareness of Net Zero and a fairly widespread desire to take climate action. However, there are indications that SMEs are struggling to engage with Net Zero to the same extent as larger companies, in particular in setting Net Zero targets.

- A survey from Lloyd's bank suggests that 95% of SMEs are aware of the UK's Net Zero target.[12]

- In 2022 the SME Climate Hub found that 60% of SMEs have plans to reduce their carbon impact.[13] The number of smaller businesses reporting to have targets or plans has increased over the last year.

- However, an Office for National Statistics (ONS) survey across all business types suggested that as of May 2023, 17% of firms with 100 - 250 employees have a climate strategy, 14% have a Net Zero target, but only 6% have a target which includes supply chain emissions.[14]

- The number of SMEs signed up to SBTi targets remains less than 0.1% (Figure 15.4), likely reflecting constraints SMEs report relating to time and resources.

Most UK businesses report prioritising low-cost actions to reduce emissions, with limited uptake of measures with higher impact.

Reported actions by UK businesses. Based on analysis of ONS surveys, the most common reported actions taken by UK business to reduce emissions tend to be those with lowest cost and least disruption – with around 30% of respondents reporting to have switched to LEDs or adjusting heating or cooling systems (Figure 15.5).

- The number of businesses reporting to have insulated their buildings has increased slightly from 6% in 2021 up to 8% by May 2023, possibly in response to increases in the cost of energy.

- The proportion of businesses reporting taking no action fell from 46% in April 2021 to around 30% in December 2022, with a slight increase so far in 2023. While it is too soon to say if this will be a trend, SMEs have reported that inflation and other cost pressures have reduced their capacity to take action on Net Zero.[2]

Sector-specific business indicators highlight mixed progress in business actions and behaviours.

Sector-specific business indicators. Sector-specific indicators suggest that business actions and behaviours in response to Net Zero have made mixed progress.

- The proportion of zero-emission vans in the UK grew from 0.4% to 0.6% between 2020 and 2021, while the proportion of zero-emission HGVs remained at 0.1% (see Chapter 4).

- The proportion of total flights taken for business purposes from the UK in 2022 remained at 6% - the same proportion as in 2021 (see Chapter 10).

- The proportion of SMEs reported to have installed energy efficiency measures in the 12 months from 2020 to 2021 increased from 13% to 19%.[15]

- The private sector has played a central role in delivering aspects of the transition where sector indicators suggest good progress has been made in the last year - such as the sale of electric cars (see Chapter 4).

The CCC convened an Advisory Group of businesses, who published a report offering their insights into the opportunities, drivers and barriers to business action on Net Zero.

Insights from UK businesses. The CCC convened an Advisory Group of businesses from across different sectors and regions of the UK, to provide insights around the opportunities, drivers and barriers to business action on Net Zero (see Box 15.4 and accompanying report).

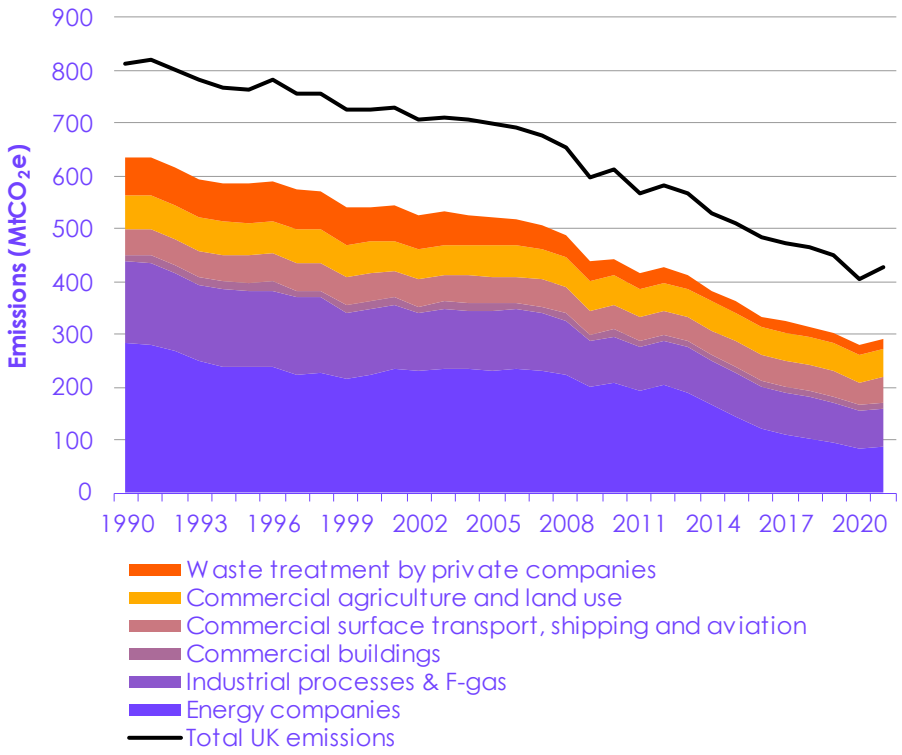
- The Group's report highlights opportunities for UK business to drive and benefit from the transition to Net Zero, and includes case studies from members pointing to steps some UK companies are taking to realise these opportunities.

- The Group recognises the need for businesses to go further and recommends a set of benchmark actions for businesses to strive towards but argues that Government must put in place a much stronger policy framework to realise the full potential of the private sector to accelerate progress on Net Zero.

- We will consider the Group's insights and recommendations in full as part of a dedicated report on the role of business, which we will publish in the next year.

Estimated emissions from business 'Scope 1' emissions increased from 2020 to 2021.

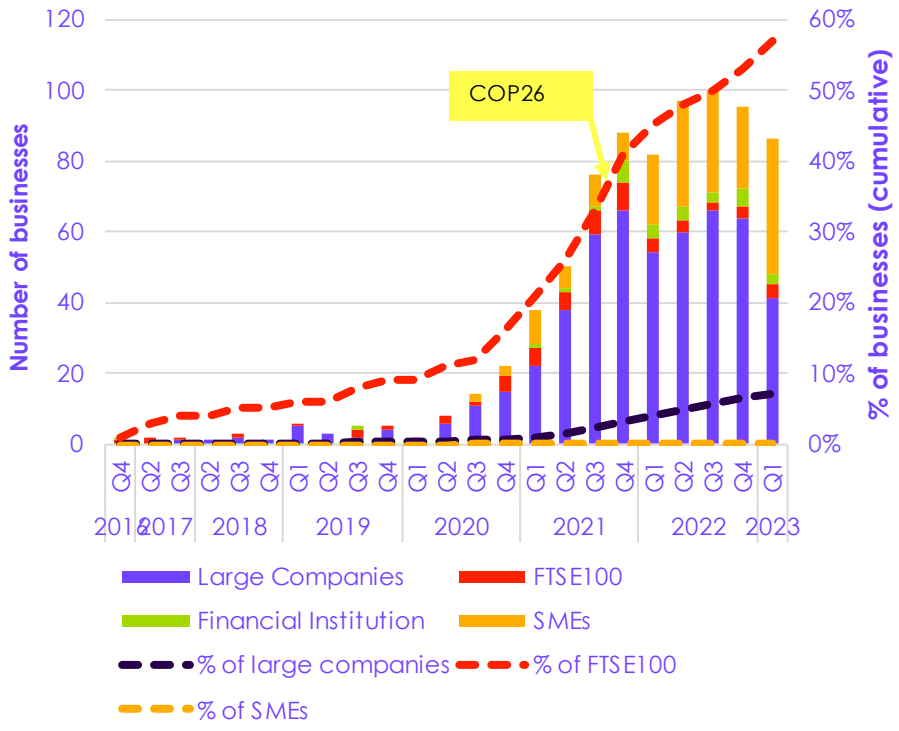
Figure 15.3 Breakdown of UK territorial emissions attributed to business 'Scope 1' emissions



Source: DESNZ (2023) *Final UK greenhouse gas emissions national statistics*; CCC analysis.
Notes: Each emitting activity was labelled as either not falling within a business's 'Scope 1' emissions, falling within a business's 'Scope 1' emissions, or having a proportion falling within a business's 'Scope 1' emissions. For example, we assumed 8% of emissions from passenger vehicles fell within a business's 'Scope 1' emissions, based on the proportion of vehicles on the road in the UK that are registered for commercial use. Different proportions were assumed for HGVs and other surface transport. For sectors such as waste, where even household waste is processed using assets owned by a private company, all emissions were marked as 'Scope 1' business emissions. We hold the proportion of an emitting activity's emissions associated with commercial 'Scope 1' emissions as constant across time. We will be reviewing our methodology for attributing business-related emissions for our forthcoming report on the role of business.

Large businesses continue to commit to SBTs.

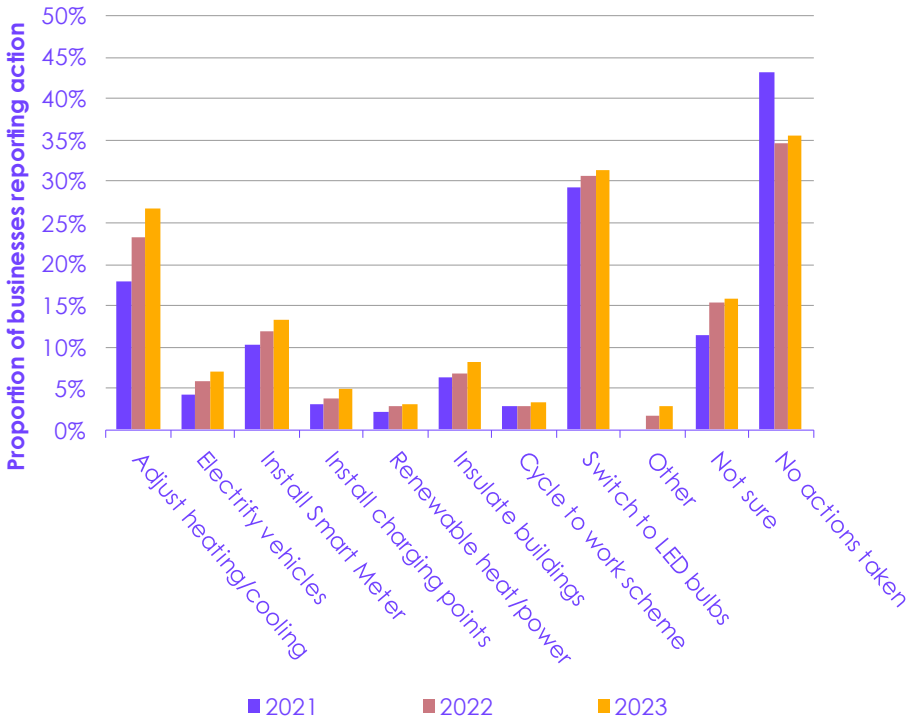
Figure 15.4 Businesses committed to a Science Based Target (SBT) by business type



Source: SBTi (2023) *Companies Taking Action Data;* CCC analysis.
Notes: The % figure does not include financial institutions or oil and gas companies. Includes companies that have both committed to setting a target and those that have fully implemented an SBT. FTSE100 companies are not included within the numbers for large companies. SBTi's definition of SMEs includes all non-subsidiary, independent companies with fewer than 500 employees.

The most common actions businesses report taking are low cost and relatively low impact.

Figure 15.5 Reported actions by UK businesses to reduce emissions



Source: ONS (2023) Business Insights and Conditions Survey, 2021 – 2023 averages, responses to question "Which of the following actions, if any, have you taken to reduce your business's carbon emissions?".

(c) Fair funding and affordability

Indicators on the distributional impacts and co-benefits of climate policies will be published later this year.

Monitoring the fair funding and affordability of low-carbon measures can cover multiple dimensions, from identifying the distributional impacts of climate policies, to assessing the market distortions created by energy subsidies and tax breaks, or the general affordability of low-carbon products and technologies. There is currently limited evidence available on these issues, which is why we have focussed on monitoring fuel poverty in the UK. We will publish further work later this year on the impact of the Net Zero transition on fair funding and affordability outcomes, including analysis of the distributional impacts of sample climate policy packages.

Fuel poverty rates rose from 20% to 30% in England in 2022, with provisional projections of 49% in 2023.

Fuel poverty. Energy prices remain high, largely as a result of global supply shortages and continued conflict in Ukraine, with significant impacts on fuel poverty rates. Although it is difficult to compare or aggregate figures between devolved administrations*, there is a general trend of rising fuel poverty across the UK.

- The data presented in Figure 15.6 show for each devolved administration the most recent estimates for the number of households who are required to spend more than 10% of their income (before or after housing costs, depending on region) on domestic energy – which is one definition of fuel

* Due to differences in methodology and lack of recent evidence, it is difficult to compare or aggregate figures between devolved administrations.

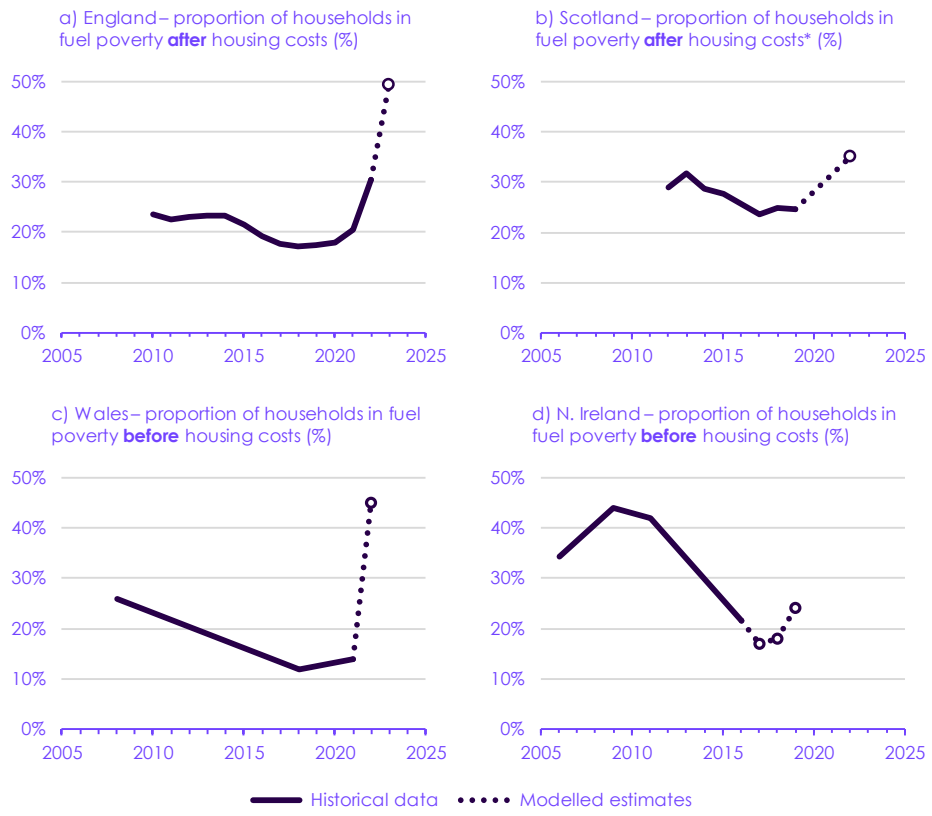
poverty.* Fuel poverty rates had previously decreased across the UK from 2010 to 2017, before remaining approximately level from 2017 to 2020.

- In England, fuel poverty rates rose from 20% to 30% from 2021 to 2022, with provisional Government projections of 49% in 2023.[16] Similarly, modelled estimates from Scottish Government suggest an increase from 25% to 35% between 2019 and 2022 in Scotland.[17]

- In Wales and Northern Ireland, estimates have not been published since 2021 and 2019 respectively. However, preliminary analysis from Welsh Government suggested that up to 45% of all households in Wales were in fuel poverty in 2022†, an increase from 14% in 2021.[18,19]

The proportion of households who are required to spend more than 10% of their income on domestic energy has been increasing across the UK in recent years.

Figure 15.6 Fuel poverty rates across the UK



Source: Scottish Government (2020) *Scottish Household Survey*, Welsh Government (2021) *Dwelling Stock Estimates for Wales*, Northern Ireland Executive (2017) *Northern Ireland House Condition Survey*, BEIS (2022) *Fuel poverty statistics.*
Notes: Fuel poverty measurement methodologies differ between devolved administrations. All numbers shown are based on the number of households who are required to spend more than 10% of their income on domestic energy, however in Northern Ireland and Wales this is before housing costs, while in England and Scotland this is after housing costs. Dashed lines represent modelled estimates published by the Government, rather than survey data. *Figures for Scotland also consider factors such as benefits received for a care need or disability, and childcare costs.

* For England and Scotland this figure is calculated after housing costs, while in Northern Ireland and Wales it is calculated before housing costs. Data for Scotland is calculated after housing costs and also considers other factors such as benefits received for a care need or disability, and childcare costs.

† The Welsh Government analysis assumes that the energy bills from all households were set on the price cap.

(d) Workers and skills

In our Net Zero Workforce brief we identified how sectors might change as a result of Net Zero. Based on these categories, we have developed an initial set of indicators.

In May 2023 we published our Net Zero Workforce analytical brief. As part of this analysis, we considered how sectors might change as part of the Net Zero transition, as some economic sectors will grow or phase down, while others will redirect means of production or play an enabling role. In our brief we identified the share of current workers across these categories of change (Box 15.1). Building on this approach, we have developed an initial set of indicators monitoring the quantity and quality of jobs available in these sectors, presented below.

Employment is growing in sectors with expected UK growth as part of the transition, but it is falling in areas where UK growth is conditional.

Employment in core and enabling Net Zero sectors. Here, we assess changes to employment in the past six years for the main categories identified in our Net Zero Workforce analytical brief. We do not have quantified benchmarks for how employment should change, but we would broadly expect to see increased employment in growth sectors and a decrease in phase-down sectors. Employment is growing in sectors with expected UK growth as part of the transition, however it is falling in areas where UK growth is conditional. Employment is falling in sectors expected to phase down, although these are a small proportion (0.2%) of total UK employment (Figure 15.7).

- Employment in sectors where growth is expected in the UK is increasing, but slowly. Employment grew by 1% from 2020 to 2021, remaining 2% lower than pre-pandemic levels.[20] This is in comparison to the overall economy where employment grew by 6%, but remained 3% below pre-pandemic levels.

- In sectors where growth is conditional (i.e. growth is expected but could occur in the UK or overseas), employment fell by 4% from 2020 to 2021, to 5% below pre-pandemic levels. The evidence does not suggest that this has been driven by growing economic activity and employment overseas, but rather by changes in domestic economic output. However, in the context of the US Inflation Reduction Act and EU Green Industrial Plan (see Chapter 2), there is a risk that the UK is missing a window of opportunity to compete in key sectors such as battery manufacturing.

- Employment in sectors expected to phase down fell by 7% over the same period, falling to 10% lower than pre-pandemic levels. In 2021, employment in these sectors made up 77,500 FTE jobs (0.2% of UK jobs). While job losses are expected in these sectors as part of the transition, there are also other drivers of this change. For example, for oil and gas production, the availability of reserves and resources in the North Sea will be an important determinant for employment in the sector.

It is important to consider how attractive Net Zero work and reskilling will be for workers.

Attractiveness of Net Zero work. It is also important to consider incentives for workers to take up jobs and skills training programmes created in the transition to Net Zero, such as salaries, job security, working conditions and enjoyment, union representation and the cost of training itself. We do not have indicators for all these elements, but consider salary premiums as a proxy.

Median salaries in sectors expected to grow as part of the Net Zero transition are above average, but not as high as median salaries in sectors expected to phase down.

CCC analysis suggests that in sectors that we expect to grow in the UK as well as those we expect to redirect means of production or play an enabling role in the Net Zero transition, salary premiums exist relative to the UK median salary. However, the highest median salaries are found in the few sectors where employment is expected to phase down as part of the transition. Evidence is limited on other indicators of job attractiveness beyond salary levels.

- CCC analysis suggests that salaries are highest in sectors expected to phase down as part of the Net Zero transition, with a median salary of £34,387 relative to a national median of £27,109 in 2021.[*,21] The gap between the two salary levels is decreasing over time, with the relative difference decreasing from 37% to 27% from 2015 to 2021 (Figure 15.8).

- Salaries in sectors expected to grow in the UK are also higher on average than other sectors, with a median salary of £32,201. The gap above the national median salary is decreasing over time, with the relative difference decreasing from 29% to 19% from 2015 to 2021.

- In sectors where growth in the UK is conditional (i.e. growth is expected but it could happen in the UK or overseas), median salaries are £26,772 – 17% lower than in expected UK growth sectors, and 1% below the national median. The gap between median salary in conditional growth sectors and the national median grew from 1% in 2015 to 6% in 2018, but has since returned to 1% in 2021.

- Salaries in phase-down and redirect sectors vary significantly across sectors, with median salaries in oil and gas (£50,438) considerably above the national median, compared to animal agriculture and processing (£24,392) where median salaries fall below the national median.

Women and ethnic minorities are underrepresented in many sectors expected to grow as part of the Net Zero transition, while older workers are overrepresented in sectors expected to phase down.

Characteristics of the Net Zero workforce. To date, certain sectors have had a disproportionate over- or under-representation of demographic groups in their workforce relative to the UK average. There is a risk that a lack of diversity in these sectors limits the effective delivery of Net Zero and means people with these characteristics are not included in the opportunities the transition brings. Sub-sector data aligned with the categorisations made in the previous paragraphs is not available, but workforce characteristics in key sectors related to the Net Zero transition are presented below.

- In the construction sector, 120,000 to 230,000 jobs could be created across the UK in order to retrofit and insulate the UK housing stock.[†,22] Women make up 12% of the sector's workforce despite representing 47% of the UK's total workforce, while workers from ethnic minority backgrounds workers make up 4% of the sector's workforce compared to 13% of the overall UK workforce.

- Forestry and peatland restoration could lead to over 40,000 new jobs,[‡] but there could also be job losses in livestock agriculture. The transition will mainly require farmers to redirect farming practices towards low-carbon alternatives. With there being twice as many workers over the age of 55 in the agriculture, forestry and fishing sector relative to other sectors, the transition could be made difficult if incentives are not put in place for those workers that are less likely to retrain. It is also a sector that has not historically attracted a diverse pool of workers: only 1% of workers in the agriculture, forestry and fishing sector identify as ethnic minorities, compared to the national average for workers of 13%. Women similarly represent only 26% of workers in the sector, below the national average of 47%.

[*] All salary figures are presented in 2022 equivalent GBP values.

[†] These are external estimates and not official CCC estimates. The figure of 120,000 jobs refers to new jobs for heat pump installations and energy efficiency programmes as estimated by the IPPR and EEIG respectively, whereas the figure of 230,000 refers to CITB estimates for the total increase in construction jobs required to reach Net Zero.

[‡] These are external estimates discussed in our Net Zero Workforce brief and not official CCC estimates.

Jobs in traditional 'green' sectors are growing quickly, with fastest growth in the construction sector.

Low-Carbon and Renewable Energy Economy (LCREE) employment. Separately to our analysis, the ONS publishes annual data that shows the number of workers in the low-carbon and renewable energy economy (LCREE).* The LCREE data has focused on jobs in the energy sector that have traditionally been categorised as 'green', but does not include all sectors relevant to Net Zero such as land use. Overall, LCREE sectors are growing quickly, with fastest growth in the construction sector (Figure 15.9).

- LCREE employment across the UK grew 16% from 207,800 in 2020 to 247,400 in 2021, representing the largest year-on-year increase recorded (Figure 15.9).[23] Although a proportion of this could be attributed to the recovery of the UK economy from the COVID-19 pandemic, this is not likely to be the whole picture as total UK employment only grew by 6%.

- As a proportion of total jobs, LCREE jobs fell from 0.7% to 0.6% between 2015 and 2019, before returning to 0.8% in 2021.

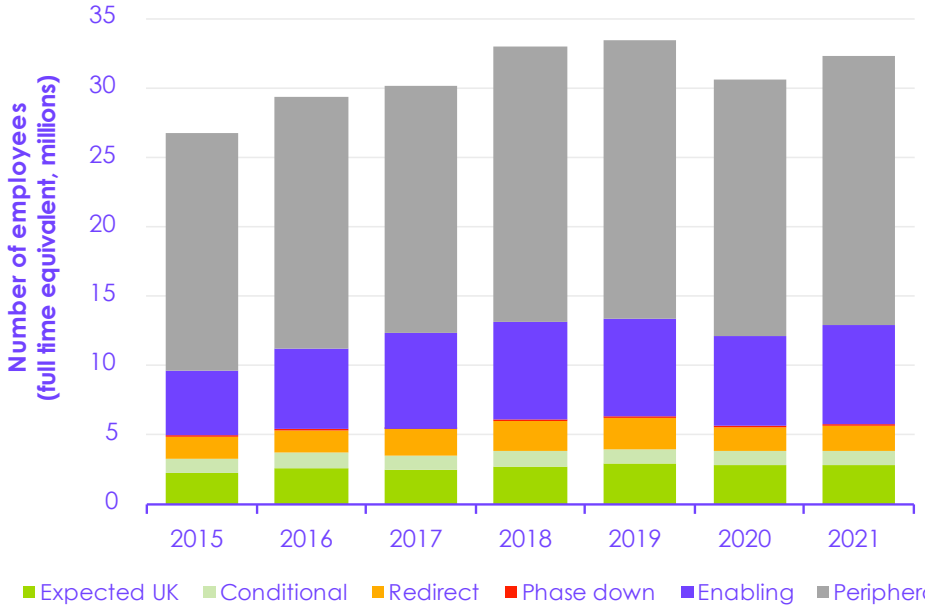
- LCREE employment was largest in the construction sector in 2021, with 91,000 FTEs (37% of total), and the largest increase in employment (19%) from 2020. Other key growth sectors include wholesale and retail trade; repair of motor vehicles; professional, scientific and technical activities, and manufacturing.

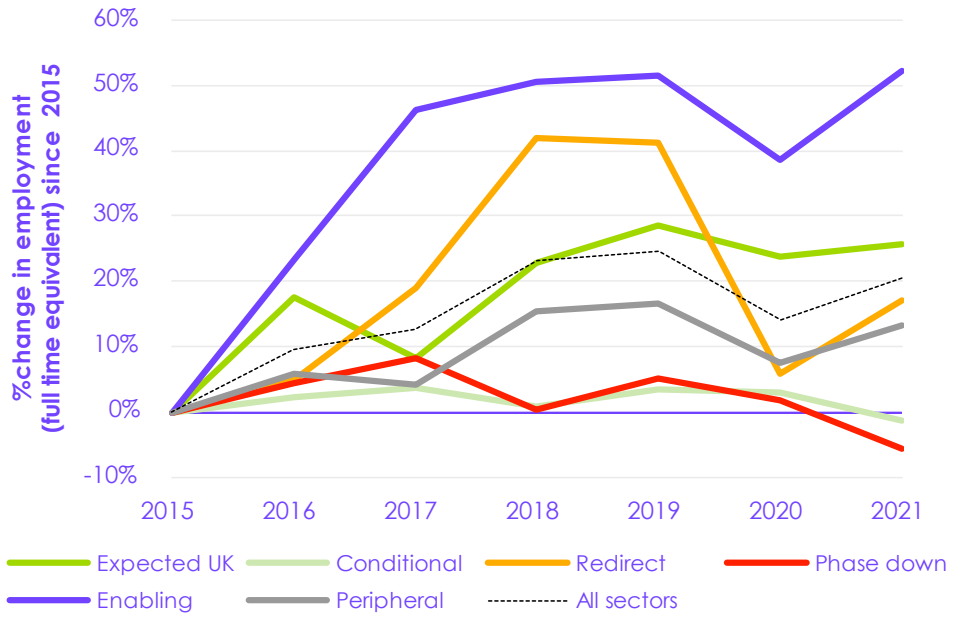
Green skills. No consistent UK-wide evidence is available for monitoring progress on green skills as part of the Net Zero transition.

* The scope and methodology used to estimate these figures are not consistent with the CCC analysis above, and therefore should not be compared.

Jobs in sectors expected to grow or transition made up 18% of total UK jobs in 2021.

Figure 15.7 Number and change in number of employed workers by type of Net Zero impact



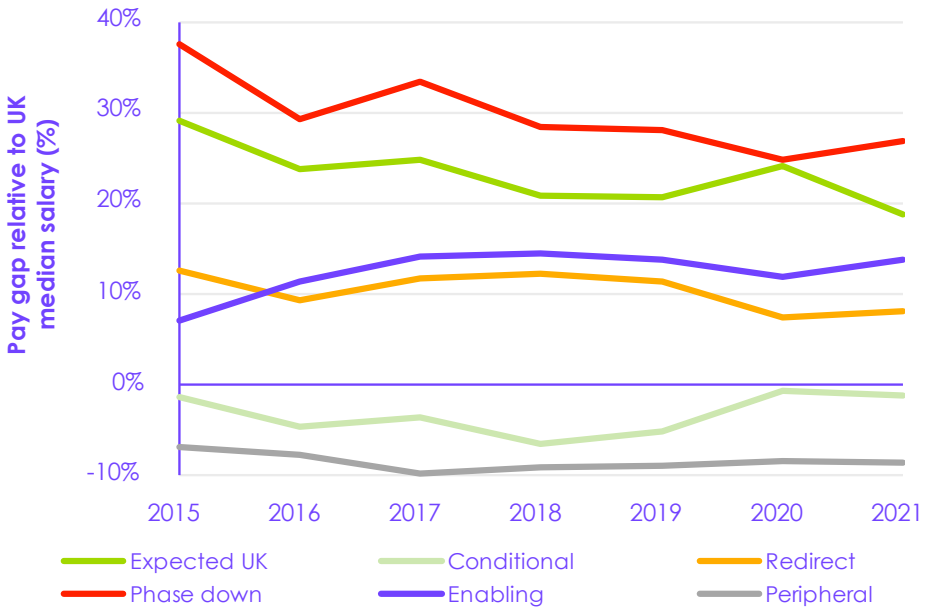


Expected UK growth	Conditional UK growth	Redirect	Phase Down	Enabling	Peripheral
Sector will grow in the UK.	Sector will grow in the UK or overseas.	Sector will take up new low-carbon technology, likely to require a change in skills.	High-emitting sectors will see reduced demand for goods, services & associated jobs.	Sector will embed the transition in regulation, finance, education and knowledge.	Sector will adjust to the Net Zero context, including indirect effects from other sectors.

Source: ONS (2021) *Industry (two, three and five-digit Standard Industrial Classification) – Business Register and Employment Survey (BRES): Table 2*; CCC analysis.
Notes: Figure shows total UK employment, categorised by sub-sector based on expected Net Zero impact on employment. Data is shown in terms of full-time equivalent employees (FTEs). For more information on sector classifications, please refer to the CCC's 2023 Net Zero Workforce report. 'Expected UK' and 'Conditional' in figure legends refer to 'Expected UK Growth' and 'Conditional UK Growth' respectively.

There is a salary premium for workers in sectors with expected UK growth, but it is decreasing – and it is lower than the salary premium for sectors expected to phase down.

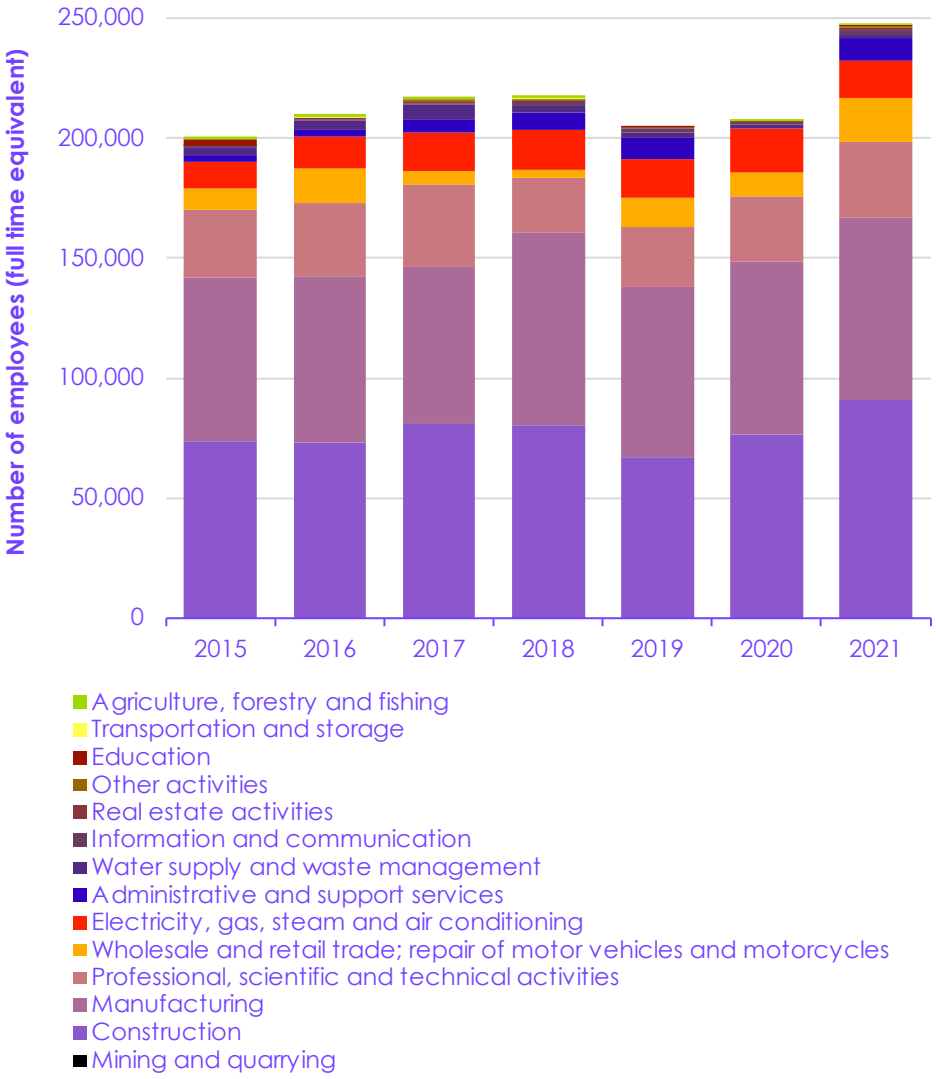
Figure 15.8 Median annual salary of employed workers based on expected Net Zero impact



Source: ONS (2022) *Annual Survey for Hours and Earnings - Table 16.7a Annual pay - Gross (£) - For all employee jobs: United Kingdom, 2021*; CCC analysis.
Notes: This figure compares full time equivalent per annum salaries, in 2022 GBP values. UK average salary refers to national median salary across all UK sectors. Positive values mean salaries are higher than UK average, negative values mean they are lower. For more information on sector classifications, please refer to our Net Zero Workforce brief. 'Expected UK' and 'Conditional' in figure legends refer to 'Expected UK Growth' and 'Conditional UK Growth' respectively.

The number of jobs in the low-carbon and renewable energy economy grew by 16% from 2020 to 2021.

Figure 15.9 Employment in the Low-carbon and Renewable Energy Economy (LCREE)



ONS (2022) *Low-carbon and renewable energy economy, UK: 2021 - Table 1: LCREE employment by sector and industry, UK, 2014 to 2021.*
Notes: Sectors shown are based on SIC 2007 classifications. ONS figures for jobs in the low-carbon and renewable energy economy are not intended as a complete measure of green jobs or businesses but do provide a measure of employment in green occupations within 17 predefined LCREE sectors.

(e) Recent CCC work

Since our last Progress Report, we published two CCC briefs, which have informed the indicators and policy scorecard, and are summarised in Boxes 15.1 and 15.2 below.

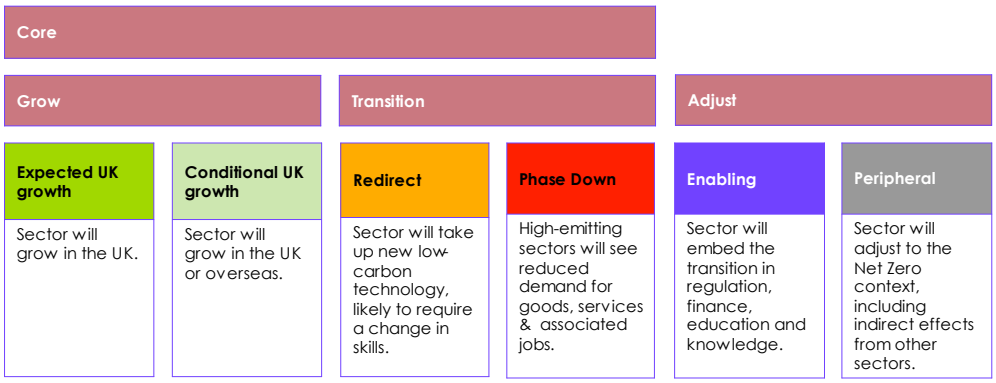
We published a brief assessing the potential impacts on the workforce of the Net Zero transition.

Box 15.1
CCC brief – A Net Zero Workforce

In May 2023 the CCC published a brief, A Net Zero Workforce, to provide an overview of the evidence on the potential impacts of Net Zero for the workforce, set out the risks and opportunities that will come from the transition, and map the analytical and policy considerations that could inform the Government's Net Zero and Nature Workforce Action Plan that is due in early 2024.

Our analysis and evidence review considered how sectors might change as part of the Net Zero transition, identifying that the transition to Net Zero could broadly lead sectors to grow, transition, and adjust (below). We took into account geographical, workforce, labour market and timing dimensions to identify key risks and opportunities this posed to those in the workforce and to the delivery of the Net Zero transition.

Figure B15.1 Sectors of the Net Zero transition



Source: CCC (2023) *A Net Zero Workforce.*

Examples of sectors we assigned labels based on impacts are:

- **Expected UK growth:** buildings retrofit; peatland restoration; afforestation.
- **Conditional UK growth:** EV and battery manufacturing; CCS; hydrogen.
- **Redirect:** energy-intensive manufacturing; livestock agriculture.
- **Phase Down:** oil, gas and coal.
- **Enabling:** education and finance.

Key messages included:

- Net Zero will transform the economy but the majority of workers will not see major impacts. Only around one-fifth of workers will see the largest impacts – those that are currently employed in sectors that will have a core role in delivering Net Zero, often in the next decade.
- There is potential for the Net Zero transition to create more jobs than will be lost. Between 135,000 and 725,000 net new jobs could be created by 2030 in low-carbon sectors, such as buildings retrofit, renewable energy generation and the manufacture of electric vehicles.*
- The transition provides a range of opportunities, from driving growth in areas with historically low employment to diversifying the workforce of core Net Zero sectors. It also comes with risks that will need to be managed to deliver a just transition, including an inadequate supply of skilled workers, and potentially disruptive impacts to some communities. The risks and opportunities are unique to each sector.
- Government has policy levers at its disposal to support workers during the transition to Net Zero. It does not need to intervene in every sector of the economy, but clearer plans are needed to harness the potential of the transition and to manage its risks. A hands-off approach will not work.

Source: CCC (2023) *A Net Zero Workforce.*

* While the range for job creation we present is net job creation (so factors in potential job losses), the range of potential job losses we present are potential gross job losses. We show a wide range: there is much uncertainty in these estimates and there are different ways to calculate changes in job numbers.

We published a report on voluntary carbon offsetting, highlighting the need for better guidance and definitions on appropriate business use of carbon credits in net emissions claims.

Box 15.2
CCC report - Voluntary Carbon Markets and Offsetting

In October 2022 we published a report on voluntary carbon markets (VCMs) and offsets. The report reviewed evidence on the risks and opportunities that VCMs and the practice of business offsetting present to Net Zero and set out a series of recommendations to Government. Overall, we found that while VCMs could in future support Net Zero, currently there are significant risks that need to be addressed. Below we set out in more detail the key risks, opportunities and recommendations we identified.

Risks

- There is a risk that business reliance on offsetting disincentivises businesses from directly decarbonising their own operations and supply chains. Carbon credits are typically very low in price, and many UK companies rely to a large degree on offsets in their published emissions reduction plans.
- There is evidence that many carbon credits have historically overstated the emissions reductions or removals they lead to. Coupled with the above risk, this means reliance on offsets could slow progress to Net Zero.

Opportunities

- Voluntary purchase of carbon credits could facilitate much-needed financial support towards global ecosystem restoration and the development of engineered removal technologies.
  - However, even with much higher prices and demand, funds generated by VCMs would be a relatively small portion of the overall funding for the low-carbon transition required globally. Business voluntary action should not be relied on as a substitute for UK international climate finance responsibilities.
- Purchase of high-quality carbon credits from the UK by UK businesses could help support land use outcomes, which are currently off track and lack long-term funding commitments. Carbon credits from the UK might also be a stepping stone towards compliance regimes for sectors such as aviation where residual emissions are expected in 2050, and provide early complimentary funding for engineered removals.
  - However, Government should not solely rely on carbon credits from the UK to meet UK and devolved administration emissions targets. UK Government and devolved administrations are responsible for meeting the statutory goal of Net Zero and the associated interim emissions targets.

Recommendations

- Encourage businesses to support high integrity nature-based and biological solutions and engineered removals, while focussing on direct business emissions reduction.
  - Publish guidance on what activities it is appropriate to 'offset'. Consider the role of other 'beyond value chain mitigation' and prioritise encouraging businesses to take direct action to reduce their emissions.
  - Establish what constitutes a business reaching 'Net Zero' or being 'Net Zero aligned' or 'Offset Zero'. This could draw on aspects of the SBTi's Net Zero Standard and Voluntary Carbon Market Initiative (VCMI)'s draft Code of Practice. 'Net Zero' should only be claimed by organisations once almost all emissions are reduced and the remaining are neutralised by permanent removals.
  - Building on the above guidance on appropriate activities and Net Zero business claims, set out plans to turn this into regulation or other formal channels, possibly through a statutory definition, the Competition and Markets Authority (CMA) or UK Environmental Reporting Guidelines.
- Continue efforts to protect and raise the integrity of carbon credit projects, in the UK and globally, and to ensure VCMs are resulting in lower overall global emissions and positive wider impacts.

  - As they emerge, extend the UK registry to include all land-based carbon credit projects as appropriate. Continue to take steps to ensure strong transparency across carbon credits from the UK.
  - Use global influence to support efforts for a raised global standard for carbon credits. This could include integrating the Integrity Council for the Voluntary Carbon Market (ICVCM)'s Core Carbon Principles into a UK British Standards Institute (BSI) standard, required in UK Environmental Reporting Guidelines, to encourage existing standards to adopt ICVCM's Core Carbon Principles.
  - Develop an approach on Corresponding Adjustments.
- Support the modest but useful role VCMs can play in the UK Net Zero pathway, in tandem with other measures.
  - Prioritise mechanisms other than VCMs to stay on track or go ahead of the Net Zero pathway, such as regulations, financial incentives and other market mechanisms.
  - As recommended elsewhere, the Government's UK Land Strategy due in 2023 must coordinate changes in land use needed as part of the Net Zero transition. It should include a consideration of the role of VCMs within this.
  - Set out what role (if any) VCMs could play within the Government's strategy for developing engineered removals.
- Ensure that VCMs consider and integrate with wider environmental, public and community benefits to build resilience and prevent unintended negative outcomes.

Source: CCC (2022) *Voluntary Carbon Markets and Offsetting.*

(f) Advisory group work

Since our last Progress Report two advisory groups convened by the CCC have published independent reports, which have informed our indicators and policy scorecard, and are summarised in Boxes 15.3 and 15.4 below.

Our Expert Advisory Group on workers and skills published an independent report on what is needed to ensure the skills system is supportive of Net Zero.

Box 15.3
Advisory Group – Skills and Net Zero

The CCC convened an expert advisory group, led by Professor Dave Reay, on workers and skills to support and critically evaluate our analysis of the impacts of Net Zero on workers and skills needs in the UK (Box 15.1). In parallel, the group developed a report independently of the CCC that provided advice on what is needed from the UK Government on skills policy, and was published in May 2023.

The report summarised the key takeaways from the Net Zero Workforce brief in relation to skills needs and assessed current policy, funding and governance within the UK skills system that relates to Net Zero.

The report outlines key risks, opportunities and based on these outlines recommendations across each level of the skills system:

- **Schools.** Government to play a supporting and coordinating role for the many education providers and organisations already working to enhance school education for Net Zero, and provide targeted support for those schools least able to engage with Net Zero.
- **Higher education.** Strategic plans of higher education institutions to be updated to address Net Zero skills needs, with Net Zero-focussed continuous professional development provided for all teaching staff.
- **Further education.** Government to review Further Education support and funding for Net Zero skills, at a devolved and regional level, and to ensure sufficient funding to Local Skills Improvement Plans (or DA equivalents) to allow in-depth assessments of Net Zero skills needs in each area.

- **Wider skills and education system.** Government to develop a green careers marketing campaign, underpinned by enhance careers support, and to integrate Net Zero skills considerations into other areas, such as the recommended 'Net Zero Test' and the existing 'Contracts for Difference' scheme.
- **Talent attraction and retention.** In light of international developments such as the Inflation Reduction Act, Government to update its approach to talent attraction and retention in the UK, such as through the Global Talent and Graduate Route schemes.
- **Governance.** Government to embed devolved administration plans in its Net Zero and Nature Workforce Plan in early 2024, and to strengthen coordination mechanisms for Net Zero skills between the UK and devolved administrations.

Source: Professor Dave Reay (2023) *Skills and Net Zero.*

We invited BCC to convene an Advisory Group on Business, who published 'The Power of Partnership - Unlocking business action on Net Zero' summarising their own insights into barriers to business Net Zero action, and setting out key asks of Government.

Box 15.4
Advisory Group - The Power of Partnership - Unlocking business action on Net Zero

In 2022 the CCC invited the British Chambers of Commerce (BCC) to convene a group of business representatives from across different sectors and regions of the UK, to consider what barriers and opportunities there are for business to accelerate action towards Net Zero.

The Advisory Group on Business met four times and shared insights from their professional experiences in implementing Net Zero across a range of business roles – from measuring emissions and setting targets, to shifting investment and procurement practices, collaborating across supply chains and influencing consumers and policy.

Case studies from members of the group capture some examples of good practice by UK businesses in responding to Net Zero, such as:

- **Embedding Net Zero into business planning and decision making**, for example by implementing an internal carbon price, developing short-term emissions-related KPIs and requiring business teams to consider climate impacts as part of investment decisions.
- **Unlocking green investment**, for example through long-term investments low-carbon start-ups and leveraging infrastructure debt to support clean energy projects across the UK.
- **Adopting low-carbon solutions which deliver operational efficiencies and working collaboratively to reduce 'Scope 3' emissions**, for example by setting supplier standards and convening supply chain partners to understand support needs.
- **Supporting low-carbon innovation in the UK**, for example by establishing pilot facilities to test and refine new technologies and methods and using corporate procurement to drive demand for emerging technologies.
- **Informing the public about Net Zero and promoting low-carbon consumer choices**, for example by integrating sustainability into mainstream media content and making robust, science-based Net Zero claims.

These insights are presented in the group's independent 'The Power of Partnership - Unlocking business action on Net Zero', published in June 2023. The paper presents five opportunities to catalyse business action on Net Zero provided Government puts in place a supportive policy environment.

Key actions for business and Government are summarised below:

- **Opportunity 1: Integrity and transparency of impact and actions.**
  - Actions for business: Set robust science-based targets, develop credible Net Zero plans and integrate Net Zero throughout their company performance measures.
  - Actions for Government: Set clear, robust and proportional requirements for companies to report emissions and the actions taken to reduce them, including to guide the appropriate use of carbon offsets.

- **Opportunity 2: Investment into Net Zero solutions.**
  - Actions for business: Increasingly invest in commercially viable low-carbon solutions and seek opportunities to scale up Net Zero aligned investments.
  - Actions for Government: Co-develop technology route maps for key sectors and a Green Taxonomy to send clear signals as to which technologies and sectors to invest in. Address the balance of incentives for low-carbon alternatives and provide access to public backed loans and grants for SMEs.
- **Opportunity 3: Implementing Net Zero through supply chains, procurement, and infrastructure.**
  - Actions for business: Integrate Net Zero into procurement and collaborate with customers and suppliers to reduce emissions within business models, operations and supply chains.
  - Actions for Government: Enhance support for SMEs and accelerate delivery of Net Zero infrastructure priorities (including removing planning barriers, addressing delays to upgrade the electricity grid and charging network).
- **Opportunity 4: Innovative industries and workers.**
  - Actions for business: Design, provide proof of concept, and market innovative Net Zero solutions and proactively consider future Net Zero skills needs and how they can develop their workforce.
  - Actions for Government: Review funding and finance for Net Zero research and development, early and mid-stage innovation and late-stage commercialisation. Set out a plan to deliver thee pipelines of skilled people required to deliver Net Zero.
- **Opportunity 5: Influence of business on society.**
  - Actions for business: Channel consumer influence in support of Net Zero societal changes and technologies – helping to educate, encourage and enable the public.
  - Actions for Government: Coordinate a long-term public engagement strategy which includes media and communications sectors.

In addition, the group recommended the following transformative actions to deliver a step-change in UK business action on Net Zero:

- Government should establish a new **Net Zero partnership** approach with business to strengthen collaboration with the private sector around accelerating delivery of Net Zero and boosting the uptake of low-carbon solutions throughout society.
- Government and businesses should introduce a **Net Zero test** to ensure integrity of decision making and spending.
- Government should consider targeted reforms to the tax regime, capital allowances and lending requirements to **unlock greater flows private sector green investment.**
- Government and businesses should **prioritise Net Zero within procurement** policies and practices to drive demand for Net Zero products, services and practices throughout supply chains.
- Government should take a **strategic approach to identifying, enabling and incentivising Net Zero innovations** in the UK.
- Government and business should **develop a compelling consumer offer** to incentivise and empower the public to adopt low-carbon lifestyles and products.

The recommendations from the Advisory Group on Business have partly informed our recommendations to Government and we will consider the group's manifesto as part of our dedicated report looking at business action in the next year.

Source: Advisory Group on Business (2023) *The Power of Partnership - Unlocking business action on Net Zero.*[24]

(a) People and business

There has been some policy progress in relation to business, the public, workers and fair funding. However, significant risks remain for all four areas. Table 15.1 summarises our assessment of progress (based on the criteria outlined in Annex 1) and what needs to be addressed. The detailed recommendations for these cross-cutting enablers are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 15.1.

The policy assessment in this report focuses on measures to reduce emissions, but cross-cutting enablers will also be important to ensure the UK is adapted to the impacts of climate change. In the CCC's recent reports - Progress in adapting to climate change – 2023 Report to Parliament, Investment for a well-adapted UK, and Resilient Supply Chains – we set out a number of recommendations in this area. These include strengthening adaptation reporting requirements in the Sustainability Disclosure regime, public financial institutions creating adaptation financing strategies and including community engagement activities under NAP3.

Table 15.1
Policy scorecard for people and business

Theme	Ambition and timelines of proposals	Delivery mechanisms (including funding and incentives)	Overall assessment
Public engagement and green choices	O	Y	O

Progress:

- In the March 2023 Net Zero Growth Plan the Government said it will set out further detail on how to increase public engagement on Net Zero.[25] This includes setting out how to support public awareness through digital platforms and developing a roadmap explaining Net Zero plans and proposals. It also highlighted that DESNZ and Defra have expanded capacity for behavioural research for climate through an Energy & Climate Behavioural Science Framework to enable rapid procurement of behavioural research.
- In July 2022, the Government launched an online energy advice service to provide homeowners with advice on how to improve their home's energy efficiency and save money.
- In December 2022 the Government launched its campaign 'It all adds up' to encourage households to reduce energy and save on bills, including behaviour change measures such as reducing boiler flow temperatures and turning down radiators. On their 'Help for Households' website they included similar energy saving tips for saving money.[26] In the March 2023 Net Zero Growth Plan the Government committed to reviewing further advice and measures as part of this campaign.
- In the March 2023 Net Zero Growth Plan the Government said it will further pursue the role of ecolabelling for a wider range of products and services and intend to bring in new recyclability labelling on packaging.
- The Government held a public dialogue on biomass and bioenergy with carbon capture and storage, and the Government Office for Science commissioned a public dialogue to inform its April 2023 Net Zero Society Foresight project.[27,28] The project entailed public deliberations of

different Net Zero scenarios, which included different levels of aviation demand and meat and dairy consumption.

- In terms of supporting the public to make green choices by making them attractive and affordable, the Government has introduced a number of policy interventions (see sector chapters for more detail). For example, in January 2023 the Government introduced a £2 cap for single journey bus fares in England, incentivising greener travel.

To be addressed:

- In the March 2023 Net Zero Growth Plan the Government said it will construct a guiding framework, in conjunction with partners and trusted messengers, to amplify Net Zero messaging. While this is welcome, in the same month the Government Communication Plan for 2023-24 was published, with minimal mention of climate change, except for noting plans to persuade consumers to adopt energy efficient behaviours.[29]
- Participatory and deliberative methods need to be embedded in the Net Zero policy-making process, where appropriate (recommendation R2022-130).
- Further work is required to embed key pillars of behavioural science into policies to make green choices easier (recommendation R2022-130)
- A public engagement strategy remains much-needed, prioritising sectors and areas where Net Zero policies require a high pace of change or highly visible technological change, and including priority adaptation actions individuals can take (recommendation R2022-139).
- In the design and advertising of policies, government departments should utilise 'moments of change' or 'windows of opportunities' (recommendation R2023-160).
- Important data gaps on societal indicators, including consistent tracking of support for climate policies, remain. The Government should extend information gathering on societal attitudes in relation to green choices, and Net Zero policies in order to build a better understanding of public behaviours and support for Net Zero and adaptation policy options (recommendation R2023-161).
- To empower people to make green choices, the Government needs to communicate clearly what the most effective ways are for households to reduce emissions, and demonstrate leadership in adopting these green choices (priority recommendation R2023-162). Information alone is not sufficient - it must be accompanied by implementation of policies that both make low-carbon choices easy, attractive and affordable.

Workers and skills	R	O	O

Progress:

- The Green Jobs Delivery Group continued to meet through 2022, following its launch in May 2022. In March 2023, Government announced it would publish a Net Zero and Nature Workforce Action Plan in early 2024, building on the Group's findings.[30] In March 2023, Wales published a Net Zero Skills Action Plan, following Scotland's 2020 Climate Emergency Skills Action Plan.[31,32]
- To help address significant data gaps on current levels of employment in specific key growth occupations (e.g. home retrofit coordinators), in March 2023, ONS provided an initial definition of 'green' jobs and committed to publish occupation-based statistics on green jobs.[33]
- Since the passage of the Skills and Post-16 Education Act in April 2022, Local Skills Improvement Plans (LSIPs) are required to include consideration of the skills, capabilities or expertise required in relation to climate change mitigation and adaptation.[34]
- The Government announced the establishment of an Energy Efficiency Taskforce in Autumn 2022, with a focus on the role of the private sector and the stimulation of investment. This launched in Spring 2023, with an aim to 'reduce skills gaps' and 'accelerate pathways to accreditation'.
- Some sector-specific funding has been provided to support skills development. For example, in March 2023, Government announced an additional £5 million to support low-carbon heating training, expected to support around 10,000 training opportunities. Government is also providing funding to support engineers and technicians to take up training through the Home Decarbonisation Skills Training competition which launched in September 2022.

	• In July 2022, the Institute for Apprenticeships and Technical Education (IfATE) put out a call to the building sector 'seeking more trailblazer group members for the Retrofit Co-ordinator and Energy Efficiency Assessor apprenticeships', with the aim of getting a standard completed in 2023. **To be addressed:** The UK Government is yet to publish a detailed strategy or action plan for Net Zero skills. Scotland and Wales have published Net Zero skills action plans, but key dates, responsibilities and timelines are still required (priority recommendation R2022-128). As part of a Net Zero Skills action plan: • Government should publish a detailed Net Zero skills roadmap, outlining the relevant skills standards, frameworks, and qualifications that need to be developed or updated, including a delivery timeline (recommendation R2023-168). • Government should address barriers to employment and training opportunities, especially for under-represented demographics. A lack of diversity in these sectors limits the effective delivery of Net Zero and means people with these characteristics are not included in the opportunities Net Zero brings (recommendation R2023-173). • Government should assess the impacts for workers and communities affected by industries that are expected to experience job losses as a result of the Net Zero transition (Box 15.1), including by providing reskilling packages and tailored support to transition to alternative low-carbon sectors (recommendation R2023-169). • As noted in Chapter 4, Chapter 5 and Chapter 6, Government should focus attention within its plan on sectors which will need to grow rapidly to support the transition, such as buildings and EV manufacturing (Box 15.1), and on areas which could grow in particular regions, but are exposed to international competition, such as industry (recommendations R2022-070, R2022-247). In addition, the Government should also develop a public-private partnership with a clear definition of responsibilities to help to coordinate action across government, businesses, local authorities, education providers and workers, aiming to grow and meet demand for workers in sectors that are key to the Net Zero transition (recommendation R2023-175). While Government should not let limited data delay action, in parallel to developing plans for Net Zero skills, it should address evidence gaps, which are outlined in our Monitoring Framework.		
Business and finance	Y	O	O
	Progress: • The updated Green Finance Strategy included some promising new commitments on consulting on regulating Environmental, Social and Governance (ESG) rating providers, a call for evidence on 'Scope 3' reporting and the publication of 'Investment Roadmaps' in key sectors (hydrogen, heat pumps and CCS have since been published).[35] • The Government's wider package of decarbonisation updates on 30 March included some encouraging progress, including a consultation on addressing carbon leakage, a commitment to decouple gas and electricity pricing and adoption of most of the recommendations from the review of regulation for innovation in green industries.[36] • The Transition Plan Taskforce has published a draft framework for larger companies to disclose Net Zero Transition Plans, due to be mandated by 2024.[37] It incorporates CCC suggestions around ensuring a holistic approach, strengthening transparency and comparability, and considering Just Transition issues. The Government confirmed in the Green Finance Strategy that it intends to apply reporting to requirements to both listed and private companies. • The UK Infrastructure Bank's strategic plan identifies delivering Net Zero as one of its two main objectives.[38] The sectors and prospective investment opportunities identified in the plan are broadly consistent with delivering Net Zero. Provision of low-cost finance to local authorities could be transformative for local Net Zero implementation. • To clamp down on greenwashing, the CMA is reviewing the green claims associated with a range of 'Fast Moving Consumer Goods', while the FCA has set out new rules governing the use of terms such as 'ESG' and 'sustainable'.[39] The CMA published guidance to enable		

- Establishment of the Net Zero Council should improve coordination between Government and the private sector. The Government also plans to streamline resources for SMEs through the UK Business Climate Hub and launch a new energy advice service later this year.
- The Government is working with the British Standards Institute to develop nature market standards for investment in carbon. In June 2022 VCMI published a draft claims Code of Practice to guide how carbon credits can be voluntarily used by businesses.[41]
- The Government has committed to providing businesses with relief from their energy bills from September 2022 through to April 2024. The initial scheme provided relief above fixed prices set by the Government. The cost of energy has been cited as a key barrier to capacity to invest in Net Zero, but also a driver to reduce energy use.

To be addressed:

- Chris Skidmore's independent review of Net Zero emphasised the need for a decisive UK response to the US Inflation Reduction Act and EU Green Industrial Plan (see Chapter 2 for more detail).[42] While the Government response accepted some of the Review's recommendations (see below), it has been reluctant to promise significant sums of new money or deploy fiscal incentives to support key Net Zero industries in the UK. Government should set out its priorities for developing emerging Net Zero industries and technologies in the UK and use the Autumn Statement to put in place strong signals to stimulate their development and deployment (recommendation R2023-172).
- Notable gaps in the Government's response to recommendations in Chris Skidmore's independent review of Net Zero include support for SMEs, frameworks for long-term funding certainty (aside from CCS), certainty around commercial building energy efficiency standards, the adoption of a Net Zero Charter mark for firms and a review of policy incentives including the tax regime (recommendation R2023-195).
- Key measures summarised in the Green Finance Strategy are yet to be implemented and should be put in place as soon as possible, including the Green Taxonomy, a mechanism to track investment flows and Solvency UK (recommendation R2023-084).
- Direction and governance around the appropriate use of voluntary carbon offsets is urgently needed and has not yet been addressed by the Government. Future UK implementation of the VCMI's draft claims Code of Practice should make clear the label 'Net Zero' can only be used once nearly all emissions are reduced (priority recommendation R2023-165, recommendations R2023-166 and R2023-167 and Box 15.2).
- The Public Procurement Bill being considered by Parliament no longer has a reference to meeting the UK's climate commitments.[43] Government should capitalise on the significant potential for Government to drive delivery of Net Zero, extending coverage of climate-related procurement requirements and tracking the emissions performance of suppliers and contracts (recommendation R2023-082).
- Building on the welcome creation of the Net Zero Council, Government should consider reinstating the Business Champion, or equivalent (recommendation R2023-085).
- The draft framework of the Transition Plan Taskforce should be implemented in full, with requirements on large private and public companies to report against the framework from 2024. The Government should explain how the suitability of companies' plans will be monitored and assured recommendation R2023-164).
- Government should empower public institutions such as Local Authorities and development banks to provide small businesses with low-cost green loans similar to those provided by the Development Bank for Wales.[44] Government should remove barriers for business tenants to understanding and addressing emissions associated with energy use in rented properties (recommendation R2023-083). SMEs also need better guidance and resources to understand and reduce their emissions footprints (recommendation R2023-163).

Innovation	Y	O	O

Progress:

- In March 2023, the Government published Sir Patrick Vallance's review on pro-innovation regulation for digital technologies, which recommended regulatory flexibility for emerging technologies, promotion and support for key technologies, and international regulatory harmonisation for technologies becoming established.[45] The Government accepted these recommendations and published some details of how it proposes to implement them.
- In May 2023, the Government published a progress report on the Net Zero Innovation Portfolio and the Advanced Nuclear Fund.[46]
- An example of Government support for innovation in emissions mitigation is the Jet Zero Council trying to support cross sector innovation on new planes and fuels. Industry has praised this Council for getting them together, getting them talking to departments beyond DfT and raising ambition of what innovation could do in this area. However, there are many obstacles in the area of Net Zero aviation fuels.

To be addressed:

- The Government should develop an effective mechanism for supporting early-stage start-ups working on new low-carbon technologies. Early-stage technologies need to be pulled through by deployment policy.
- There is also a need for more innovation in climate science projections, climate services and measurement, reporting and verification of greenhouse gas emissions, to improve the accuracy and quality of work in these areas.
- An evidence-based roadmap for the development of new technologies necessary to reach Net Zero should be published, building on Figure 2 of the 'UK Net Zero Research and Innovation Framework: Delivery Plan 2022-2025', providing quantified targets for each relevant technology area and evidence to support each of these targets.[47] This would provide signalling to the private sector to ensure that investment occurs in the necessary areas sufficiently quickly. An Energy Innovation Needs Assessment was published in 2019, but the landscape for energy production, transmission, distribution and use has changed significantly since then.[48]
- Innovation research results must be disseminated with transparent methodologies so that knowledge is built on and not lost.

Fair funding and affordability	R	O	O

Progress:

- The Government provided financial support to households from October 2022 to June 2023 to mitigate the impacts of energy cost increases. The Energy Price Guarantee (EPG) provides a cap on the unit cost of gas and electricity, to an annual equivalent of around £2,500 for a typical household in Great Britain.[49]
- According to the Office for Budget Responsibility, the total cost of energy support, including the energy price guarantee, cost of living payments, similar schemes to support businesses and the cut in fuel duty schemes, will reach an estimated £78 billion from 2022-2024.[50] The Government has introduced the Energy Profits Levy and Electricity Generator Levy to partially fund these energy support schemes, with temporary taxes of 35% and 45% on the profits of oil and gas companies and electricity generators respectively.[51,52]
- The Government continues to support energy efficiency improvements in homes through existing and new policies such as the Local Authority Delivery scheme, Home Upgrade Grant, Social Housing Decarbonisation Fund and Energy Company Obligation (see Chapter 5).[53,54,55,56] Policies also exist to support a switch away from fossil fuels, including the Boiler Upgrade Scheme. Overall, uptake has been low, with criticism largely focused on scheme design and rollout.[57]

To be addressed:

- The Government's response to the energy price crisis missed a key opportunity to provide matching support for energy efficiency measures (see Chapter 5).

	• Overall, there is little targeted incentive to support decarbonisation of low-income households. The Treasury's Net Zero Review recognised the importance of targeted support.[58] However, assessments of distributional impacts are not yet made transparent in policymaking. The Government committed to work with the Office for Budget Responsibility and CCC to develop this process in its response to the Skidmore Review in March 2023.[59] • In the Spring Budget 2023, the Chancellor announced a continuation of the fuel duty freeze and 12-month extension of the temporary 5p cut in rates, while the plug-in electric vehicle grant ended in March 2023.[60,61] Both of these changes have decreased relative subsidies of low-carbon transport options. In order to get widespread uptake of low-carbon technologies, it will be necessary to reduce their costs in all sectors below that of the high-carbon alternatives, while also incentivising demand reduction measures such as home energy efficiency improvements (recommendation R2023-170). • As part of this, an overarching review is needed from the Government on how tax and price incentives can correct distortions that penalise low-carbon technologies (recommendation R2023-195). A number of policy distortions still exist, for example the relative levels of taxation in the aviation sector, and subsidies provided to livestock farmers. It is essential to the Net Zero transition that people are not worse off from making low-carbon choices. • The Government is yet to publish the outputs of the Fairness and Affordability Call for Evidence on the options for energy levies and obligations to help rebalance electricity and gas prices and to support green choices, despite a commitment to do so in 2022 (priority recommendation R2022-200).[62] • Finally, the Government should build the evidence and make transparent the climate impacts of major government budgets, spending decisions and spending reviews in coordination with the Office for Budget Responsibility (OBR) (recommendation R2023-177).[63]

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy;* CCC analysis.
Notes: See Annex 1 for the assessment criteria.

(g) Governance

There has been some progress in reshaping the UK's governance system to meet the Net Zero challenge over the past year, particularly through the introduction of a number of new mechanisms that could help address issues with existing structures and processes. However, these will need to deliver as significant risks remain in many areas.

Table 15.2 summarises our assessment of progress (based on the criteria outlined in Annex 1) and what needs to be addressed. The detailed recommendations for these cross-cutting enablers are given in Annex 2 and in filterable and searchable tables on our website, with a reference provided to each unique recommendation ID within Table 15.2.

Table 15.2
Policy scorecard for governance

Theme	Current structures and processes	Mechanisms and timelines for overcoming barriers	Overall assessment
Governance overall assessment	O	Y	O
Clarity and certainty in aligning policy-making processes and key enabling frameworks with Net Zero pathways	O	Y	O

Progress:

- The Government has committed to work with the CCC and OBR through HMT to improve existing processes and develop new methods to consider the climate impacts of spending decisions.
- Defra published the Environmental Principles Policy Statement, which reinforces the status of the five environmental principles that were set out in the Environment Act.[64] This statement makes it clear that ministers are expected to pay due regard to the principles when making policy.
- DLUHC's action plan for reforms to the planning process for nationally significant infrastructure includes 'realising better outcomes for the natural environment' as one of five priority areas for reform.[65] This commits to a new system of Environmental Outcomes Reports, on which the Government has recently launched a consultation.[66] This consultation recognises issues with the current processes, whereby materiality and significance provisions often allow carbon assessments to be bypassed.
- The Government is also consulting on revisions to a number of other national policy statements, with the aim of strengthening their consistency with environmental goals. One of these is a new strategy and policy statement for energy policy, which includes a number of strategic priorities and policy outcomes relating to enabling clean energy and Net Zero.[67] Once enacted, Ofgem and the new Future System Operator (FSO) will have a duty to regard these strategic priorities in fulfilling their functions.
- The publication of the CBDP significantly increased the transparency around how the Government's decarbonisation pathway will be delivered.
  - The quantification of policies and the identification of risks increases clarity around the actions that are needed. However, the framework is currently missing coherent plans to mitigate the delivery risks to meeting the UK's 2030 NDC and the Sixth Carbon Budget.

  - The court ruling that led to the CBDP's publication also demonstrates the effectiveness of the Climate Change Act in requiring the Government to set out not just ambition but also clear delivery policy for meeting this.

- The Scottish Government's Joint Budget Review committed to developing a Net Zero assessment process that would apply during the early stages of policy development, building on a recommendation from the Fraser of Allander Institute.[68]
- The Welsh Government's response to the independent Roads Review introduces strict environmental requirements for any future road-building projects.[69] This provides an example of how a sector-specific Net Zero test can be applied in practice.

To be addressed:

- As highlighted in Delivering a reliable decarbonised power system, currently the institutional responsibilities for strategic planning and delivery of a decarbonised, resilient power system are unclear.[70] A more strategic and joined-up approach to infrastructure planning and investment is also urgently needed.
  - Ofgem and the FSO should have formalised responsibilities with respect to Net Zero and ensuring climate and weather resilience. There is also a need to clearly delineate the respective roles of the Government, Ofgem and the FSO, and set out how they are expected to work together (recommendation R2022-132 and priority recommendation R2023-126).
  - Careful system-level and asset-level planning and design will be needed from the outset alongside proactive decision-making – the Government should either take on the role of designing the overall system or delegate it clearly to another body. The Committee supports the call made in the Skidmore Review for a long-term cross-sectoral infrastructure strategy, spanning liquid and gaseous fuels, electricity, CO_2 and heat networks, to facilitate coordinated planning across vectors (recommendation R2023-127).[71] Investment decisions will need to anticipate new sources of generation and demand out to 2050, and planning must take into account future climate risks.
  - Delays in the planning system and other regulatory processes are key barriers to deploying low-carbon infrastructure. The Government should set up a Minister-led infrastructure delivery group to ensure enabling initiatives for infrastructure build are taken forward at pace, so that investments can be planned, consented and built in sufficient time. This includes ensuring that different parts of the system (including planning frameworks in the different nations) work together constructively to facilitate the changes that are needed (priority recommendation R2023-129).
- The spatial planning system continues to cause issues, with inconsistent and misaligned decisions undermining local efforts to deliver Net Zero actions. The Government has committed to undertake a full review of the National Planning Policy Framework (NPPF) to ensure it contributes to mitigation and adaptation as fully as possible.[72] This review should take place this year, and should ensure that the NPPF is better aligned to the scale and urgency of the Net Zero, nature recovery and adaptation challenges.
  - At present, the NPPF is out-of-date and inconsistent with the level of ambition required to deliver Net Zero and climate adaptation (Box 15.5).
  - The review must ensure that Net Zero and adaptation outcomes are consistently prioritised through the planning system, making clear that these should work in conjunction with, rather than being overridden by, other outcomes such as development viability (the process of determining whether the value generated by a development exceeds the cost of developing it) (priority recommendation R2023-155).
  - Alongside the NPPF, the Government should provide clear guidance to planning authorities on carbon assessment and measuring environmental outcomes. This will help develop more consistent approaches and reduce wasted resource duplicating evidence-gathering (recommendation R2023-174).
- Policy, funding and delivery mechanisms across all sectors of the economy need to be properly aligned to the pace of transition required and must work together constructively towards Net Zero. The Government should continuously improve processes and decision-making to achieve this, ensuring that policymakers are empowered to make more consistent judgements on alignment with the Net Zero pathway and have access to robust evidence that can inform changes to proposals where these are required to improve environmental

	outcomes. Introducing a Net Zero test at an early stage of the policymaking process could help to achieve this (recommendation R2022-143).		
Coordination of Net Zero within central Government	Y	O	Y

Progress:

- The establishment of the new Department for Energy Security and Net Zero (DESNZ) means there is now a department, and Secretary of State, with a specific remit to oversee delivery of the cross-cutting actions needed to reach Net Zero.
- The corresponding establishment of an Energy Security and Net Zero Select Committee in Parliament should also represent a positive step in scrutinising Government's progress.
- At Cabinet level, coordination of Net Zero delivery is overseen by the new Domestic and Economic Affairs (Energy, Climate and Net Zero) Committee, which was established by the new Prime Minister.
  - It is important that this Committee meets frequently and gives priority to the coordination challenges of delivery, as was implied by the previous arrangement of two separate Committees – focussing on strategy and implementation respectively.
  - Unlike the previous Climate Action Strategy Committee, this Committee is no longer chaired or attended by the Prime Minister, which could reduce its political capital.
  - The CBDP confirms that this Committee will receive regular updates on the UK's progress against carbon budgets and its 2030 NDC and act based on them to ensure that policies remain on track to deliver the outcomes that are required.
- DESNZ, alongside Defra and DfT, has developed the Net Zero Systems Tool under the Shared Outcomes Fund.[73] It aims to help the Government to better visualise and manage interdependencies across the Net Zero system, gaining greater insight into the potential wider impacts of different policy options and risks.
- The Government has accepted the Skidmore Review's recommendation to establish a forum to strengthen coordination between the key Net Zero-enabling regulatory bodies.

To be addressed:

- The Committee supports the recommendation in the Skidmore Review that the Government should establish a dedicated unit with specific responsibility for managing cross-departmental risks and dependencies, coordinating cross-cutting actions and holding departments to account for delivery (recommendation R2023-151).
  - There are various ways that this can be achieved. The Skidmore Review recommended that a new 'Office for Net Zero Delivery' should be established, with joint ministerial oversight from DESNZ and the Cabinet Office.
  - In its response to the Review, the Government claimed that the new Department for Energy Security and Net Zero has the capability to fulfil this recommendation.[74] If the Government intends to meet the recommendation fully through the establishment of DESNZ, then it must designate a specific unit within the department with dedicated responsibility for these coordination tasks and sufficient senior empowerment to hold departments to account for delivery. These principles must be embedded within the department's new Outcome Delivery Plan.
  - One of the first tasks of the unit should be to map out the key interdependencies and work with the departments, agencies and devolved and local governments involved to develop an agreed understanding – which will need to evolve and respond in a dynamic manner – clarifying roles and responsibilities for delivery, as well as developing monitoring and accountability mechanisms for keeping progress on track and ensuring system-level resilience is considered throughout.
- The Government has made good progress in embedding Net Zero within training for the Civil Service Fast Stream and Policy Profession and extending Carbon Literacy training across the wider public sector. This should continue, and the Government should also develop plans to support development of the wide range of supporting skills that will be needed across the public sector to meet Net Zero and manage climate risk (recommendation R2022-144).

Collaboration between UK Government and devolved administrations	O	O	O

Progress:

- The CBDP recognises the importance of action taken in the devolved administrations (DAs) in delivering the UK-wide carbon budgets. Where responsibilities and policy delivery tools remain reserved, the DAs have been integrated in the design of policies to deliver emissions reductions.
  - For example, the final consultation on the zero-emission vehicle mandate is being conducted on a four-nations basis, jointly between the UK Department for Transport and the Scottish, Welsh and Northern Irish Governments.[75]
- We assume that both the forum bringing together all the relevant DA ministers, as well as the structures put in place to deliver the UK Government's Net Zero Strategy, continue to operate and provide the space for engagement.
- DAs have developed decarbonisation plans that require close collaboration with Whitehall to deliver emissions cuts across key sectors (e.g. power generation, industry, development of engineered removals). Northern Ireland is now also covered by a Net Zero target and is in the process of developing a decarbonisation delivery plan.

To be addressed:

- There is currently a lack of transparent and effective coordination and delivery structures across the board.
  - Lack of transparency on frequency and process around inter-ministerial meetings on Net Zero delivery continues to make it challenging to monitor the effectiveness of engagement. Examples such as the Net Zero Strategy and the development of Track 1 CCS clusters suggest that past engagement has, at times, been insufficient or ineffective.[76] Inconsistent engagement is not conducive to effective collaboration and risks not taking full advantage of the opportunities offered by shared outcomes.
  - While the CBDP recognises the necessity of action in the DAs to deliver Net Zero, it is still unclear which aspects of delivery the UK Government is relying on the DAs for.
  - There is also no clear policy delivery plan developed in collaboration with the devolved governments to account for areas of joint responsibility. Not only does this create a gap in the necessary delivery structures, it also gives rise to significant risk in critical and time-sensitive areas of emissions reduction – such as land use – due to lack of coordination of different approaches across the nations.
- Processes for collaboration should be continuously reviewed to ensure they are working effectively. As part of this collaboration, the UK and devolved governments should work to identify opportunities for synergies between the UK-wide Net Zero Strategy and DA targets (recommendation R2023-152).
  - Where DAs have more ambitious targets that can credibly be achieved, the UK Government should work in collaboration with the DAs to explore how it can facilitate realisation of this ambition, including by agreeing responsibilities for delivery and understanding interdependencies between reserved and devolved powers. This could help mitigate delivery risks along the UK's pathway.

Partnership between UK Government and local government	O	Y	O

Progress:

- The Local Net Zero Forum has potential to facilitate co-development of policy and delivery mechanisms across UK and local government.[77] It has so far held four meetings and has established sub-groups looking at key themes such as roles and responsibilities, funding and monitoring data. Ongoing co-development continues under the joint chairmanship of DESNZ and the Local Government Association.
  - Alongside the official-level Forum, a political Forum was convened in February 2023, bringing together Ministers and Councillors. This should be useful in agreeing a shared sense of direction and priority.
  - Alongside the Forum, a Net Zero Places stakeholder group is being developed.

- Funding has been continued for the five Local Net Zero Hubs and the Net Zero Go website, showing commitment to building capacity in the local government sector.[78]
- 'Devolution deals' with Greater Manchester and the West Midlands combined authorities committed to providing a single settlement for both areas at the 2025 Spending Review.[79,80] The settlement will cover a pilot for building retrofits and involve reporting requirements. Six other deals have been agreed since August 2022.
- There is potential for the UK Infrastructure Bank (UKIB) to be a strong source of support for local government and others to develop investable proposals for Net Zero programmes, as well as accessing existing Government funds at preferential lending rates (e.g. the Green Heat Network and Local Electric Vehicle Infrastructure Funds), but it is too early to assess delivery.[81] The first pilot projects for an advisory function for local authorities with Bristol, Greater Manchester and West Yorkshire were announced in September 2022.[82] The UKIB will only lend for high value (over £5 million) and strategic projects that are intended to deliver a positive financial return, which leaves a gap for smaller local authority projects.
- In February 2023, Innovate UK announced 31 projects that would receive a share of £2 million of funding through their Net Zero Living Programme.[83] This funding will enable these 'pathfinder places' to develop local plans for cross-cutting actions to address the whole Net Zero system.
- The Government has improved the practical guidance provided to local government across a number of areas, including local transport (through Active Travel England's toolkit and upcoming Local Transport Plan guidance) and energy efficiency in homes (through the EPC Action Plan and the Social Housing Decarbonisation Fund).[84,85,86]
- Both Scotland (through the launch of the Local Heat and Energy Efficiency Strategies) and Wales (through supporting all local authorities to develop plans) have formalised a role for local area energy planning.[87]

To be addressed:

- Co-development of the Local Net Zero Forum should continue, with it playing a central role in design and implementation of policies to deliver Net Zero at a local level.
  - To allow scrutiny and maximise buy-in to the objectives of the Forum, it is vital that both its membership list and Terms of Reference are published (recommendation R2022-140).
  - A process must also be developed to share the insights, lessons learned and next steps from the Forum with all relevant authorities and departments (recommendation R2023-154).
  - The Forum's roles and responsibilities sub-group should prioritise co-developing a framework that sets out an agreed view of the key roles and responsibilities between central and local governments, as well as mechanisms to coordinate delivery of these (recommendation R2022-118).
- Clear, joined-up cross-department coordination and guidance for local government is still lacking. Net Zero implications and regulation are not embedded within other policies which affect local authorities, such as the Environment Act and the NPPF. This must be addressed to enable consistent but appropriately flexible delivery, while allowing local government to also address adaptation and nature recovery goals.
- There are currently large capability and capacity gaps that are preventing many local authorities from benefiting from some of the progress outlined above (e.g. accessing funding streams or implementing guidance). Further long-term funding is needed to address these gaps to allow local authorities to develop credible Net Zero and climate resilience plans that deliver upon the roles and responsibilities that they are expected to meet. This should be achieved by simplifying and consolidating the large variety of funding pots that are available, as highlighted in the Skidmore Review (recommendation R2023-153).
- The UKIB is likely to become a significant part of the governance landscape for Net Zero in time, but it is currently still establishing itself as an organisation, with the UK Infrastructure Bank Act (passed in March 2023) coming into force in May 2023. The Bank's current remit is relatively narrow, which may be limiting its ability to support innovative and valuable projects. HMT should continue to support the UKIB and should assess whether there is scope to adjust its remit slightly to enable it to support a wider range of activities.
- A clear process and governance framework should be set out for energy planning across national, regional and local levels. Planning should be on a whole-system basis and should

include both technical and non-technical evaluation, with the process acting as a locus for meaningful public engagement on decisions (priority recommendation R2023-176).

- There is a need to clarify which organisations should be involved in the process and the scope of plans and decisions to be made at each level. This should be cognisant of the fact that it is not sensible to delay all infrastructure decisions until the Government's 2026 decision on decarbonising heating – local plans could provide a meaningful route for decisions to electrify in advance of that.
- A consistent methodology, standardised assumptions framework and process for coordinating across boundaries are important to support the delivery of high-quality and coordinated plans.
- The governance framework should formalise the status of plans, such that they can be used to inform network planning and target policy (e.g. heat pump deployment).

Source: DESNZ (2023) *Carbon Budget Delivery Plan*; BEIS (2021) *Net Zero Strategy*; CCC analysis.
Notes: See Annex 1 for the assessment criteria.

Box 15.5
Alignment of planning policy with Net Zero and adaptation

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England. It provides the framework within which locally-prepared plans are produced – local planning authorities have a statutory duty to regard these policies when bringing forward plans. It is therefore of key importance that the framework aligns with Net Zero and climate adaptation goals. However, recent research, commissioned by the CCC and carried out by the Centre for Sustainable Energy (CSE) and the Town and Country Planning Association (TCPA), shows the NPPF does not currently enable planning decisions to prioritise climate mitigation and adaptation goals sufficiently.

While the framework discusses reducing emissions in general terms, the Climate Change Act is only specifically mentioned once in a footnote and the term Net Zero does not appear at all. The text fails to explicitly tie planning policies to emissions reduction targets across a range of areas, including economic development, housing provision, sustainable transport, renewable energy generation, fossil fuel development and creating development strategies.

Although the NPPF states that 'the purpose of the planning system is to contribute to sustainable development', the definition of sustainability is broad, giving equal weight to social, economic and environmental considerations, with no mention of the Climate Change Act. Furthermore, the presumption in favour of sustainable development means that proposals can be approved promptly unless they compromise these broad sustainable development principles, with objective housing needs prioritised. This effectively means that climate considerations must compete with other, more clearly measurable, priority areas and are often set aside.

The CSE and TCPA research suggests that the lack of clarity and detailed methods for accounting for climate issues in comparison to other priority areas, such as economic growth and housing, result in practical barriers to prioritising climate in local plans. In addition to practical barriers to including Net Zero in plan-making, there are practical barriers at the decision-making stage. For example, a 2015 Written Ministerial Statement and corresponding National Planning Practice Guidance are currently leading to unpredictable and inconsistent inspectorate decisions on whether local authorities can set standards (e.g. on energy efficiency in buildings) that go beyond those set in national building regulations. This uncertainty acts as a barrier to local authorities seeking to include Net Zero buildings policies in local plans.

There are further detailed points within the NPPF which appear to be misaligned to Net Zero, such as the section on mineral extraction. This places an expectation that planning authorities should actively identify areas where coal extraction may be acceptable and allows schemes to proceed should other benefits be shown to outweigh environmental impacts.

The NPPF was revised in July 2021 but remains outdated in its alignment with climate goals. As part of the Levelling-up and Regeneration Bill reforms, aspects of the framework have recently been consulted on (the consultation closed in March 2023). Carbon impact assessments for plan-making are part of forthcoming promised consultations which may help address the lack of objectivity in targets. If these are to be effective, they must be woven through the NPPF to make clear their importance and how they should interact with other objectives within the framework. More generally, proposed updates to the NPPF must urgently resolve uncertainties in competing priorities and embed climate mitigation and adaptation goals.

Source: Centre for Sustainable Energy and Town and Country Planning Association (2023) *Spatial Planning for Climate Resilience and Net Zero;* DLUHC (2021) *National Planning Policy Framework.*

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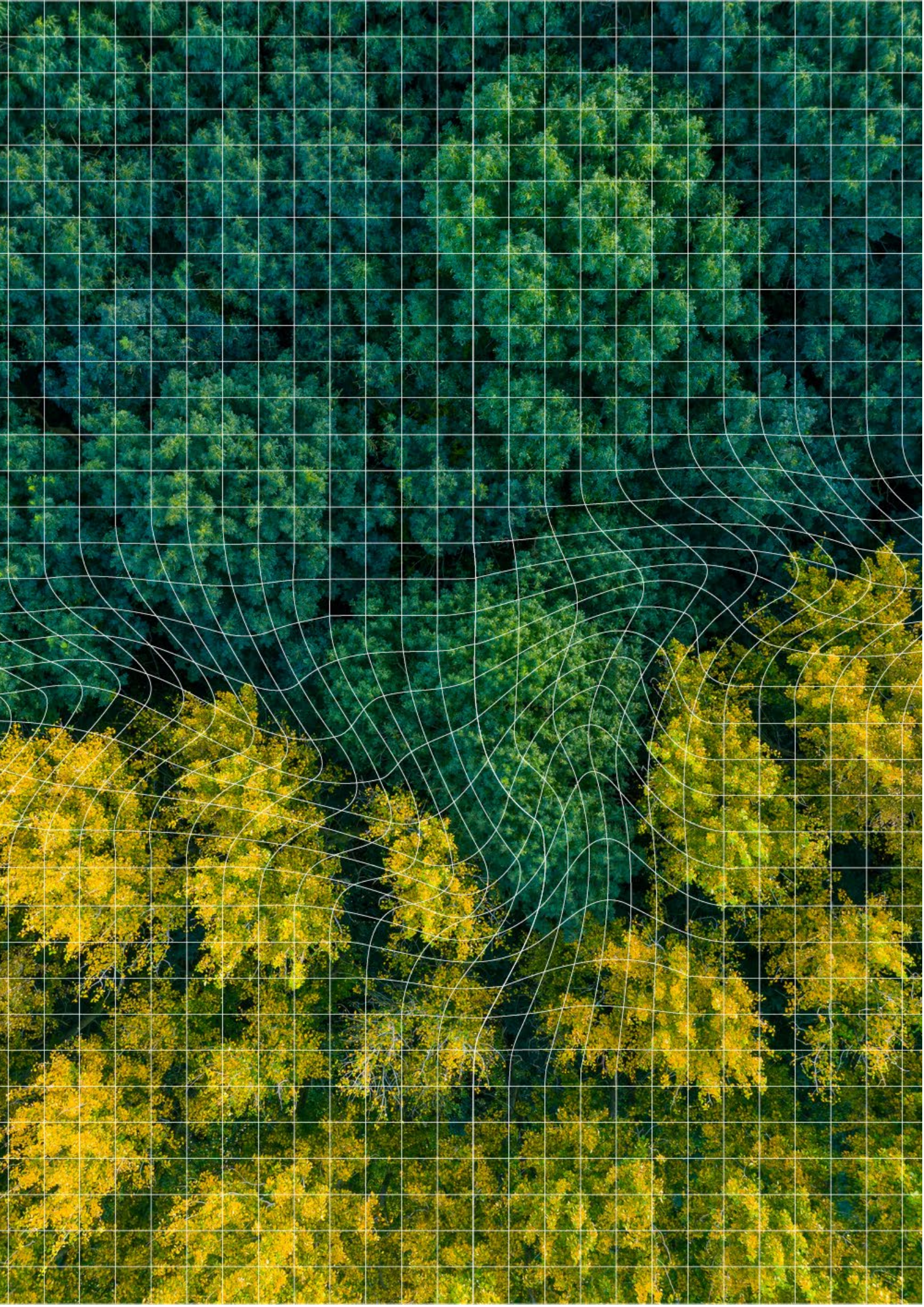

Annex 1: Policy assessment criteria

Our policy scorecards and policy assessment charts track the UK Government's progress and advise on what needs to be addressed in each sub-sector or policy area in order to meet the Government's targets. For the different sectors of the economy (Chapters 3-14) we have assessed the risks relating to the delivery of the Government's targets and scored them using the criteria in Table A1.

For cross-cutting enablers in Chapter 15 we use different criteria. For business and finance, innovation, public engagement, fair funding and affordability, and workers and skills, we have assessed the risks using the criteria in Table A2. We have done a similar exercise for scoring governance using the criteria in Table A3. For international policy and progress in Chapter 2, the assessment criteria is given in Table A4.

Table A1
Scoring criteria for assessing policies and plans for each sector

	Delivery mechanism and responsibilities	Funding and other financial incentives	Enablers in place and barriers overcome	Timeline for future policies	Overall assessment
Credible plans (G)	Proven delivery mechanism that covers all the important elements in the sector	Combination of public funding and plans to encourage private funding is credible	Plans consider enablers, such as governance, fair funding, public engagement, and workers & skills; potential barriers are overcome	Appropriate timelines are given for future decisions and policy development	Credible plans with funding, enablers and timelines in place
Some risks (Y)	Mostly based on proven delivery mechanism, but missing a small number of key elements	Combination of public funding and plans to encourage private funding are credible, but some risks remain	Plans consider some, but not all, of the enablers and/or some barriers remain	Timelines are proposed for some future decisions and policy development, but questions remain	Some adjustment to plans may be needed to mitigate uncertainties and delivery or funding risks
Significant risks (O)	Some plans based on proven mechanism, but several key elements are missing	Some funding commitments but unclear where a significant part of the funding will come from	Plans do not address significant key enablers and barriers	Plans provide only partial indication of the timeline for future decisions and policy development	Plans under development and/or further work needed to enact policies and overcome uncertainties and delivery or funding risks
Insufficient plans (R)	No comprehensive plan or strategy; or plan/strategy missing most key elements	Unclear where the bulk of funding will come from; not yet considered incentives to address these	Plans give negligible consideration of the enablers and barriers	Plans do not indicate when gaps will be filled, or when future decisions will be made	Plans are either missing, clearly inadequate, or lack funding, and new proposals are needed

Table A2
Scoring criteria for assessing policies and plans – for cross-cutting enablers

	Ambition and timelines of proposals	Delivery mechanisms (including funding and incentives)	Overall assessment
Credible plans (G)	Appropriate ambition and timelines for emissions reduction and future decisions and policy development are given	Proven delivery mechanism that covers all the important elements; the combination of public funding and plans to encourage private funding is credible	Credible plans with funding and timelines in place
Some risks (Y)	Suitable ambition and timelines for some future decisions and policy development are given, but questions remain	Mostly based on proven delivery mechanism but missing a small number of key elements; combination of public funding and plans to encourage private funding are credible, but some risks remain	Some adjustment to plans may be needed to mitigate uncertainties and delivery or funding risks
Significant risks (O)	Plans provide only partial indication of the timeline for future decisions and policy development, and ambition is insufficient	Some plans based on proven mechanism, but several key elements are missing; some funding commitments but unclear where significant part of the funding will come from	Plans under development and/or further work needed to enact policies and overcome uncertainties and delivery or funding risks
Insufficient plans (R)	Plans do not indicate whether or when gaps will be filled, or when future decisions will be made	No comprehensive plan or strategy, or plan/strategy missing most key elements; unclear where the bulk of funding will come from; not yet considered incentives to address these	Plans are either missing, clearly inadequate, or lack funding, and new proposals are needed

Table A3
Scoring criteria for assessing policies and plans – for governance

	Current structures and processes	Mechanisms and timelines for overcoming barriers	Overall assessment
Credible plans (G)	Coordinating structures and governance processes are proven to be effective and expected to be suitable to enable delivery of the actions required	Suitable mechanisms and appropriate timelines have been established to improve existing structures and processes	Credible plans with funding and timelines in place
Some risks (Y)	Coordinating structures and governance processes have potential to be effective, but are currently missing and/or unproven in a small number of key elements	Mechanisms and timelines are proposed to improve existing structures and processes, but questions remain	Some adjustment to plans may be needed to mitigate uncertainties and delivery or funding risks
Significant risks (O)	Coordinating structures and governance processes are at least partially in place, but several key elements are missing and/or unproven	Plans provide only a partial indication of what mechanisms and timelines will be used to improve existing structures and processes and/or how these will address key barriers	Plans under development and/or further work needed to enact policies and overcome uncertainties and delivery or funding risks
Insufficient plans (R)	Coordinating structures and governance processes are missing most key elements	Plans do not indicate how or when gaps will be filled, or when future decisions will be made	Plans are either missing, clearly inadequate, or lack funding, and new proposals are needed

Table A4
Scoring criteria for assessing policies and plans – for international

	Ambition	Delivery	Overall assessment
Credible plans (G)	Appropriate ambition and timelines for domestic and international policy are given and communicated	Decisive public action in the UK and abroad that delivers against expressed strategic aims and contributes to international climate progress	Appropriate ambition that is clearly defined and communicated and backed up by public action
Some risks (Y)	Suitable ambition and timelines for some future decisions given, but ambition in some areas is lacking or uncertain	Some evidence of positive public action that delivers against strategic aims on international climate; action has been delayed or is missing in some areas	Ambition is supported by delivery, but gaps remain in both areas
Significant risks (O)	Plans provide only partial indication of the timeline for future decisions and ambition is insufficient	Some evidence of positive public action against international climate aims, but several examples of contradictory or regressive developments	Significant risks to UK international climate progress posed by gaps in ambition and delivery or contradictory and regressive developments
Insufficient plans (R)	Plans do not indicate whether or when gaps will be filled, or when future decisions will be made	No positive action being taken; UK developments on international climate do not reflect its stated aims or contribute to global progress	Ambition is unclear or insufficient and delivery does not contribute to international climate progress

Annex 2: Departmental recommendations

The CCC's departmental recommendations set out the steps required by each Government department and other key bodies to stay on track to meeting the UK's climate targets. This year, we present 300 recommendations, over half of which were carried forward from our previous progress report.

Recommendations are carried forward if they are not fully achieved, or if they require ongoing action. Where a recommendation is carried forward, the wording is updated to reflect any changes in context.

The tables contain only the recommendations where the given department has primary responsibility. We include recommendations for Scotland, Wales and Northern Ireland, but only those with priority status; there are more detailed recommendations made in country-specific reports. The CCC has also made recommendations on adapting to climate change in our recent progress reports on adaptation.

We have introduced unique ID numbers to make it easier to identify individual recommendations. These ID numbers also highlight the year in which the recommendation was first made (starting from 2022).

The recommendations are available in filterable tables on our website, along with our assessment of progress on recommendations made last year.

1. Recommendations for Cabinet Office and Number 10

ID	Sector	Recommendations for Cabinet Office and Number 10	Timing
R2022-087	Buildings: Public buildings	Ensure that public-sector organisations (including those not captured by Greening Government Commitments) have the resources required to reduce energy use and emissions from their buildings in line with Government targets. Monitor progress across the public sector, enabling organisations which are underperforming to be identified and put measures in place to help those organisations which are failing to meet targets. **Primary responsibility: CO & Number 10** Supporting actors: DESNZ; Defra	2023
R2022-143	Cross-cutting: Governance	Ensure that all policies, funding and delivery mechanisms are properly aligned to the pace of transition required and work together constructively towards Net Zero, for example through introduction of a Net Zero test. **Primary responsibility: CO & Number 10** Supporting actors: DESNZ; HMT; Scotland; Wales; N. Ireland	Ongoing
R2022-144	Cross-cutting: Governance	Extend the delivery of climate skills training across the Civil Service, wider public sector and local authorities. Consider what wider supporting skills (e.g. delivery, coordination, legal, financial) will be needed in the public sector to enable effective delivery of the transition to Net Zero and climate risk management. **Primary responsibility: CO & Number 10** Supporting actors: DESNZ; Scotland; Wales; N. Ireland	Ongoing
R2023-152	Cross-cutting: Governance	Review and improve processes for collaboration with the devolved administrations, including by working together to identify opportunities for synergies between UK and devolved delivery plans. **Primary responsibility: CO & Number 10** Supporting actors: DESNZ; Scotland; Wales; Northern Ireland	Ongoing

2. Recommendations for HMT

ID	Sector	Recommendations for the Treasury (HMT)	Timing
Priority: R2022-200	Cross-cutting: Fair funding and affordability	As part of reforms to electricity pricing, remove legacy policy costs associated with the historical deployment of less-mature low-carbon electricity generation from electricity prices. The rebalancing of policy costs should remove market distortions, and manage any adverse distributional impacts of a 'polluter pays' approach. **Primary responsibility: HMT** Supporting actors: DESNZ	2022 Overdue
R2022-236	International: Climate finance	Follow up on commitment to restore UK Official Development Assistance to 0.7% of Gross National Income once the underlying debt to GDP ratio will be falling and the UK will not be borrowing to finance day-to-day spending (now expected by the OBR in 2023/24). Do not introduce additional conditions relating to macroeconomic and fiscal uncertainty. **Primary responsibility: HMT** Supporting actors: FCDO	Ongoing
R2023-150	Surface transport: Active travel	Restore the funding allocated for active travel at Spending Review 2021. **Primary responsibility: HMT** Supporting actors: DfT	Q1 2024
R2022-292	Surface transport: Car demand	Scope and develop options for addressing the fiscal risks from transport's decarbonisation pathway (e.g. road pricing). **Primary responsibility: HMT**	Q1 2023 Overdue
R2022-107	Buildings: Finance	Outline a comprehensive vision to leverage private financing for the retrofit of UK homes and businesses. Plans should be designed to operate in tandem with the other enablers needed to unlock home retrofit at scale, such as better buildings data and public engagement. Financial levers to consider include green stamp duty, green mortgages, energy as a service, property-linked finance, and using the UKIB to de-risk retail investment into home retrofit. **Primary responsibility: HMT** Supporting actors: DESNZ	2022 Overdue
R2022-066	Buildings: Public buildings	Increase the multi-year funding commitments for decarbonisation in public buildings up until 2025 to match the Government's ambition for public-sector decarbonisation and commit to continuing similar levels of funding beyond 2025. **Primary responsibility: HMT** Supporting actors: DESNZ	H1 2023 Overdue

ID	Sector	Recommendations for the Treasury (HMT)	Timing
R2022-106	Buildings: Funding	Recognising that the transition needs to scale up over this decade and that stable funding provides certainty to households, businesses, and public bodies, strongly and credibly signal that the Boiler Upgrade Scheme, Home Upgrade Grant, Local Authority Delivery Scheme, Social Housing Decarbonisation Fund, Energy Company Obligation and public sector decarbonisation will continue to be fully funded as required beyond the spending review period. **Primary responsibility: HMT** Supporting actors: DESNZ	2022 Overdue
R2023-090	Energy supply; Industry	Set out a long-term pathway for the UK ETS cap beyond 2030. **Primary responsibility: HMT** Supporting actors: DESNZ	2023
R2022-323	Waste; Industry	Review the impact of the newly introduced Plastic Packaging Tax and consider opportunities to go further, including integrating an escalator on the price of the tax and the recycling threshold to which it applies. **Primary responsibility: HMT** Supporting actors: Defra	Ongoing
R2022-057	Aviation: Demand	Demand-mitigation measures should be used to address price imbalances between aviation and low-emission forms of surface transport (e.g. rail travel). Taxes should send clearer signals to consumers on the high emissions cost of flying (e.g. by reversing the 2021 cut in Air Passenger Duty). Fair funding mechanisms should be used to ensure alternatives are affordable (e.g. invest in low-emission alternatives for journeys where domestic flights are faster/cheaper than surface transport). **Primary responsibility: HMT** Supporting actors: DfT	2023
R2022-058	Aviation: Demand	Fiscal policy should be used (e.g. taxation, quotas or a frequent flyer levy), alongside improvements in broadband, to embed positive behaviours that have arisen during the pandemic, replacing business travel with videoconferencing and online collaboration. The price of flying should be raised to the point that it acts as an effective signal to consumers that aviation has high emissions costs. **Primary responsibility: HMT** Supporting actors: DfT	2022 Overdue
R2023-172	Cross-cutting: Business	Government should set out its priorities for developing emerging Net Zero industries and technologies in the UK and use the Autumn Statement to put in place strong signals to stimulate their development and deployment. **Primary responsibility: HMT** Supporting actors: DESNZ	Q3 2023

ID	Sector	Recommendations for the Treasury (HMT)	Timing
R2023-195	Cross-cutting: Fair funding and affordability	In line with the Glasgow Climate Pact, commit to phasing out inefficient production subsidies for fossil fuels that lock-in financial resource towards oil and gas extraction, which could result in a breach of the UK's climate budgets or assets that may need to be stranded to comply. **Primary responsibility: HMT** Supporting actors: DESNZ	Q1 2024
R2023-170	Cross-cutting: Fair funding and affordability	Develop an overall review of the market price of low-carbon technologies and develop tax and price incentives so that low-carbon options are affordable and cheaper than their high-carbon alternatives, and demand reduction measures are appropriately encouraged. **Primary responsibility: HMT** Supporting actors: DESNZ	2023
R2023-177	Cross-cutting: Fair funding and affordability	Build the evidence for and make transparent the climate impact assessments of major government budgets, spending decisions and spending reviews in coordination with the Office for Budget Responsibility. **Primary responsibility: HMT** Supporting actors: DESNZ	2023

3. Recommendations for DESNZ

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
Priority: R2023-111	International: UK Climate Envoy	Announce a Secretary of State-level Climate Envoy that acts as the ministerial Head of Delegation before the 2023 UN General Assembly. **Primary responsibility: DESNZ**	Q3 2023
Priority: R2023-190	Buildings: Low-carbon heat	Narrow the scope of the strategic decision prior to 2026 by: publicly affirming that electrical heat is the default option in all new buildings and existing properties off the gas grid; prohibiting connections to the gas grid for new buildings from 2025; setting out clear routes for other properties or areas where electrification or heat networks represent low-regret options; and clarifying the Government's position on the economy-wide priority of use-cases for hydrogen – in particular its potential to help manage peak demands for both heat and electricity, and its role in hybrid heating systems. **Primary responsibility: DESNZ**	2023
Priority: R2022-072	Buildings: Low-carbon heat	Finalise and ensure the timely implementation of plans to prohibit fossil fuel boiler replacements in off-gas grid buildings from 2026 (2024 for large non-residential buildings). Confirm the proposed regulatory mechanism for phasing out fossil fuel boilers, and clarify whether the required powers are devolved or reserved. **Primary responsibility: DESNZ**	2022 Overdue
Priority: R2022-073	Buildings: Energy efficiency	Respond to the 2020 consultation by finalising and implementing plans to require privately rented homes in England and Wales to reach EPC C by 2028 (as the Government committed to in autumn 2021). **Primary responsibility: DESNZ**	2022 Overdue
Priority: R2023-080	Industry: Electrification	Develop policies for industrial electrification that address general barriers such as investment constraints, as well as specific barriers for different industrial sub-sectors. **Primary responsibility: DESNZ**	H1 2024
Priority: R2022-241	Industry: Fuel switching	Create clear incentives for manufacturing facilities not currently covered by the UK ETS to decarbonise. **Primary responsibility: DESNZ** Supporting actors: HMT	Q1 2023 Overdue

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
Priority: R2023-176	Cross-cutting; Buildings; Electricity supply	Set out a clear process and governance framework for delivering credible, coordinated energy planning across local, regional and national levels. This should include guidance on responsibilities for producing, feeding into and implementing plans at each level (e.g. clarifying the respective roles of local authorities, Ofgem, the Future System Operator, network operators and the Government among others); their scope and the decisions to be made at each level; and a required methodology and standardised assumptions framework. This should include providing appropriate support and funding for delivery, ensure that proposals complement existing initiatives (e.g. on heat network zoning) and put in place processes for coordinating across boundaries and incorporating meaningful public engagement into decision-making. **Primary responsibility: DESNZ** Supporting actors: DLUHC; Scotland; Wales; Northern Ireland	Q1 2024
Priority: R2023-138	Electricity supply: Strategy	Publish a comprehensive long-term strategy for the delivery of a decarbonised, resilient, power system by 2035. This should comprise a portfolio approach to developing the full range of low-carbon flexibility options, including demand flexibility, storage, hydrogen, gas CCS and interconnection capacity. It should set out how the low-carbon flexibility required to replace unabated gas will be delivered (12-20 GW of low-carbon dispatchable capacity by 2035), as well as clarifying any minimal residual role unabated gas is expected to play by 2035 (up to around 2% of annual electricity production) and the strategy for unabated gas phase-out. It should cover the strategic decisions required, the milestones and timeline for delivery and the governance and oversight arrangements. It must set out plans and contingencies for addressing key risks on a co-ordinated basis (e.g. network development and connections, planning and consenting, CCS, hydrogen and nuclear). **Primary responsibility: DESNZ**	2023 Overdue
Priority: R2023-129	Electricity supply: Networks; Governance	Create a Minister-led infrastructure delivery group, advised by the new Electricity Networks Commissioner, to ensure enabling initiatives for energy infrastructure build are taken forward at pace and necessary policy changes are implemented across the UK, to deliver a decarbonised and resilient power system by 2035. This should bring together key senior parties in DESNZ, Ofgem, Defra, DLUHC, the Scottish and Welsh Governments, the Future System Operator and asset owners, to deliver necessary policy changes and monitor progress across the initiatives so that swift action can be taken where required to expedite progress. Priorities include overhauling planning and consenting (with strategically important projects prioritised); adequately resourcing regulatory, planning and environmental consenting bodies; reforming the connections process; driving strategic investment; and ensuring the necessary strategic planning and skills/supply chain development is taking place. **Primary responsibility: DESNZ** Supporting actors: Ofgem; Defra; DLUHC; Scottish Govt; Welsh Govt; FSO; Electricity Networks Commissioner	2023

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
Priority: R2023-126	Electricity supply; Fuel supply	Clarify urgently and formalise the institutional responsibilities of the FSO, Ofgem and Ministers, for strategic planning and delivery of a decarbonised, resilient energy system. As part of this, Ofgem's objectives and duties must be updated to drive explicitly the delivery of the statutory Net Zero target, and to ensure climate and weather resilience. In addition to its Net Zero objective, the FSO must have responsibility for ensuring weather and climate resilience through its strategic planning role. The critical role of strategic investment in delivering these outcomes must be recognised, with appropriate mandates and powers for Ofgem and the FSO. The formalisation of responsibilities should be implemented through the Energy Bill and revisions to the Strategy and Policy Statement. As part of the phased approach to the implementation of the FSO, expanding the remit with respect to hydrogen should be considered as a priority. **Primary responsibility: DESNZ** Supporting actors: Ofgem; FSO	2023
Priority: R2023-128	Electricity supply; Fuel supply; Cross-cutting	Identify a set of low-regret electricity and hydrogen infrastructure investments that can proceed now. Either prior to, or as part of publication of the cross-sectoral infrastructure strategy, identify on a whole system and economy-wide basis which areas are unlikely to be suitable for hydrogen (such that electrification and alternatives can be progressed), alongside potential candidate areas for hydrogen. This should be used to inform a set of low-regret investments that can proceed immediately. **Primary responsibility: DESNZ** Supporting actors: FSO	2024
Priority: R2023-093	Fuel supply: Fossil fuel supply	Strengthen and clarify the tests in place for allowing any further exploration and extraction of oil and gas. Stringent tests, in line with the advice in our 2022 oil and gas letter, should be applied at each stage of the licensing and consenting process. These tests should be underpinned by a presumption against exploration and tighter limits on production, be assessed against more ambitious decarbonisation targets (well beyond the 50% target set out in the North Sea Transition Deal), and make use of the best available technology to minimise emissions associated with production. The criteria for approval, including with regard to decarbonisation targets, should be set out clearly and transparently. **Primary responsibility: DESNZ** Supporting actors: NSTA; OPRED; DLUHC	2023
Priority: R2023-073	Waste: Energy from Waste / Incineration	Implement a whole-systems approach to address Energy from Waste (EfW) emissions, including setting out the implications of rising EfW use for waste decarbonisation and confirming plans to include EfW within the UK ETS. A moratorium on additional EfW capacity should be introduced subject to a review of capacity needs and how they align with Government emissions pathways. Further clarity is also needed on how decisions on allowing further EfW plants will be made. **Primary responsibility: DESNZ** Supporting actors: Defra	H1 2024

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
Priority: R2022-207	Engineered removals: Funding	Publish a proposal on the business model for deployment of large-scale (>1 $MtCO_2$/year) engineered removals. **Primary responsibility: DESNZ**	Q1 2023 Overdue
Priority: R2023-162	Cross-cutting: Public engagement	Empower people to make green choices by communicating the most impactful ways to reduce emissions, such as changing car travel, home energy use and dietary behaviours and reducing air travel, and support people to make these choices including through regulation and incentives. Government should lead by example by visibly adopting these green choices. **Primary responsibility: DESNZ**	2024
Priority: R2022-128	Cross-cutting: Workers and skills	Publish an evidence-based Action Plan for Net Zero Skills that includes a comprehensive assessment of when, where, and in which sectors there will be skills gaps specific to Net Zero. This should include consideration of particular barriers to inclusive and accessible labour market entry into occupations needed for the transition and Government plans for action on the skills system to facilitate entry into these occupations. **Primary responsibility: DESNZ** Supporting actors: DfE; DWP; DLUHC; Home Office	2022 Overdue
Priority: R2023-165	Cross-cutting: Business	Publish guidance for businesses on what activities it is appropriate to 'offset' and when. This guidance should include confirmation that a business can only accurately use carbon credits to claim to be 'Net Zero' once nearly all emissions are reduced and the remaining are neutralised by high-quality permanent removals. Formalise this by: establishing 'Net Zero' as a statutory definition; drawing on consumer protection law or advertising standard rules to ensure businesses don't claim 'Net Zero' based on an inappropriate reliance on 'offsetting'; and setting out in UK Environmental Reporting Guidelines and the Net Zero Transition Plan Standard a requirement for businesses to disclose why carbon credits are used rather than direct emissions reduction in net emissions claims. **Primary responsibility: DESNZ** Supporting actors: Defra; HMT	2024
Priority: R2022-119	Cross-cutting: Governance	Develop and begin to implement alternative options to address the range of risks to meeting the NDC and carbon budgets. These should broaden the set of emissions reductions pursued, in particular by implementing policies aiming to empower the public to make green choices and stating clearly how they will contribute to emissions reduction. The timeline for implementing the plans should consider the time it takes policies to take effect. **Primary responsibility: DESNZ**	Q1 2023 Overdue
R2022-230	International: UK NDC	Outline governance and accountability structures for tracking progress against the 2030 NDC target and future UK NDCs, noting that the UK NDC is not in scope of the Climate Change Act (2008) and the Carbon Budgets framework and is therefore not directly accountable to Parliament. **Primary responsibility: DESNZ**	2022 Overdue

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-227	International: UK NDC	Conduct a comprehensive public engagement and consultation process on the target level and delivery of the NDC for emissions reductions to 2035 submitted in 2025. **Primary responsibility: DESNZ**	2024
R2022-229	International: UK pledges and commitments	Set out plans for reducing domestic methane emissions in line with the collective aims of the Global Methane Pledge (a reduction in UK methane emissions of at least 30% from 2020 levels by 2030) and announce an intention to set a longer-term pathway for these emissions in 2023. These plans for contributing to the Global Methane Pledge should be included in the enhanced 2030 NDC the UK resubmits in 2022 for COP27. **Primary responsibility: DESNZ** Supporting actors: Defra	2022 Overdue
R2023-114	International: COP28	Produce a Written Ministerial Statement in advance of COP28 outlining the UK's priorities for the summit and for the conclusion of the Global Stocktake. **Primary responsibility: DESNZ** Supporting actors: FCDO	2024
R2023-110	International: Energy Charter Treaty	The UK should announce intent to withdraw from the Energy Charter Treaty given the insufficient reach of the reforms secured in 2022, the risks associated with remaining in the Treaty and the bargaining power that could be associated with a critical mass of exiting parties. **Primary responsibility: DESNZ** Supporting actors: FCDO	2024
R2022-237	International; Cross-cutting	Set out the Government's approach to domestically achieving aims of priority sectoral COP26 Pledges before COP28. **Primary responsibility: DESNZ** Supporting actors: CO & Number 10; Defra; DfT; FCDO; DBT	2023
R2023-178	Buildings: Low-carbon heat	Ensure that necessary legislation and regulations are in place to commence obligations on boiler manufacturers under the Clean Heat Market Mechanism. **Primary responsibility: DESNZ**	2023
R2023-181	Buildings: Low-carbon heat	Monitor the impact of the Clean Heat Market Mechanism and evaluate its effects on deployment of heat pumps and development of supply chains. Develop contingency plans for other interventions should progress prove insufficient, and develop further options for incentivising uptake of heat pumps beyond the lifetime of the Market Mechanism. **Primary responsibility: DESNZ**	H1 2025

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2023-180	Buildings: Public engagement	Ensure that the Government's energy advice service and funding schemes (such as the Boiler Upgrade Scheme and Great British Insulation Scheme) are adequately publicised to ensure widespread take-up. Deliver strategies to signpost households to advice on energy efficiency and low carbon heating at potential trigger points such as buying a property, obtaining a mortgage, or undertaking home improvements. Deliver strategies to target appropriate advice at hard to reach groups and for difficult to treat properties. **Primary responsibility: DESNZ**	H1 2024
R2022-063	Buildings: Low-carbon heat	Reform energy markets to ensure that heat pumps are cheaper to run than gas boilers, through removing market distortions (whereby policy costs are primarily added to electricity bills), reviewing the scope of carbon pricing, and wider improvements to pricing mechanisms in the electricity market. Ensure that distributional impacts of reforms are carefully considered and appropriately addressed. **Primary responsibility: DESNZ** Supporting actors: HMT	2022 Overdue
R2023-188	Buildings: Low-carbon heat	Consider the case for setting a 2033 date (rather than 2035) for prohibiting replacement gas boilers in residential and commercial buildings. Set out a timetable for implementing regulations, taking into consideration the benefits of providing early policy certainty. **Primary responsibility: DESNZ**	H1 2024
R2023-193	Buildings: Low-carbon heat	Launch a UK-wide multi-year campaign to improve the public's confidence in and understanding of the coming transition for heat. The goals of this campaign should be to provide assurances and combat misinformation, and raise awareness of the schemes and policies which may help households and businesses. This campaign should encourage households and businesses to plan ahead, providing detail on when policy changes will come and how they will affect consumers. It should also be designed and implemented alongside wider improvements to information for consumers, such as the Government's One-stop-show advice service, EPC reform and Green Building passports. **Primary responsibility: DESNZ**	2024
R2023-194	Buildings: Low-carbon heat	Increase policy and funding support for hybrid heating systems to help consumers access them as bridging options where a direct switch to a heat pump or other form of electrical heat is not currently feasible, with a view to helping households transition to technologies which provide 100% low-carbon heat. **Primary responsibility: DESNZ**	2024
R2023-184	Buildings: Public engagement	Provide publicly visible Government support to the hydrogen village trials. Assist local authorities in their role, help to address public concerns and deliver community backing for the trials, including through direct involvement in public engagement if requested. **Primary responsibility: DESNZ**	2023

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-079	Buildings: Heat networks	Implement legislation for heat network zoning in England and Wales this parliamentary session and provide Ofgem with powers to regulate heat networks. **Primary responsibility: DESNZ**	H1 2023 Overdue
R2022-081	Buildings: Heat networks	Publish targets for low-carbon heat networks which explicitly set out their contribution to decarbonising heat, outline plans for converting existing heat networks to low-carbon, and ensure that new heat networks are low-carbon from the start. **Primary responsibility: DESNZ**	H1 2023 Overdue
R2022-065	Buildings: Energy efficiency	Develop and publish new policies (with a clear implementation timeline) to ensure that owner-occupied homes reach a minimum energy performance of EPC C by 2035, through incentives or regulation. This should go beyond voluntary standards for mortgage lenders, and could include requirements at the point of sale, tax incentives, and/or a mandatory standards for mortgage lenders. **Primary responsibility: DESNZ**	H1 2023 Overdue
R2023-189	Buildings: Finance	Respond to the 2020 consultation 'Improving home energy performance through lenders' by finalising and implementing plans to incentivise lenders to improve the energy efficiency of mortgaged properties. **Primary responsibility: DESNZ**	2023
R2022-078	Buildings: Fuel-poor homes	Ensure adequate targets and public funding commitments for decarbonisation in fuel-poor homes, to reduce energy bills and help meet climate targets. **Primary responsibility: DESNZ** Supporting actors: HMT	2022 Overdue
R2023-185	Buildings: Energy efficiency	Urgently identify and address problems with ECO4, ensuring that the rules of the schemes are realistic, and the scheme delivers the targeted rate of energy efficiency installations. **Primary responsibility: DESNZ**	2023
R2022-074	Buildings: Energy efficiency	Set a long-term regulatory standard for social homes to reach EPC C by 2028 and finalise policy plans and a delivery mechanism. **Primary responsibility: DESNZ**	2023
R2023-186	Buildings: Products policies	Develop energy-related products policies in time to enable implementation by 2025. This should include developing and consulting on policies to decarbonise commercial catering equipment, domestic cooking appliances and garden machinery. **Primary responsibility: DESNZ**	H1 2024
R2023-187	Buildings: Energy efficiency	Respond to the 2021 consultation by finalising and implementing plans for minimum energy efficiency standards for the non-domestic private rented sector. **Primary responsibility: DESNZ**	2023

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-075	Buildings: Commercial buildings	Develop and consult on policies for delivering energy efficiency and low-carbon heat in owner-occupied commercial buildings, including proposals to require a minimum EPC rating. **Primary responsibility: DESNZ**	2023
R2022-076	Buildings: Commercial buildings	Implement the performance-based rating scheme for offices and publish timelines for other building types, outlining how timelines correspond to the expected emissions reduction trajectory of commercial buildings in the 2020s. **Primary responsibility: DESNZ**	2022 Overdue
R2022-082	Buildings: Progress monitoring and data	Publish a monitoring framework for tracking delivery of the Heat and Buildings Strategy, setting out how key indicators of progress will be tracked and published. Indicators should include forward tracking of supply chain build-up in key areas, including heat pumps, heat networks, and energy efficiency. **Primary responsibility: DESNZ**	2023
R2022-070	Buildings: Workers and skills	Clearly set out how plans to grow and upskill the workforce will support the Government's pathways for low-carbon heat and energy efficiency and fill the skills gap identified in the Heat and Buildings Strategy. **Primary responsibility: DESNZ** Supporting actors: DfE; DWP; DLUHC; Home Office	2022 Overdue
R2023-179	Buildings: Public engagement	Continue developing the Government's energy advice service, to provide a comprehensive service to provide households and businesses with advice, access to government schemes, and connect them with trusted suppliers. Refine the service to avoid recommending measures that have already been installed (such as solar panels and heating controls). Consider including information on the benefits of developing a home retrofit and renovation strategy and obtaining professional advice (such as from a retrofit assessor/designer or architect). **Primary responsibility: DESNZ**	H1 2024
R2022-077	Buildings: Commercial buildings	Develop plans to encourage SMEs to invest in energy efficiency measures, building on the Government's call for evidence, commissioned research, and BASEE programme. Publish the evaluation of the BASEE programme and funded projects. **Primary responsibility: DESNZ**	2022 Overdue
R2022-080	Buildings: Fuel-poor homes	Publish plans to improve the targeting of support for fuel poor households to retrofit their homes, including through clear steps and timelines to facilitate data sharing between Government departments. **Primary responsibility: DESNZ** Supporting actors: DWP; HMRC	2023

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-069	Buildings: Public engagement	Monitor and publish data on the reach and effectiveness of the Government's energy advice service, ensuring the information offer to households on required changes to their homes is continuously improved in line with these findings, and results in genuine carbon savings. **Primary responsibility: DESNZ** Supporting actors: DLUHC	Ongoing
R2023-079	Industry: Electrification	Provide greater levels of funding for industrial electrification consistent with the support available for hydrogen and CCS. Funding should support the additional operational and capital costs of electrification in manufacturing. **Primary responsibility: DESNZ**	H1 2024
R2023-086	Industry: Energy efficiency	Publish a strategy that sets out how the UK Government will achieve the abatement from industrial energy efficiency committed to in the Carbon Budget Delivery Plan. **Primary responsibility: DESNZ**	2023
R2023-087	Industry: Energy efficiency	Confirm the long-term future (e.g. to 2040) of energy efficiency measures such as the Climate Change Agreement scheme and the Energy Savings Opportunity Scheme, or suitable replacements. **Primary responsibility: DESNZ**	Q1 2024
R2023-089	Industry: Business	Develop policies for decarbonising smaller industrial facilities, focused on those not covered by the UK ETS and/or not in an industrial cluster. **Primary responsibility: DESNZ**	H1 2024
R2023-158	Industry: Energy efficiency	Develop an indicator to track energy efficiency in industry. This might be done by measuring the energy-intensity of a fixed 'basket' of industrial products in a similar way to inflation indices. **Primary responsibility: DESNZ**	2023
R2022-244	Industry: Electrification	Resolve the distortive disincentive against electrification of sites within the UK ETS caused by the design of Climate Change Agreement targets. **Primary responsibility: DESNZ**	2022 Overdue
R2022-240	Industry: Data	Review, invest in, and initiate reform of industrial decarbonisation data collection and annual reporting to enable effective monitoring and evaluation, and policy implementation. This will require additional data collection and reporting to allow for effective tracking of energy efficiency, material efficiency, fuel switching, CCS, including progress developing these measures, and more holistic measurement on a product or whole lifecycle carbon basis. This reform should also be used as an opportunity to remove overlaps in reporting between existing schemes, which place an unnecessary burden on industry. **Primary responsibility: DESNZ** Supporting actors: ONS; Defra	Q1 2023 Overdue

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2023-076	Industry: Electrification	Take action to reduce the electricity costs of industrial users. This should start with greater exemptions for policy costs and network charges, but further measures will be needed to bring the electricity price closer to the gas price. **Primary responsibility: DESNZ**	H1 2024
R2023-077	Industry: Electrification	Set out the Government's approach to ensuring electricity networks have the capacity to meet increased demand from industry. **Primary responsibility: DESNZ**	H1 2024
R2023-157	Industry: Bioenergy	Undertake and publish research on trends and drivers of increased bioenergy use in industry over the past 15 years, to inform the Government's strategy on biomass use and the policy levers to incentivise best use. **Primary responsibility: DESNZ**	2023
R2023-081	Industry: CCS	Publish details of the £20 billion spending commitment for CCUS, including what it is to be spent on and how much is earmarked for different types of CCUS. **Primary responsibility: DESNZ**	Q3 2023
R2023-078	Industry: Electrification	Introduce specific funding for research and development in industrial electrification. **Primary responsibility: DESNZ**	H1 2024
R2022-246	Industry: Innovation	Continue to support innovation and demonstration of fuel switching and CCS technologies for end-use in manufacturing and construction, for example through grant funding and government-backed business models. **Primary responsibility: DESNZ**	Ongoing
R2022-247	Industry: Workers and skills	Design industrial decarbonisation policies in a way that supports and creates jobs, especially in regions with reliance on industrial jobs. **Primary responsibility: DESNZ** Supporting actors: DWP	Ongoing
R2022-250	Industry; Agriculture & land use	Set out a strategy for decarbonisation of off-road mobile machinery to set direction for the private sector. The strategy should include policy proposals, which could include the future of emissions standards, and a proposal for how best local authorities can bring off-road mobile machinery into their regulatory framework for construction within urban areas. **Primary responsibility: DESNZ** Supporting actors: DLUHC; DfT; Defra	Q1 2023 Overdue
R2022-253	Industry; Engineered removals	Finalise the Industrial Carbon Capture (ICC) business model and deliver the first industrial carbon capture contracts to enable final investment decisions on the first ICC projects in H1 2023, consistent with the Government's ambition to deploy carbon capture in at least two clusters by the mid-2020s. **Primary responsibility: DESNZ**	2022 Overdue

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-256	Industry; Fuel supply	Publish a plan for distribution and storage of hydrogen outside clusters. **Primary responsibility: DESNZ**	Q1 2023 Overdue
R2022-261	Industry; Waste	Publish a plan for CO_2 transport from dispersed sites before the end of 2022. **Primary responsibility: DESNZ**	2023 Overdue
R2023-132	Industry; Waste	Develop detailed policies to achieve the level of abatement from resource efficiency set out in the Carbon Budget Delivery Plan, including measures to both reduce consumption and improve the resource efficiency of production. **Primary responsibility: DESNZ** Supporting actors: Defra	2024
R2022-254	Cross-cutting; Industry; Engineered removals; Electricity supply	Finalise and deliver the Transport and Storage Regulatory Investment business model in 2022, consistent with the Government's ambition to establish at least two CCS transport and storage clusters in the mid-2020s. This will require promptly beginning the process of awarding permits and construction of the necessary infrastructure, to ensure that it is ready in time for deployment. **Primary responsibility: DESNZ**	Q1 2023 Overdue
R2022-206	Electricity supply: Supply chains	Identify and address potential key supply-chain bottlenecks for delivering up to 50 GW of offshore wind by 2030, including for investment in ports, adequate vessel capacity, manufacturing capability and floating wind. Take opportunities to link supply chain action to key decision points in offshore leasing and Contract for Difference auctions. **Primary responsibility: DESNZ**	2023
R2023-125	Electricity supply: Flexibility; CCS	Ensure new gas plant are genuinely CCS- and / or hydrogen-ready as soon as possible and by 2025 at the latest. **Primary responsibility: DESNZ**	2025
R2023-124	Electricity supply: Bioenergy; removals	Ensure that large-scale unabated biomass power plants are converted to BECCS as early as feasible, and are not given extended contracts to operate unabated at high load factors beyond 2027. **Primary responsibility: DESNZ**	2023
R2023-139	Electricity supply: Electricity market design	Through the Review of Electricity Market Arrangements, develop a strategy as soon as possible on market design for the medium to long term for a fully decarbonised, resilient electricity system in the 2030s and onwards. It is essential that in introducing changes to market arrangements, this is done in a way that does not deter the investment required to deliver a decarbonised system by 2035. **Primary responsibility: DESNZ**	2023

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2023-127	Electricity supply; Fuel supply; Cross-cutting	Develop a long-term cross-sectoral infrastructure strategy to adapt and build, respectively, the distribution of liquid and gaseous fuels, electricity, CO_2 and heat networks over the next decade. This should be led by DESNZ, drawing on the advice of the FSO and building on the findings of the forthcoming National Infrastructure Assessment. It must have a view to facilitating Net Zero while ensuring climate and weather resilience. A key aim should be to inform and narrow the decision space for future decisions on hydrogen use. **Primary responsibility: DESNZ** Supporting actors: FSO	2025
R2023-109	Industry; Engineered removals; Fuel supply; Waste; Electricity supply	Develop alternative plans for meeting the 2030 NDC in case of delays to abatement and removals that rely on CCS. These plans should outline measures that can achieve emissions reductions in three years or less and include conditions for progress on CCS that will be used to determine whether these contingency measures are progressed. **Primary responsibility: DESNZ**	2025
R2023-143	Surface transport; Electricity supply	Work collaboratively with Ofgem, distribution network operators and local government to develop a clearer and simpler process for delivering new and upgraded connections to the electricity grid. This process should include consideration of local demand forecasts to allow planning ahead to avoid bottlenecks, considering demand for both public charging stations and electrification of van and HGV depots. **Primary responsibility: DESNZ** Supporting actors: Ofgem; DfT	Q1 2024
R2022-003	Agriculture & land use: Coastal and marine	Produce a roadmap to inclusion of saltmarsh and seagrass in the greenhouse gas inventory, and specify a suggested level of inclusion (i.e. Tier 1, 2 or 3), the additional data required to facilitate this, and an indicative timescale for inclusion. **Primary responsibility: DESNZ** Supporting actors: Defra	2024
R2023-096	Fuel supply: Fossil fuel supply	Publish a delivery plan for the decarbonisation of oil and gas infrastructure, as part of, or alongside, an offshore industries integrated strategy. As recommended by the Skidmore review, Government should publish an offshore industries integrated strategy. As part of, or alongside this, a delivery plan should be published for the decarbonisation of oil and gas infrastructure, including a timetable for electrification and the phase-down of production. This should include more ambitious decarbonisation targets (well beyond the 50% target set out in the North Sea Transition Deal), roles and responsibilities, a plan for how decarbonisation will be regulated (e.g. minimum emission-intensity standards) and incentivised, how barriers will be addressed (including around connections, planning and consenting), and sequencing. **Primary responsibility: DESNZ** Supporting actors: NSTA; Ofgem; Crown Estate; Crown Estate Scotland	2024

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2023-095	Fuel supply: Fossil fuel supply	Targets for methane flaring and venting should be strengthened and brought forward. For all facilities that will remain in operation post 2030, flaring and venting should only be permitted beyond 2025 when necessary for safety reasons. **Primary responsibility: DESNZ** Supporting actors: NSTA; Scotland; Wales; Environment Agency; Scottish Environment Protection Agency; Natural Resources Wales	Q3 2023
R2023-099	Fuel supply: Hydrogen supply	Government should clarify its 2030 10 GW hydrogen production commitment in TWh/year and review whether this target is sufficient to meet future demands. Pending the outcome of this, strategic decisions may be needed around the scale of hydrogen use across sectors, or to adjust the level of the target. **Primary responsibility: DESNZ**	2023
R2023-097	Fuel supply: Hydrogen supply	Finalise funding mechanisms and allocate funding to support the development of 10 GW of low-carbon hydrogen production by 2030, ensuring these are designed to limit residual and upstream emissions, but also reflect hydrogen costs in a way that does not bias towards hydrogen where electrification is competitive. **Primary responsibility: DESNZ**	2023
R2023-098	Fuel supply: Hydrogen supply	Accelerate the development of new business models for hydrogen transportation and storage infrastructure, with a view to keeping options open for larger scale hydrogen use by 2030. **Primary responsibility: DESNZ**	2023
R2022-222	Fuel supply; Engineered removals	The Biomass Strategy needs to set out a best-use hierarchy for biomass and address the sustainability of the biomass supply (e.g. through high sustainability standards) required to support the rapid and sustainable deployment of BECCS (for power and biofuels). The Strategy should consider reducing reliance on imports by increasing domestic biomass supply as part of wider land-use changes (including diet change). **Primary responsibility: DESNZ** Supporting actors: Defra	2022 Overdue
R2022-221	Fuel supply; Engineered removals	Continue to take a global lead on further developing and improving UK and international biomass governance and sustainability criteria. **Primary responsibility: DESNZ** Supporting actors: Defra	Ongoing
R2023-121	Aviation; Shipping	Complete legislative changes for inclusion in the Carbon Budgets of international aviation and shipping from the Sixth Carbon Budget onwards. **Primary responsibility: DESNZ**	2024 Overdue
R2022-264	Shipping: Demand	Consider how to avoid the extension of the UK Emissions Trading Scheme to shipping causing displacement of activity to higher-carbon alternative modes (e.g. road freight). **Primary responsibility: DESNZ** Supporting actors: DfT	2022 Overdue

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-304	Waste: Energy from Waste / Incineration	Continue to develop plans for shifting towards an Energy from Waste (EfW) fleet fitted with CCS from the end of this decade. As part of this set out an assessment of potential viability of existing and future EfW sites for CCS and implications for decarbonising the sector. **Primary responsibility: DESNZ** Supporting actors: Defra	2023
R2023-012	Waste: Energy from Waste / Incineration	Start reporting emissions from Energy from Waste (EfW) as a separate source within national greenhouse gas inventories. **Primary responsibility: DESNZ** Supporting actors: Scotland; Wales; N. Ireland	H1 2024
R2022-216	F-gases: F-gas technology replacement	Publish targets for the roll-out from now until 2037 of heat pumps that do not use F-gases as a refrigerant and set out how the Government plans to meet these targets. **Primary responsibility: DESNZ**	Q1 2023 Overdue
R2023-106	Engineered removals: BECCS	Finalise details of the power BECCS business model and launch a process for applications, ensuring consistency with other mechanisms such as the future engineered removals business model and any import standards outlined in the upcoming Biomass Strategy. **Primary responsibility: DESNZ**	2023
R2023-107	Engineered removals: CCS	Clarify whether engineered removals projects are eligible for support as part of the expansion of Track 1 clusters and set out a timeline for this expansion. **Primary responsibility: DESNZ**	2023
R2023-108	Engineered removals: Public engagement	Set out plans for soliciting public views on engineered removals. These plans should cover both education and engagement, ensuring that the public understand and are comfortable with the need for, benefits and potential risks of using these technologies to deliver Net Zero in the UK. **Primary responsibility: DESNZ** Supporting actors: Scotland; N. Ireland; Wales	2024
R2022-209	Engineered removals: MRV	Publish plans for monitoring, reporting and verification systems for engineered removals, noting the recommendations of the 2021 Task & Finish Group report and responses to the consultation on business models. **Primary responsibility: DESNZ**	Q1 2023 Overdue
R2022-211	Engineered removals: Governance	Work with the Interministerial Group for Net Zero, Energy and Climate Change to publish a joint position on the contribution of engineered removals and CCS to meeting UK-wide and DA targets to 2030. **Primary responsibility: DESNZ** Supporting actors: Scotland; N. Ireland; Wales	2023 Overdue

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-210	Engineered removals: Legislation	Take legislative steps to allow for engineered removals to count towards achievement of UK carbon budgets. **Primary responsibility: DESNZ**	2023
R2022-130	Cross-cutting: Public engagement	Embed participatory and deliberative methods in the Net Zero policy-making process, where appropriate, as a means of improving the design of, the acceptability of, and public support for, new policies. Embed key pillars of behavioural science into policies that make green choices easier, ensuring these methods are coordinated across departments. **Primary responsibility: DESNZ**	Ongoing
R2022-139	Cross-cutting: Public engagement	Publish a public engagement strategy that sets out a clear long-term vision of how to engage people and businesses in delivering Net Zero and climate change adaptation, with the aim to develop and maintain support for Net Zero policies, especially where these require a high pace of change and/or highly visible technological change. It should include public communications plans to inform key audiences about the important changes required to deliver Net Zero and adapt to climate change, building understanding of the associated timelines, benefits (including co-benefits) and costs, and impacts on fairness and accessibility. Communications should be designed with the UK's diverse communities in mind. **Primary responsibility: DESNZ** Supporting actors: Defra	2022 Overdue
R2023-160	Cross-cutting: Public engagement	Publish new guidance for government departments for improved targeting of polices aimed at changing behaviours in order to deliver Net Zero and effectively adapt to climate change. This guidance should direct all departments to ensure that the design and promotion of new and existing policies which aim to create behavioural change are targeted at specific 'moments of change/windows of opportunity'. These should be based on well-understood trigger points, such as when individuals change house, job or tenancy, remortgage, or engage in home improvements. **Primary responsibility: DESNZ** Supporting actors: Defra	Ongoing
R2023-168	Cross-cutting: Workers and skills	As part of the Net Zero Skills Action Plan, publish a detailed roadmap of when relevant skills standards, frameworks, and qualifications to net zero will be developed or updated, including a delivery timeline. **Primary responsibility: DESNZ** Supporting actors: DfE; DWP; DLUHC; Home Office	Q1 2024
R2023-173	Cross-cutting: Workers and skills	As part of the action plan for Net Zero skills, the Government should address barriers to employment and training opportunities, especially for under-represented demographics. A lack of diversity in these sectors limits the effective delivery of Net Zero and means people with these characteristics are not included in the opportunities Net Zero brings. **Primary responsibility: DESNZ** Supporting actors: DfE; DWP; DLUHC; Home Office	Q1 2024

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2023-169	Cross-cutting: Workers and skills	As part of the Net Zero Skills Action Plan, publish a strategy for workers and communities in those areas of the economy affected by industries that are expected to experience job losses as a result of the Net Zero transition, including by providing reskilling packages and tailored support to transition to alternative low-carbon sectors. **Primary responsibility: DESNZ** Supporting actors: DfE; DWP; DLUHC; Home Office	Q1 2024
R2023-175	Cross-cutting: Workers and skills	Develop a public-private partnership with a clear definition of responsibilities to help to coordinate action across government, businesses, local authorities, education providers and workers, aiming to grow demand for workers in sectors that are key to the Net Zero transition. **Primary responsibility: DESNZ** Supporting actors: DfE; DWP; DLUHC; Home Office	Q1 2024
R2023-084	Cross-cutting: Business	Implement without further delay key measures presented in the updated Green Finance Strategy, specifically: an internationally aligned Green Taxonomy, Solvency UK and a mechanism to track investment flows. **Primary responsibility: DESNZ** Supporting actors: HMT	H1 2024
R2023-167	Cross-cutting: Business	Build the international evidence base on the impacts on Corresponding Adjustments under Article 6 of the Paris Agreement, including through supporting global initiatives such as VCMI to assess in what country contexts attaching a Corresponding Adjustment can add most value to project additionality and to overall global emissions reduction. **Primary responsibility: DESNZ** Supporting actors: FCDO; HMT	H1 2024
R2023-082	Cross-cutting: Business	Strengthen requirements for suppliers to demonstrate suitable Net Zero targets, plans and actions as part of forthcoming changes to Public Procurement. This includes incorporating Net Zero criteria within procurement contracts, broadening the scope of contracts covered by requirements beyond the current £5 million threshold and introduce metrics to monitor the emissions-performance of key suppliers and contracts. **Primary responsibility: DESNZ** Supporting actors: DBT; HMT; Cabinet Office	H1 2024
R2023-085	Cross-cutting: Business	Continue to collaborate with business through the Net Zero Council and appoint a Net Zero champion for business to drive private sector action in the UK. **Primary responsibility: DESNZ** Supporting actors: DBT	2023

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2023-164	Cross-cutting: Business	Introduce legal requirements without delay on large private and public companies to report against the Transition Plan framework in full, endorse the ISSB standard and set out how firms transition plans will be assessed for credibility and compatibility with the UK's climate targets. **Primary responsibility: DESNZ** Supporting actors: DBIT; HMT	H1 2024
R2023-083	Cross-cutting: Business	Address key barriers preventing SMEs from effectively responding to Net Zero, specifically: requiring landlords to provide relevant energy-use information to tenants and empowering public institutions (such as Local Authorities and development banks) to provide more low-cost green finance to SMEs. **Primary responsibility: DESNZ** Supporting actors: DBT; HMT	H1 2024
R2023-163	Cross-cutting: Business	Improve the provision of guidance and information to SMEs to understand and respond to Net Zero. This should include: expanding the provision of tailored expert advice to SMEs to reduce their emissions - alongside more general resources such as the SME Climate Hub; and simplifying guidance and resources to inform carbon foot-printing - including establishing a national repository for SMEs and partners to access standardised emissions data. **Primary responsibility: DESNZ** Supporting actors: DBIT	H1 2024
R2022-132	Cross-cutting: Governance	Ensure that public bodies with a role in delivering Net Zero have a clear duty to facilitate this and work together. This should apply, for example, to Ofgem and the Future System Operator. **Primary responsibility: DESNZ**	Ongoing
R2023-151	Cross-cutting: Governance	Establish a dedicated unit with specific responsibility for managing cross-departmental risks and dependencies, coordinating cross-cutting actions and holding departments to account for delivery. If the Government intends to achieve this through the establishment of the Department for Energy Security and Net Zero, then it must designate a sufficiently senior unit with dedicated responsibility for delivering this coordinating role and must embed coordination and accountability as key objectives within the department's Outcome Delivery Plan. **Primary responsibility: DESNZ** Supporting actors: CO & Number 10	2023
R2022-140	Cross-cutting: Governance	Publish the Terms of Reference and membership list for the Local Net Zero Forum. **Primary responsibility: DESNZ**	2022 Overdue
R2023-154	Cross-cutting: Governance	Create a process by which the insights, lessons learned and next steps identified by the Local Net Zero Forum are shared with all relevant authorities and fed back to central government departments. **Primary responsibility: DESNZ**	2023

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2022-118	Cross-cutting: Governance	The Local Net Zero Forum, through its 'roles and responsibilities' subgroup, should develop an agreed framework setting out what aspects of Net Zero central and local government are responsible for and how these will be coordinated. This should be circulated around local authorities and other relevant stakeholders to enable input from those not involved with the Forum. **Primary responsibility: DESNZ** Supporting actors: DLUHC; Scotland; Wales; N. Ireland	2022 Overdue
R2023-153	Cross-cutting: Governance	The Local Net Zero Forum must address the question of local government powers, capacity, skills and funding to identify gaps and barriers that could hinder the ability of local government to deliver the roles and responsibilities for delivery of Net Zero that the Forum agrees. This should be used to inform development of an evidence-based approach to clearer, simpler and longer-term funding and resourcing of local authority delivery of Net Zero. **Primary responsibility: DESNZ** Supporting actors: DLUHC; HMT	Q1 2024
R2023-091	Cross-cutting: CCS	Publish a detailed timeline specifying each stage of the process of CCS development for Tracks 1 and 2 of the CCUS Cluster Sequencing Programme from now through to first capture and storage of CO_2 in each cluster and sector, including completion of engineering design, contracts and permitting, construction and commissioning, and publish a plan of how the Government will ensure this timeline aligns with their planned first capture dates for each cluster and sector. **Primary responsibility: DESNZ**	Q1 2024
R2023-059	Cross-cutting: Data	Work with other departments and the ONS to fill the data gaps identified in the CCC's Monitoring Framework (www.theccc.org.uk/publication/ccc-monitoring-framework), with a focus on those the CCC have flagged as high priority. **Primary responsibility: DESNZ** Supporting actors: ONS	Ongoing
R2023-058	Cross-cutting: Monitoring	The Government's annual reporting on progress on progress towards Net Zero should be improved by: (1) explicitly comparing historical data against Government milestones and clearly stating where areas are on or off track, which reports to date have not done; (2) enhancing the suite of indicators tracked by drawing on the CCC's Monitoring Framework; and (3) making this accessible to the public, for example by leveraging the existing cross-government data portal (climate-change.data.gov.uk), as recommended in the Skidmore Review. Progress on addressing climate change should be presented with a level of clarity comparable with the COVID-19 pandemic (coronavirus.data.gov.uk). **Primary responsibility: DESNZ** Supporting actors: ONS	Q1 2024

ID	Sector	Recommendations for the Department for Energy Security and Net Zero (DESNZ)	Timing
R2023-161	Cross-cutting: Public engagement	Collect further information on societal attitudes in relation to green choices and Net Zero policies via surveys and public dialogue activities. This should include extending questions about everyday behaviours and perceived impact of behaviours assessed in the BEIS Public Attitude Tracker to behaviours around reducing air travel and changing diets. In addition, the government should establish regular assessments of attitudes towards potential Net Zero policy options. **Primary responsibility: DESNZ**	Ongoing
R2023-056	Cross-cutting: Transparency	Where possible, publish an estimate of the additional abatement expected from the 'unquantified' plans listed in the Carbon Budget Delivery Plan (CBDP). For example, the emissions savings from transport modal shift proposals can be quantified, but were classified as unquantified in the CBDP. This is needed for a full and fair assessment of whether the Government's would achieve targets. **Primary responsibility: DESNZ**	Q1 2024

4. Recommendations for Defra

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
Priority: R2023-171	Agriculture & land use: Peatlands	Implement a comprehensive delivery mechanism to address degraded peatland and extend current restoration ambition set out by the UK government and the devolved administrations beyond existing timeframes, including through addressing barriers to increasing capacity. Peat restoration targets include the need to remove all low-productive trees (i.e. less than YC8) from peatland (equivalent to 16,000 hectares by 2025), and restore all peat extraction sites by 2035 (equivalent to 50,000 hectares by 2025). **Primary responsibility: Defra** Supporting actors: Scotland; Wales; Northern Ireland	2024
Priority: R2023-102	Agriculture & land use: Agriculture and land use strategy	Publish the land use framework. Set out how this feeds into a wider agriculture and land use strategy that brings together how land can deliver its multiple functions including: reducing emissions and sequestering carbon, adapting to climate change, food security, biodiversity, domestic biomass production and wider environmental goals. The strategy must clearly outline the relationships and interactions with other relevant strategies and action plans across the UK, be spatially and temporally targeted, and aligned with action in the devolved administrations. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q3 2023
Priority: R2023-192	Agriculture & land use: Trees and woodland	Ensure that funding and support are set at the correct level to meet the UK Government afforestation target of 30,000 hectares per year by 2025, and illustrative Net Zero Strategy targets of 40,000 hectares and 50,000 hectares by 2030 and 2035 respectively. Further clarity is required regarding funding beyond 2025. Support for delivery of new woodland creation should integrate with nature and adaptation objectives, and also address contractor availability, capacity to process funding applications, and advice for farmers to transition to woodland management approaches. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2023 Overdue
R2022-251	Industry; Buildings; Agriculture & land use	Publish the timber policy roadmap setting out the policies needed to substantially increase the use of wood in construction. **Primary responsibility: Defra**	Q1 2023 Overdue
R2022-262	Industry; Waste	Set the 'Resource efficiency and waste reduction' target(s), enabled by the new Environment Act powers, in a way that drives the delivery of emissions abatement from resource efficiency set out in the Resources and Waste Strategy and the Net Zero Strategy. This should recognise the role that raw material extraction and the design, longevity and reuse of materials and products can play in reducing the impacts of new product demand, while realising potential co-benefits. **Primary responsibility: Defra**	Q1 2023 Overdue

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2023-133	Industry; Waste	Publish details and timelines on the maximising resources and minimising waste programme in England. **Primary responsibility: Defra**	H1 2024
R2022-320	Waste; Industry	Finalise the Waste Prevention Programme, including by setting out details on additional actions needed to achieve committed recycling and waste reduction targets. **Primary responsibility: Defra**	2023
R2022-322	Waste; Industry	Set ambitious post-2035 recycling targets alongside possible policy options for delivering such targets, including increasing investment to deliver long-term infrastructure needs. **Primary responsibility: Defra**	2023
R2023-065	Agriculture & land use: Farming practices	Build on current research and innovation funding streams, such as the Farming Innovation Programme, to specifically target measures that aim to reduce agricultural greenhouse gas emissions via productivity improvements. **Primary responsibility: Defra**	Q3 2023
R2022-006	Agriculture & land use: Farming practices	Continue to support research and development into low-carbon farming practices, including behavioural, innovation and productivity measures. The risk of a high dependency on innovation and technology to meet GHG emission reductions should be assessed, and integrated with demand-side measures such as diet change and waste reduction. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2023
R2022-029	Agriculture & land use: Low-carbon farming	Set in place action to overcome financial barriers that prevent take-up and innovation in low-carbon farming practices. This should include management incentives under the ELM scheme and approaches set by devolved administrations, grants for capital items and infrastructure, and support for research and development. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Ongoing
R2023-101	Agriculture & land use: CAP reform	Adopt in UK legislation existing baseline land management rules (e.g. cross compliance rules) which offer mitigation benefit. This is to ensure sustainable land management approaches are adhered to irrespective of whether voluntary schemes (e.g. ELMs) are being accessed. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2024
R2023-063	Agriculture & land use: Low-carbon farming	Set out a consistent and robust approach to support farmers to carry out on-farm monitoring, reporting and verification of agricultural and land-based GHG emissions. This should include support to interpret and take action to deliver emissions reduction based on the results. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2024

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2023-061	Agriculture & land use: Low-carbon farming	As part of strengthening the regulatory baseline, introduce regulations under the Clean Air Strategy to reduce enteric methane emissions, specifically under environmental permitting to the dairy and intensive beef sectors. **Primary responsibility: Defra**	2024
R2023-062	Agriculture & land use: Low-carbon farming	Mandate the addition of methane-inhibiting additives to feed products for UK beef and dairy systems. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2025
R2022-027	Agriculture & land use: Diet and demand	Set out how the objective in the Government Food Strategy to 'deliver a sustainable, nature positive, affordable food system' will be achieved, including the mechanisms to address the interaction between food systems and other land use needs, climate, nature, and integrated alongside a public shift towards low-carbon diets. **Primary responsibility: Defra**	Q1 2023 Overdue
R2022-036	Agriculture & land use: Diet and demand	Take low-cost, low-regret actions to encourage a 20% shift away from all meat by 2030, rising to 35% by 2050, and a 20% shift from dairy products by 2030, demonstrating leadership in the public sector whilst improving health. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2022 Overdue
R2022-037	Agriculture & land use: Diet and demand	Introduce policy to support the reduction of food waste at the farm, supply chain and household levels. Food-waste reduction, and its implications, should also be integrated into the recommended Net Zero delivery strategy for the agriculture and land use sectors, as well as in plans for the waste sector. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q1 2024
R2022-010	Agriculture & land use: Peatlands	Ensure incentives are set at the correct level to set a trajectory to achieve 58% of peatland restored by 2035, and 79% under restoration by 2050. All upland peat should be under restoration management by 2045. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2024
R2022-021	Agriculture & land use: Peatlands	Introduce the proposed regulations to ban the retail sale of peat in horticulture in England and Wales by 2024. Use by the horticultural sector should also end in 2024, earlier than the currently proposed 2028. Government must work with the horticultural industry achieve this. **Primary responsibility: Defra** Supporting actors: Wales	2024

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2022-032	Agriculture & land use: Peatlands	Set out clear timeframes to end domestic and industrial peat extraction across the UK. Provide a mechanism to ensure the peat-extraction industries restore extraction sites to protect the peat resource. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q1 2023 Overdue
R2023-068	Agriculture & land use: Peatlands	Promote consistent annual reporting of national peatland restoration action across the UK, ensuring that data are comparable and openly accessible. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2024
R2022-039	Agriculture & land use: Trees and woodland	Work with the forestry sector and government agencies to support UK tree nurseries to increase domestic production of trees to meet the planting ambition and reduce reliance on imports, along with the associated risks of pests and disease. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2023
R2022-045	Agriculture & land use: Forestry	Develop a comprehensive plan to increase the production and use of UK-sourced timber and support the long-term economic viability of domestic woodlands. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q1 2024
R2022-031	Agriculture & land use: Agroforestry and hedgerows	Set incentives to support agroforestry and hedgerows on UK farms. Plant trees on 2% of farmland by 2025 while maintaining its primary use, rising to 5% by 2035, and extend hedgerows by 20% by 2035 and better manage existing hedgerows. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q3 2023
R2023-070	Agriculture & land use: Agroforestry and hedgerows	Improve monitoring and reporting of the national extent and condition of hedgerows to track delivery against the Government's commitment to restore and create these boundary features. Govenment should also set a target and take steps to monitor and report the delivery of agroforestry measures. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2024
R2023-100	Agriculture & land use: Finance	Government should help facilitate conditions that stimulate investment to contribute to emissions reduction in the agricultural and land use sectors, including habitat creation and restoration, through promoting policy stability and good governance to attract private investment. This will include detail on how private funding will be aligned with public subsidies, and promote the use of existing verifiable standards (such as the Woodland Carbon Code and Peatland Code) whilst also considering the need to develop new ones. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	H1 2024

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2022-023	Agriculture & land use: Non-financial barriers	Provide support to tenant farmers to overcome contractual issues that restrict the long-term commitment and investment required to reduce emissions and sequester carbon on the land they manage. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q1 2024
R2022-028	Agriculture & land use: CAP reform	Put in place robust frameworks for monitoring, reporting and verification of post-CAP farm subsidies and agriculture environment schemes to assess their effectiveness in delivering their environmental objectives, including for climate change mitigation and adaptation. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Q1 2023 Overdue
R2022-035	Agriculture & land use: CAP reform	Set out how reform of agricultural subsidies in England under the new Environmental Land Management scheme will be targeted through the "public money for public goods" approach, both regionally and temporally, to incentivise land managers to adopt measures to reduce greenhouse gas emissions alongside delivery for food security, biodiversity and other environmental goals. **Primary responsibility: Defra**	Ongoing
R2023-103	Agriculture & land use: CAP reform	The UK Government and devolved administrations should build on their current advice and guidance approaches and set out their understanding on how the transition to Net Zero in the agriculture and land use sectors will affect employment in these sectors. This should include a timeframe of change and the scale of impact, to inform how pathway will be managed to be fair and equitable. New skills, training and advice should be made widely available to facilitate the transition, increase capacity and enable farmers to make changes on the land they manage, while supporting the achievement of environmental targets in these sectors. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2024
R2022-004	Agriculture & land use: Low-carbon farming	As part of strengthening the regulatory baseline, extend coverage of Nitrate Vulnerable Zones across all of the UK in order to promote best practice in management of inorganic fertilisers and organic manure and slurry. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	2024
R2022-030	Agriculture & land use: Non-financial barriers	Put in place action to overcome non-financial barriers that prevent adoption of low-carbon farming measures and land-use change (such as forestry, peatland restoration, establishment of agroforestry and biomass crops) to deliver emission reduction and carbon benefits. These include streamlining application processes and providing support for skills, training, and knowledge exchange in order to provide confidence to farmers to take up new measures. **Primary responsibility: Defra** Supporting actors: Scotland; Wales; N. Ireland	Ongoing

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2023-191	Agriculture & land use: Peatlands	Extend the policy requiring a licence for burning management to cover all protected peatlands, as a step towards limiting its use on all peat soils. Land managers wishing to use burning management must comply with the relevant standards (such as the Heather and Grass Burning Regulations 2021 in England and the Muirburn Code in Scotland), demonstrating its necessity in achieving stated land-use outcomes as well setting restoration plans. **Primary responsibility: Defra** Supporting actors: Scotland	H1 2024
R2022-007	Agriculture & land use: Trade and consumption emissions	Develop the option of applying minimum environmental standards to imports of selected agricultural products, either for application via due diligence or at the border. **Primary responsibility: Defra** Supporting actors: FCDO; DBT	Q1 2023 Overdue
R2022-012	Agriculture & land use: Trade and consumption emissions	Implement Government's proposed policy on due diligence of forest-risk commodities and develop a further policy to remove unsustainable legal deforestation from UK supply chains that avoids the risk of resource shuffling. **Primary responsibility: Defra**	Q1 2023 Overdue
R2022-013	Agriculture & land use: Trade and consumption emissions	Improve data collection and standardise methodologies for monitoring of, and reporting on, international land use emissions that arise from UK consumption, particularly from deforestation. The Government should aim to report on these international emissions from deforestation on an annual basis from 2023. This may build on the experimental statistic of the Joint Nature Conservation Committee. **Primary responsibility: Defra** Supporting actors: ONS	2023
R2022-044	Agriculture & land use; Fuel supply	The Biomass Strategy should set out the role that sustainable domestic production of perennial energy crops and short rotation coppice will play to contribute towards Net Zero. The strategy should align with the recommended development of a Government agriculture and land use strategy and outline how land for UK biomass and forestry will be freed up. This should include specific targets to increase the area growing energy crops across the UK to 6,000 hectares per year by 2025, and 30,000 hectares per year by 2035. **Primary responsibility: Defra** Supporting actors: DESNZ	2022 Overdue
R2022-319	Waste; Agriculture & land use	Set out an assessment of the behaviour changes needed to achieve targets for food-waste reduction, recycling and improved end user consumption. We will assess whether this is included in either the forthcoming final Waste Prevention Programme or the Resources and Waste Strategy addendum. **Primary responsibility: Defra**	Q1 2023 Overdue

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2022-321	Waste: Waste prevention	Implement initial Extended Producer Responsibility, the Deposit Return Scheme and consistent collections of recycling and food waste in a coordinated way and without further delay and confirm that funds raised by EPR will be used to support recycling and waste prevention efforts. Consider how EPR can be improved in the future to specifically encourage re-use. **Primary responsibility: Defra** Supporting actors: Wales; Scotland; N. Ireland	Q1 2024
R2022-302	Waste: Cross-cutting	Publish a detailed plan to decarbonise the waste sector (including Energy from Waste and wastewater) in line with meeting the Sixth Carbon Budget and Net Zero. This should set out how policies are expected to deliver emissions reduction in the Waste sector, how these will be sufficiently funded and incentivised, how waste processing and treatment capacity aligns to emissions pathways and how efforts will be coordinated across the different nations and sectors. **Primary responsibility: Defra** Supporting actors: DESNZ; Wales; Scotland; N. Ireland	2023
R2022-314	Waste: Cross-cutting	Clarify the future role of anaerobic digestion and composting in waste treatment and set out how emissions from these treatment methods will be reduced. We will assess whether this is included in either the forthcoming final Waste Prevention Programme or the Resources and Waste Strategy addendum. **Primary responsibility: Defra**	2023
R2022-311	Waste: Infrastructure	Publish an assessment of residual waste treatment capacity needs through to 2050, consistent with meeting committed and prospective recycling and waste reduction targets, expected resource efficiency improvements and the stated goal to end the landfilling of biodegradable waste by 2028. The findings of this review should inform future incineration/EfW capacity decisions and consider the feasibility of phasing out waste exports by 2030. **Primary responsibility: Defra**	2022 Overdue
R2022-310	Waste: Market conditions	Set out how incentives across the waste sector are appropriate for achieving dual aims of waste reduction and decarbonisation. This should consider pricing of waste management solutions as well as materials. We will assess whether this is included in either the forthcoming final Waste Prevention Programme or the Resources and Waste Strategy addendum. **Primary responsibility: Defra** Supporting actors: HMT	2023
R2022-308	Waste: Landfill	Formalise commitment to prevent key biodegradable waste streams (including municipal and non-municipal sources) from going to landfill by 2028 at the latest and clarify details of additional policies needed to achieve this. **Primary responsibility: Defra**	Q1 2023 Overdue

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2022-305	Waste: Landfill and waste prevention	Clarify details of how the £295 million capital funding for food waste collections announced in the Net Zero Strategy will be spent to prevent food waste from going to landfill. We will assess whether this is included in either the forthcoming final Waste Prevention Programme or the Resources and Waste Strategy addendum. **Primary responsibility: Defra**	2022 Overdue
R2022-313	Waste: Landfill	Set out how methane capture and oxidisation rates at landfill sites will be improved. We will assess whether this is included in either the forthcoming final Waste Prevention Programme or the Resources and Waste Strategy addendum. **Primary responsibility: Defra**	2023
R2022-307	Waste: Waste prevention	Finalise plans to introduce mandatory business food-waste reporting so that it can be phased in from the beginning of 2024. Engage WRAP in providing or brokering consistent methods of measurement and associated data sets. **Primary responsibility: Defra**	Q1 2023 Overdue
R2022-312	Waste: Infrastructure	Review the National Planning Policy Statement for waste (not updated since 2014) to ensure it is fit to deliver the infrastructure needed to achieve recycling targets and support future residual waste needs and decarbonisation requirements. **Primary responsibility: Defra** Supporting actors: DESNZ	2023
R2022-212	F-gases: HFC regulation	For the review of the F-gas Regulation happening this year, match or exceed any increase in ambition in EU F-gas Regulation, which is currently being reviewed. **Primary responsibility: Defra**	2022 Overdue
R2022-213	F-gases: HFC regulation	Pass legislation to reduce hydrofluorocarbon consumption by 85% by 2036 relative to 2011-2013. **Primary responsibility: Defra**	Q1 2023 Overdue
R2022-214	F-gases: International F-gas action	Publicly push for stronger international action on reducing F-gases under the Kigali Amendment to the Montreal Protocol, including making it compatible with reaching Net Zero greenhouse gas emissions, encouraging more countries to ratify the Protocol and the Amendment, improving international monitoring of emissions, supporting the development of more robust estimates of emission metrics, and supporting the reduction of inhaler emissions in other countries' health services. **Primary responsibility: Defra** Supporting actors: DHSC	Q1 2023 Overdue
R2023-166	Cross-cutting: Business	Ensure all UK carbon credit codes follow a standardised approach to ensure confidence, consistency and robustness. Soil carbon should be a priority for this, but others under development (e.g. blue carbon and hedgerows) should be considered. **Primary responsibility: Defra** Supporting actors: DESNZ	Ongoing

ID	Sector	Recommendations for the Department for Environment, Food and Rural Affairs (Defra)	Timing
R2022-168	Cross-cutting: Consumption emissions	The Government should outline the UK's future ambitions on reducing consumption emissions. **Primary responsibility: Defra** Supporting actors: DESNZ	Q1 2023 Overdue
R2022-157	Cross-cutting: Trade and consumption emissions	The Government should increase investment in, and improve the collection and reporting of, consumption emissions data. This should include (a) establishing a short- and medium-term strategy to improve the underlying methodology to ensure it can capture key improvements in the carbon-intensity of imports (b) ensuring the resource to enable annual emissions statistics to be produced promptly each year. **Primary responsibility: Defra** Supporting actors: ONS	Q1 2024

5. Recommendations for DfT

ID	Sector	Recommendations for the Department for Transport (DfT)	Timing
Priority: R2022-272	Surface transport: Electric cars and vans	Confirm the details of the ZEV mandate in regulation. As set out in the consultation, this should impose targets on manufacturers that are at least as ambitious as those in the Transport Decarbonisation Plan and should drive consistent growth in sales of EV cars and vans through the 2020s to meet the 2030 phase-out date. **Primary responsibility: DfT** Supporting actors: Scotland; Wales; Northern Ireland	Q1 2023 Overdue
Priority: R2023-037	Aviation: Demand	No airport expansions should proceed until a UK-wide capacity management framework is in place to annually assess and, if required, control sector GHG emissions and non-CO_2 effects. A framework should be developed by DfT in cooperation with the Welsh, Scottish and Northern Irish Governments over the next 12 months and should be operational by the end of 2024. After a framework is developed, there should be no net airport expansion unless the carbon-intensity of aviation is outperforming the Government's emissions reduction pathway and can accommodate the additional demand. **Primary responsibility: DfT**	H1 2024
R2023-140	Surface transport: Electric cars and vans	Establish proactive monitoring mechanisms for delivery against the ZEV mandate, to enable early identification of areas where further supporting policy measures may be needed to address shortfall risks or harness opportunities to boost delivery. **Primary responsibility: DfT** Supporting actors: Scotland; Wales; Northern Ireland	Q1 2024
R2023-142	Surface transport: Electric cars and vans	Work with supportive stakeholders to agree a definition of what a sustainable and ethical EV supply chain should look like, and investigate ways (e.g. certification) of requiring this for vehicles sold in the UK. **Primary responsibility: DfT** Supporting actors: DBT	Q1 2024
R2022-277	Surface transport: Electric vehicle charging infrastructure	Continue to support widespread deployment of charging infrastructure, ensuring that deployment rates accelerate in line with the trajectory required to deliver a minimum of 300,000 public chargepoints by 2030. **Primary responsibility: DfT** Supporting actors: DESNZ; Ofgem	Ongoing
R2022-286	Surface transport: Electric vehicle charging infrastructure	Review and strengthen rapid charger rollout plans on the major road network out to 2035, to ensure that drivers have the confidence that they can find reliable, available chargepoints as EV uptake grows. **Primary responsibility: DfT** Supporting actors: DESNZ; Ofgem	Ongoing

ID	Sector	Recommendations for the Department for Transport (DfT)	Timing
R2022-279	Surface transport: Electric vehicle charging infrastructure	Enact legislation requiring better reliability, accessibility, interoperability and ease-of-use at public chargepoints, as committed to in the Government response to the consultation on the consumer experience at public chargepoints. **Primary responsibility: DfT**	Q1 2023 Overdue
R2023-144	Surface transport: Electric vehicle charging infrastructure	Monitor reliability across all public chargepoints, beyond just the rapid network that will be covered by the 99% target, and consider how to intervene to increase this if it does not improve. **Primary responsibility: DfT**	2024
R2023-146	Surface transport: Zero-emission HGVs and buses	Produce an infrastructure strategy that sets out how the transition of heavy-duty vehicles to ZEVs will be enabled. The strategy should consider options for depot charging, en-route ultra-rapid charging and hydrogen refuelling infrastructure. **Primary responsibility: DfT**	2024
R2023-145	Surface transport: Zero-emission HGVs and buses	Once the ZEV mandate regulations for cars and vans are implemented, begin consulting on an appropriate regulatory mechanism for delivering the ZEV transition for heavy-duty vehicles including HGVs and buses. **Primary responsibility: DfT**	2024
R2023-147	Surface transport: Conventional vehicle efficiency	Increase the ambition of the proposed CO_2-intensity regulations for new non-zero-emission cars and vans, by ensuring that manufacturers are incentivised to reduce vehicle sizes and are not subject to perverse incentives that could restrict the availability of small EVs. **Primary responsibility: DfT**	2023
R2023-141	Surface transport: Conventional vehicle efficiency; Electric cars and vans	Set out an ambitious definition of 'significant zero-emission capability' to cover which cars and vans will be permitted to be sold between 2030-2035, ideally allowing only fully electric vehicles. **Primary responsibility: DfT**	2023
R2022-283	Surface transport: Public transport	Publish a comprehensive plan setting out how the Government's target of removing diesel passenger trains from the railway by 2040 and achieving a Net Zero rail network by 2050 or earlier will be achieved. **Primary responsibility: DfT**	2022 Overdue
R2023-149	Surface transport: Car demand	Publish guidance to local authorities on what should be covered in local transport plans to deliver on the priorities set out in the Transport Decarbonisation Plan. This should include consistent guidance on how to quantify the emissions reductions that these measures can be expected to deliver as well as long-term clarity on what funding streams will be available to implement plans. **Primary responsibility: DfT** Supporting actors: DLUHC	2023

ID	Sector	Recommendations for the Department for Transport (DfT)	Timing
R2023-148	Surface transport: Car demand	Conduct a systematic review of current and future road-building projects to assess their consistency with the Government's environmental goals. This should ensure that decisions do not lock in unsustainable levels of traffic growth and develop conditions (which can be included in the Roads Investment Strategy 3 process and beyond) that permit schemes to be taken forward only if they meaningfully support cost-effective delivery of Net Zero and climate adaptation. **Primary responsibility: DfT**	2023
R2022-282	Surface transport: Public transport	Prioritise delivery of a new, transparent public transport fare structure that offers more affordable and reliable travel, ensuring fairness in relation to more carbon-intensive choices, and a more interlinked public transport system between operators. **Primary responsibility: DfT** Supporting actors: HMT	Q1 2023 Overdue
R2022-290	Surface transport: Freight demand	Work with the freight industry to design and implement pilot schemes to explore approaches to reducing van and HGV usage in urban locations. **Primary responsibility: DfT**	2022 Overdue
R2022-301	Surface transport; Electricity supply	Take action to reduce the cost of local public charging for drivers who do not have access to private off-street parking to make it more comparable to charging at home. This should include reducing VAT on residential public charging. **Primary responsibility: DfT** Supporting actors: HMT	Q1 2023 Overdue
R2023-116	Aviation: Efficiencies	Confirm when the Jet Zero Strategy will undergo its first five-yearly review and begin work in 2023 to understand what policy framework or mechanism would need to be in place for additional measures within the sector to be rapidly deployed in the late-2020s if the Government is not on track to meet its aviation pathway. These measures could include demand reduction policies. **Primary responsibility: DfT**	2024
R2023-117	Aviation: Demand	Start to track the carbon-intensity of, and demand for, different aviation ticket types (e.g. business, first class, economy class), and demand for private flying, to help understand how demand-side measures could reduce the carbon intensity of flying. **Primary responsibility: DfT**	2024
R2022-046	Aviation: Sustainable aviation fuel	Ensure the Sustainable Aviation Fuel Mandate is legislated in time for it to become operational by the start of 2025, with a strong set of criteria for the fuels included in the mandate. **Primary responsibility: DfT**	2024

ID	Sector	Recommendations for the Department for Transport (DfT)	Timing
R2023-118	Aviation: Sustainable aviation fuel	The Sustainable Aviation Fuel mandate should include provisions to ensure that eligible fuels do not have a harmful non-CO_2 impact relative to conventional jet fuel and that the minimum GHG emissions saving threshold is sufficiently ambitious to ensure the Government's aviation emissions reduction trajectory is reached. The threshold should be increased over time to ensure high future emissions savings while upholding stringent fuel eligibility standards. **Primary responsibility: DfT**	2024
R2023-119	Aviation: Sustainable aviation fuel	Build contingency measures into the Sustainable Aviation Fuel Mandate to prepare for the possibility of constrained domestic and global Sustainable Aviation Fuel feedstock and import supply throughout the 2020s and 2030s that does not overly rely on the SAF mandate buy-out mechanism. **Primary responsibility: DfT**	2024
R2022-056	Aviation: Sustainable aviation fuel	Without allowing it to delay the implementation of the Sustainable Aviation Fuel Mandate, consider whether including high-quality greenhouse gas removals into the mandate could be a more effective way of reducing emissions for the industry, particularly in the short term (e.g. up to 2030), before more scalable forms of SAF (e.g. synthetic fuels) are widely commercially available. **Primary responsibility: DfT**	2024
R2023-120	Aviation: Zero emission aircraft	Outline the role zero-emission aircraft will play in the Government's aviation decarbonisation pathway after 2030 and how Government will provide an enabling environment (regulation, infrastructure, public acceptance) for these new technologies. **Primary responsibility: DfT**	2024
R2022-048	Aviation: Offsets and removals	Commit to a policy on the UK ETS/Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) interaction as soon as possible, ensuring it is sufficiently environmentally stringent and that no credits from CORSIA are used for flights currently covered by the UK ETS unless and until they can satisfy strict eligibility criteria (equivalence, additionality, permanence, sustainability). The interaction should avoid double-compliance. **Primary responsibility: DfT**	2023
R2022-053	Aviation: Non-CO_2 emissions	Start monitoring non-CO_2 effects of aviation - including through the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) for eligible aeroplane operators - and set a minimum goal of no further additional warming after 2050 from non-CO_2 effects, research mitigation options and consider how best to tackle non-CO_2 effects alongside UK climate targets without increasing CO_2 emissions. **Primary responsibility: DfT**	2023
R2022-050	Aviation: Cross cutting	Continue innovation and funding for aircraft efficiency measures, hybrid, full electric and hydrogen aircraft development and airspace modernisation. **Primary responsibility: DfT**	Ongoing

ID	Sector	Recommendations for the Department for Transport (DfT)	Timing
R2022-054	Aviation: Cross-cutting	Use the ICAO General Assembly to protect, strengthen and extend Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) such that all residual emissions in 2050 are covered by near-permanent, sustainable greenhouse gas removals. Commit to increasing the number of airlines opting in and, if strengthening it is not possible, push for an additional policy for countries willing and able to commit to a higher standard of carbon removal for aviation than exists through CORSIA. **Primary responsibility: DfT**	Q3 2022 Overdue
R2023-104	Aviation: Skills	Identify current and future skill gaps in the aviation workforce and address them to ensure the right skills are developed and available in the sector to help achieve aviation decarbonisation. **Primary responsibility: DfT** Supporting actors: DfE	Ongoing
R2022-049	Aviation: Efficiencies	Continue to monitor seat occupancy over the period to 2027, during recovery from the COVID-19 pandemic, to ensure that the sector either returns to prior occupancy levels or routes are adjusted to account for low occupancy rates. Consider regulating aircraft occupancy standards if the trends do not return to pre-pandemic levels by 2024. **Primary responsibility: DfT**	Ongoing
R2022-051	Aviation: Sustainable aviation fuel	Continue innovation and show support for sustainable aviation fuel technologies, including research into non-CO_2 effects. Also, estimate the impact of different sustainable aviation fuel options on other countries' emissions and the opportunity costs for UK land use. **Primary responsibility: DfT**	Ongoing
R2022-268	Shipping: Low-carbon fuel	Embed the Course to Zero response into the next update of the Clean Maritime Plan. This should present a credible plan for how the trajectory to Net Zero will be delivered. **Primary responsibility: DfT**	2023
R2022-270	Shipping: Demand; Low-carbon fuel	Publish the outcome of the Course to Zero consultation. This should aim to set an ambitious trajectory to Net Zero for the domestic maritime sector. **Primary responsibility: DfT**	2022 Overdue
R2022-267	Shipping: Low-carbon fuel	Commit to the UK's first clean maritime cluster(s) operating at commercial scale (supplying at least 2 TWh/year of zero-carbon fuels) by 2030 at the latest. **Primary responsibility: DfT** Supporting actors: DESNZ	2022 Overdue

ID	Sector	Recommendations for the Department for Transport (DfT)	Timing
R2023-135	Shipping: Low-carbon fuel	Provide support and incentives to drive private-sector investment in low-carbon maritime fuels, engine technologies, and storage facilities. For example, this should include support and incentives to better understand the viability of different low-carbon fuels such as the sustainability of supply and carbon emissions for methanol. These should enable low-carbon fuels to expand to 42% of total domestic shipping fuel use by 2035 to match the deployment assumptions in the CBDP. **Primary responsibility: DfT**	2024
R2022-266	Shipping: Efficiency and electrification	Build upon the summary of responses to develop a plan on the use of shore power and electric recharging infrastructure at all of the UK's major ports. This should include identifying roles and responsibilities for delivery and providing support and incentives to drive investment. **Primary responsibility: DfT**	Q1 2023 Overdue
R2023-134	Shipping: Efficiency, zero-emission vessels and electrification	Establish a Centre for Smart Shipping (CSmart) as promised in the Technology and Innovation in UK Maritime report (part of Maritime 2050 Route Map). The centre should increase the adoption of technology in the UK maritime sector and work on developing a UK legislative framework for autonomous vessels, incorporating the as yet unpublished results from their 'Future of transport regulatory review: maritime autonomy and remote operations' consultation which closed in November 2021. Any new framework for autonomous vessels should include consideration of low-carbon fuels and operations. **Primary responsibility: DfT**	2024
R2022-265	Shipping: Demand	Build upon the proposals for the UK Emissions Trading Scheme and the UK MRV regulations to explore options for an activity-based measure of UK shipping emissions. This should include exploring the benefits of changing the emissions accounting approach for international shipping, to ensure that a fair share of emissions for voyages to and from the UK are captured within the UK's inventory even if vessels refuel in other jurisdictions. **Primary responsibility: DfT** Supporting actors: DESNZ	2023
R2022-271	Shipping: Low-carbon fuel	Continue to report on progress in identifying green shipping corridors and the actions to implement them, as agreed within the Clydebank Declaration. An annual report should be published ahead of COP28. **Primary responsibility: DfT** Supporting actors: CO & Number 10	2023
R2022-263	Shipping: Demand; Low-carbon fuel	Take a leadership role in pushing for inclusion of a 2050 Net Zero target within the 2023 update of the International Maritime Organisation's initial greenhouse gas strategy. **Primary responsibility: DfT** Supporting actors: CO & Number 10	2023

ID	Sector	Recommendations for the Department for Transport (DfT)	Timing
R2023-060	Cross-cutting: Data	Work with other departments and the ONS to fill the data gaps identified in the CCC's Monitoring Framework (http://www.theccc.org.uk/publication/ccc-monitoring-framework), with a focus on those the CCC have flagged as high priority. **Primary responsibility: DfT** Supporting actors: ONS	Ongoing

6. Recommendations for FCDO

ID	Sector	Recommendations for the Foreign, Commonwealth and Development Office (FCDO)	Timing
R2022-235	International: Climate finance	Continue to deliver a broadly 50/50 split between adaptation and mitigation spend under UK International Climate Finance, looking for opportunities that advance both outcomes. **Primary responsibility: FCDO** Supporting actors: DESNZ	Ongoing
R2023-113	International: ODA	Assess and transparently communicate the impact that reductions in the amount of ODA available for international spending have had on international mitigation, adaptation and nature programming, setting out contingency plans for ICF programming to cover the eventuality that similar cuts are made in the next financial year. **Primary responsibility: FCDO**	H1 2024

7. Recommendations for DBT

ID	Sector	Recommendations for the Department for Business and Trade (DBT)	Timing
Priority: R2023-088	Industry: Steel	Publish a strategy and timeline for the decarbonisation of the iron and steel industry in line with the Carbon Budget Delivery Plan. **Primary responsibility: DBT** Supporting actors: DESNZ	Q1 2024
R2023-115	International: Trade	Building on the high-level intention expressed in the 2030 Strategic Framework, the Government should produce detailed, high-ambition climate and nature trade principles that commit to: protecting the UK's right to regulate to achieve its Net Zero and Paris Agreement commitments; minimum environmental standards for imports; tariff-free trade for environmental goods; taking steps to eliminating inefficient fossil fuel subsidies and requiring credible Net Zero targets and plans from any FTA partners. **Primary responsibility: DBT** Supporting actors: DESNZ	2024
R2022-275	Surface transport: Electric cars and vans	Consult on regulations requiring EV batteries sold in the UK to be recyclable. These should be coordinated with requirements in other markets to ensure that batteries can be reliably recycled across jurisdictions. **Primary responsibility: DBT** Supporting actors: DfT	2022 Overdue

8. Recommendations for DLUHC

ID	Sector	Recommendations for the Department for Levelling Up, Housing and Communities (DLUHC)	Timing
Priority: R2023-092	Fuel supply: Fossil fuel supply	Ensure that planning frameworks and guidance across the UK support a clear presumption against new consents for coal production. New coal extraction, whether in new mines or through the extension of existing infrastructure, should only be permitted for safe decommissioning, or where firm policy can be demonstrated to require the coal produced to be used (domestically or internationally) in a way that is compatible with Net Zero pathways (e.g. with at least 95% CO_2 capture and storage). Planning Frameworks should reflect the declining role of coal in the context of binding UK and international GHG emissions targets. At present local plans are still required to proactively identify sites for future coal extraction. This practice is outdated and encourages new coal development. This practice should be ended immediately. **Primary responsibility: DLUHC** Supporting actors: Scotland; Wales; N. Ireland; DESNZ	2023
Priority: R2023-155	Cross-cutting: Governance	Review and update the National Planning Policy Framework to ensure that Net Zero outcomes are consistently prioritised through the planning system, making clear that these should work in conjunction with, rather than being over-ridden by, other outcomes such as development viability. **Primary responsibility: DLUHC**	2023
R2022-092	Buildings: New buildings	Consult on a full technical specification for the Future Homes Standard in 2023. Ensure that the new standards are implemented by 2025, and will deliver new buildings which are resilient to climate change impacts, with ultra-high energy efficiency standards and low-carbon heating. Define clear transitional arrangements which will require any buildings which have not meaningfully commenced on site within a year of the implementation date to meet the new standards. **Primary responsibility: DLUHC** Supporting actors: DESNZ	2023
R2023-183	Buildings: Standards and enforcement	Reform domestic EPC metrics to make them better suited to informing consumers and delivering policy, taking into account the recommendations made by the CCC in its letter on 2 February 2023. **Primary responsibility: DLUHC** Supporting actors: Scotland	2023
R2022-093	Buildings: New buildings	Ensure that Building Regulations for homes created through a material change of use to an existing building require low-carbon heating and mitigation of overheating. Consider imposing a whole-building energy and emissions standard for such homes. **Primary responsibility: DLUHC** Supporting actors: DESNZ	2023

ID	Sector	Recommendations for the Department for Levelling Up, Housing and Communities (DLUHC)	Timing
R2022-094	Buildings: New buildings	Consult on a full technical specification for the Future Buildings Standard in 2023. Ensure that the new standards are implemented by 2025, and will deliver new buildings which are resilient to climate change impacts, with ultra-high energy efficiency standards and low-carbon heating. **Primary responsibility: DLUHC** Supporting actors: DESNZ	2023
R2022-095	Buildings: Standards and enforcement	Implement improvements to the Standard Assessment Procedure (SAP) and Reduced Data SAP (RdSAP) methodologies to ensure they accurately model performance, drive deployment of the necessary energy efficiency and low-carbon heat measures, and also address overheating, ventilation, and moisture-risk. This should be done in coordination with Devolved Administrations. **Primary responsibility: DLUHC** Supporting actors: DESNZ; Scotland; Wales; N. Ireland	H1 2023 Overdue
R2022-096	Buildings: Standards and enforcement	Publish plans to enhance compliance with Building Regulations and minimum EPC requirements, including consideration of additional measures to monitor compliance of competent persons, approved inspectors, EPC assessors and landlords, and providing local authorities with sufficient resources to monitor and enforce compliance with standards. **Primary responsibility: DLUHC** Supporting actors: DESNZ; HMT	H1 2023 Overdue
R2023-182	Buildings: Standards and enforcement	Urgently update the 'reduced data' Standard Assessment Procedure (RdSAP) to ensure that current emissions factors are used in calculating the Environmental Impact Rating (EIR). Take further steps to improve the reliability of domestic Energy Performance Certificates (EPCs) including: better training and oversight of EPC assessors; reducing reliance on default values in RdSAP; improvements to RdSAP; improvements to the digital presentation of EPC data; and storage and reuse of input data. **Primary responsibility: DLUHC** Supporting actors: DESNZ	H1 2024
R2022-112	Buildings; Surface transport	Develop and implement plans to make all public sector buildings and vehicle fleets within the department's remit zero-carbon in the long term, switching to ultra-low emissions vehicles by 2030 and halving emissions from public buildings by 2032. **Primary responsibility: DLUHC**	H1 2023
R2022-252	Industry; Buildings; Surface transport	Set out a plan to make an assessment of whole-life carbon and material use of public and private construction projects mandatory by 2025, to enable minimum standards to be set. The whole-life carbon assessment should be sought at the planning stage to enable efforts to reduce embodied carbon and materials. **Primary responsibility: DLUHC** Supporting actors: DfT; DESNZ	2022 Overdue

ID	Sector	Recommendations for the Department for Levelling Up, Housing and Communities (DLUHC)	Timing
R2023-174	Cross-cutting: Governance	Alongside updates to the National Planning Policy Framework, provide clearer guidance on assessing carbon impacts, measuring environmental outcomes and evidence requirements for climate considerations in the definition of 'sustainability'. **Primary responsibility: DLUHC**	2023

9. Recommendations for DfE

ID	Sector	Recommendations for the Department for Education (DfE)	Timing
R2023-136	Shipping: Skills	In line with the terms of reference, the UK Shipbuilding Skills Taskforce (UKSST), UKSST should produce a Shipbuilding Skills Strategy with recommendations and a SMART action plan by June 2023, with implementation of actions taking place between June and December 2023 (as outlined in UKSST TOR). **Primary responsibility: DfE**	2023

10. Recommendations for DWP

ID	Sector	Recommendations for the Department for Work and Pensions (DWP)	Timing
R2022-113	Buildings; Surface transport	Publish the completed carbon and water management plan and the sustainability management plan that is under development. The plan should include clear pathways for reaching Greening the Government Commitment targets, switching to ultra-low emissions vehicles by 2030 and halving emissions from public buildings by 2032 **Primary responsibility: DWP**	H1 2023

11. Recommendations for DHSC

ID	Sector	Recommendations for the Department of Health and Social Care (DHSC)	Timing
R2022-215	F-gases: F-gas technology replacement	Publicly set targets to end the use of Metered Dose Inhalers (MDIs) for all patients where alternatives can be used, by the mid-2020s, for all NHS and private healthcare services across the four nations of the UK. For patients where MDIs are necessary, end the use of MDIs that use propellant gases with 100 year Global Warming Potentials above 200 times that of carbon dioxide. Publish a plan setting out how the Government will meet these targets. **Primary responsibility: DHSC**	Q1 2023 Overdue
R2022-173	Cross-cutting: Health	Deliver climate policy that also has health benefits, such as active travel, access to green spaces, air quality, better buildings and healthier diets. This could be done by reviewing ways in which DHSC public guidelines could integrate messages that strengthen and make more evident the co-benefits of good nutrition and exercise for both health and for the environment. **Primary responsibility: DHSC**	Ongoing
R2022-176	Cross-cutting: Health	Publicly commit to providing additional, ringfenced funding to NHS England to fund the entirety of the delivery of its Net Zero plan. **Primary responsibility: DHSC**	Q1 2023 Overdue

12. Recommendations for MoJ

ID	Sector	Recommendations for the Ministry of Justice (MoJ)	Timing
R2022-116	Buildings; Surface transport	Publish MoJ's Net Zero Carbon Strategy. The strategy should include clear pathways for reaching Greening the Government Commitment targets, switching to ultra-low emissions vehicles by 2030 and halving emissions from public buildings by 2032 **Primary responsibility: MoJ**	H1 2023

13. Recommendations for the Home Office

ID	Sector	Recommendations for the Home Office	Timing
R2022-114	Buildings; Surface transport	Building on findings from the Home Office's studies into Net Zero technologies and EV chargepoints, publish a Net Zero carbon strategy for the Home Office. The strategy should include clear pathways for reaching Greening the Government Commitment targets, switching to ultra-low emissions vehicles by 2030 and halving emissions from public buildings by 2032. **Primary responsibility: Home Office**	H1 2023

14. Recommendations for the MoD

ID	Sector	Recommendations for the Ministry of Defence (MoD)	Timing
R2022-115	Buildings; Surface transport	Develop and implement plans to make all public sector buildings and vehicle fleets within the department's remit zero-carbon in the long term, switching to ultra-low emissions vehicles by 2030 and halving emissions from public buildings by 2032. **Primary responsibility: MoD**	H1 2023

15. Recommendations for Ofwat

ID	Sector	Recommendations for the Water Services Regulation Authority (Ofwat)	Timing
R2023-074	Waste: Wastewater	Scrutinise the plans of water companies to ensure these include appropriate measures to reduce wastewater emissions in line with the Government pathway and sector targets, and set out the key measures being taken alongside performance against relevant KPIs on an annual basis. **Primary responsibility: Ofwat** Supporting actors: Defra	Ongoing

16. Recommendations for the ONS

ID	Sector	Recommendations for the Office for National Statistics (ONS)	Timing
R2022-249	Industry: Resource efficiency	Invest in a system (e.g. the National Materials Datahub) to track materials and products to share information on their quantity and quality for reuse and repurposing to retain materials at their highest value for as long as possible. **Primary responsibility: ONS** Supporting actors: DESNZ	Q1 2023 Overdue
R2022-196	Cross-cutting: Data	Work with Government departments to fill the data gaps identified by CCC in the Monitoring Framework document accompanying this report. **Primary responsibility: ONS**	Ongoing

17. Recommendations for the North Sea Transition Authority

ID	Sector	Recommendations for the North Sea Transition Authority (NSTA)	Timing
R2023-094	Fuel supply: Fossil fuel supply	Clear expectations should be set for any new oil and gas installations to electrify from the outset wherever viable, with platforms that cannot be immediately electrified being be built fully 'electrification-ready', and required to electrify as soon as possible. In line with our Sixth Carbon Budget advice, all new oil and gas platforms should have no direct emissions from operational energy use by 2027. If this is to be deliverable, swift and co-ordinated action will be required to address barriers, including around grid connections and consenting pathways. **Primary responsibility: NSTA** Supporting actors: DESNZ; Ofgem; National Grid; Crown Estate; Crown Estate Scotland	2023

18. Recommendations for the Future System Operator

ID	Sector	Recommendations for the Future System Operator (FSO)	Timing
R2023-130	Electricity supply: Networks	Publish the second transitional Centralised Strategic Network Plan, identifying the strategic investments required for a decarbonised and resilient electricity system in 2035 and delivery of Net Zero. Provide a robust treatment of uncertainty and sufficient, clear information for network development projects to be advanced in a timely manner. Ensure such projects are designed to be resilient to a changing climate. **Primary responsibility: FSO**	2023

19. Recommendations for the Scottish Government (priority only)

ID	Sector	Recommendations for the Scottish Government (priority only)	Timing
Priority: R2022-332	Surface transport: Car demand	Publish a detailed strategy, building on the Route Map consultation of 2022, setting out how the Scottish Government will achieve a 20% reduction in car-kilometres by 2030 and deliver 20-minute neighbourhoods. This should include both investment in more sustainable modes of travel and measures to reduce the attractiveness of driving. **Primary responsibility: Scotland**	2023
Priority: R2022-338	Surface transport: Electric vehicle charging infrastructure	Develop an implementation plan to deliver the Scottish Government's vision for the public EV charging network. This should ensure the EV transition works for all road users in Scotland and accelerates in line with EV uptake, delivering 6,000 chargepoints by 2026 and approximately 24,000 chargepoints by 2030. **Primary responsibility: Scotland**	2023
Priority: R2022-336	Surface transport: Public transport	Deliver the public transport fares review outlined in the Route Map. This should consider: prioritising delivery of a new, transparent fare structure that offers more affordable and reliable travel, ensuring fairness in relation to more carbon-intensive choices, and a more interlinked public transport system between operators. **Primary responsibility: Scotland**	H1 2023
Priority: R2022-384	Buildings: Non-residential buildings	Consult on and finalise plans for delivering energy efficiency improvements and low-carbon heating in non-residential buildings. These should include clear target dates for meeting standards. Consider the role of targets that look beyond EPCs to more reliable measures of performance and emissions reductions, and clarify whether Scotland will be part of the UK performance-based rating scheme for non-residential buildings. **Primary responsibility: Scotland**	H1 2023
Priority: R2022-388	Buildings: Progress monitoring and data	Publish the delayed monitoring and evaluation framework for the Heat in Buildings Strategy, or expand the set of indicators in the annual climate change plan monitoring reports. Include clear indicators for deployment of energy efficiency measures, heat pumps, and low-carbon district heating, across residential and non-residential buildings. Use the development of the framework to identify data gaps and make plans to address them. Track implementation and its costs and use this information in updates to the Strategy. **Primary responsibility: Scotland**	2023
Priority: R2022-383	Buildings: Residential buildings	Publish developed plans to deliver energy efficiency improvements and low-carbon heating in residential buildings, aligned with Scotland's ambitious targets. This will require a combination of incentives and regulation, including using tenancy and ownership changes as trigger points for change. Policies should also factor in the UK Government's proposals for a market-based mechanism for low-carbon heat. **Primary responsibility: Scotland**	H1 2023

ID	Sector	Recommendations for the Scottish Government (priority only)	Timing
Priority: R2022-406	Agriculture & land use: CAP reform	Provide detail on how post-CAP agricultural subsidies and schemes **Primary responsibility: Scotland**	H1 2023
Priority: R2022-356	Agriculture & land use: Forestry	Ensure that funding and incentives are set at the correct level to meet the Scottish Government afforestation target of 18,000 hectares per year by 2025 **Primary responsibility: Scotland**	Ongoing
Priority: R2022-348	Aviation: Aviation demand	The Scottish Government should Implement the Air Departure Tax (ADT) as soon as possible. Once implemented, use the tax to address price imbalances between aviation and alternative, lower-emissions forms of surface transport (e.g. rail) to encourage modal shift. Also consider other policy levers, such as information provision, to encourage a reduction in the number of flights taken. **Primary responsibility: Scotland**	2023
Priority: R2022-329	Waste: Energy from Waste / Incineration	Set out further detail on actions and implementation timelines to ensure all recommendations from the incineration review can be delivered. This should include explaining how the projected residual waste capacity gap in 2025 will be managed whilst ensuring commitments to end the landfilling of biodegradable waste are met. **Primary responsibility: Scotland**	H1 2023
Priority: R2022-400	Waste: Energy from Waste / Incineration	Work with the UK Government to develop a policy and funding framework to retrofit existing EfW plants with CCS from the mid-2020s, and ensure any new EfW plants are all built 'CCS-ready'. **Primary responsibility: Scotland** Supporting actors: DESNZ	2023
Priority: R2022-402	Cross-cutting: Delivery	Increase transparency around Government's expected pathways to Net Zero. This should involve publishing more details on the assumptions that underpin these pathways and how the abatement set out in the Scottish Climate Change Plan update will be achieved by planned policies, setting out the quantified abatement expected to be achieved by each policy. **Primary responsibility: Scotland**	2023
Priority: R2022-403	Cross-cutting: Governance	Map out interdependencies between reserved and devolved powers and how they might impact decarbonisation in all economic sectors, and use the results to identify significant risks to the delivery of Net Zero and construct a plan to manage them. **Primary responsibility: Scotland**	2023
Priority: R2022-410	Cross-cutting: Governance	In parallel with the Convention of Scottish Local Authorities, address the question of what aspects of Net Zero central and local government are responsible for and how these will be coordinated. As well as sharing local best practice, this should lead to a clearer shared understanding of roles and responsibilities which can be communicated across local government. **Primary responsibility: Scotland** Supporting actors: DLUHC; Wales; N. Ireland	2023

20. Recommendations for the Welsh Government (priority only)

ID	Sector	Recommendations for the Welsh Government (priority only)	Timing
Priority: R2023-020	Surface transport: Car demand	Develop and publish a full delivery plan for how to realise the ambition of reducing per-person car demand by 10% by 2030. This should include consideration of how measures that limit car usage will interact with those that enable more sustainable modes. **Primary responsibility: Wales**	H1 2024
Priority: R2023-018	Surface transport: Electric cars and vans	Monitor EV uptake in Wales and assess whether there are opportunities for further policies and incentives to drive adoption forward more quickly than through the ZEV mandate alone. This should consider opportunities to maximise emissions savings and deliver co-benefits for Welsh people. **Primary responsibility: Wales**	Ongoing
Priority: R2023-039	Buildings: Buildings decarbonisation	Develop a detailed plan for decarbonising buildings and reaching Net Zero targets, incorporating data from Local Area Energy Plans. The plan should include estimates of investment requirements and yearly targets for deployment of low carbon heating and energy efficiency measures. It should identify policy areas which are under Welsh Government control and those which require coordination with the UK Government. **Primary responsibility: Wales** Supporting actors: UK	2024
Priority: R2023-112	Buildings: Fuel poor homes	Fully assess the level of investment required to decarbonise fuel poor homes and make long-term plans for delivering the funding required. **Primary responsibility: Wales**	H1 2024
Priority: R2023-041	Buildings: Public buildings	Fully assess the level of investment required to decarbonise public buildings and make long-term plans for delivering the funding required. **Primary responsibility: Wales**	H1 2024
Priority: R2023-040	Buildings: Residential buildings	Fully assess the level of investment required to decarbonise social housing and make long-term plans for delivering the funding required. Evaluate the cost effectiveness of retrofitting social housing to reach an EPC 'A' rating, and review the proposed target. **Primary responsibility: Wales**	H1 2024
Priority: R2023-027	Industry: Business	Continue to work with the UK Government on industrial decarbonisation in Wales, formally requesting some specific support measures, including for the adoption of CCUS and hydrogen in the South Wales Industrial Cluster. **Primary responsibility: Wales**	Ongoing
Priority: R2023-131	Electricity supply: Networks; Renewables	Work closely as part of a Minister-led infrastructure delivery group, and in conjunction with the new Electricity Networks Commissioner, to ensure enabling initiatives for energy infrastructure are taken forward at pace and necessary policy changes are implemented in	2023

ID	Sector	Recommendations for the Welsh Government (priority only)	Timing
		Wales, to deliver a decarbonised and resilient power system by 2035. Wales's spatial planning regime should adequately balance local impacts on natural capital with the need for sufficient electricity network capacity, delivered in a timely fashion, to accommodate expansion of renewable electricity generation capacity in line with UK Government targets and Welsh Government ambition. **Primary responsibility: Wales**	
Priority: R2023-034	Agriculture & land use: CAP reform	Urgently address the funding gap for new land management actions in the farmed landscape for the year 2024, between the Glastir Scheme ending in late 2023 and the new Sustainable Farming Scheme beginning in 2025, to ensure delivery does not lose momentum. **Primary responsibility: Wales**	Q3 2023
Priority: R2023-054	Agriculture & land use: Forestry	Implement a strategy to address non-financial barriers to achieve annual tree-planting rates of at least 4,500 hectares/year in Wales by 2030, rising to 7,500/year by 2035. **Primary responsibility: Wales**	H1 2024
Priority: R2022-043	Agriculture & land use: CAP reform	Provide detail on how post-CAP agricultural subsidies and schemes in Wales will target incentives and delivery for climate mitigation alongside wider environmental goals such as climate change adaptation and biodiversity. **Primary responsibility: Wales**	2022 Overdue
Priority: R2023-004	Waste: Landfill	Set out policies or support to capture methane emissions from landfill sites, in addition to improving the monitoring of emissions. **Primary responsibility: Wales**	H1 2024
Priority: R2023-005	Waste: Strategy	Set out how Wales's pathway for reducing emissions in the waste sector will be achieved - including policies, funding/investment needs and provision, and any dependencies or implications for other UK nations. **Primary responsibility: Wales**	H1 2024
Priority: R2022-327	Waste: Waste prevention	Set ambitious recycling targets for 2030 and beyond, improving on the 70% target for 2025. **Primary responsibility: Wales**	H1 2024
Priority: R2022-199	Cross-cutting: Governance	Publish a transparent and quantified link between policies and milestones, and the emissions reduction they correspond to in the sectoral pathways set out in the Second Welsh Carbon Budget. **Primary responsibility: Wales**	2022 Overdue
Priority: R2023-029	Cross-cutting: Governance	Work with local authorities to develop an agreed framework of what aspects of Net Zero central and local government are responsible for and how these will be coordinated. This should lead to a clearer shared understanding of roles and responsibilities which can be communicated across local government. **Primary responsibility: Wales**	2023

21. Recommendations for the Northern Ireland Executive (priority only)

ID	Sector	Recommendations for the Northern Ireland Executive (priority only)	Timing
Priority: R2022-295	Surface transport: Electric vehicle charging infrastructure	Support the deployment of public chargepoints across Northern Ireland, to address the issue that Northern Ireland currently has the fewest EV chargepoints per capita of any of the UK nations. **Primary responsibility: N. Ireland**	Ongoing
Priority: R2022-108	Buildings: Strategy	Publish the Decarbonising Heat Consultation and follow on with a coherent, long-term strategy for heat and energy efficiency in Northern Ireland's homes and other buildings; encompassing regulatory, policy and funding commitments to facilitate delivery. **Primary responsibility: N. Ireland**	2023
Priority: R2023-067	Agriculture & land use: Peatlands	Northern Ireland should formalise its 2021 - 2040 draft peatland strategy. This should include policy and delivery mechanisms to conserve and restore Northern Irish peat soils under both land and agricultural use. **Primary responsibility: N. Ireland**	2024
Priority: R2022-315	Waste: Infrastructure	Publish an assessment of residual waste treatment capacity needs through to 2050, consistent with meeting committed and prospective recycling and waste reduction targets, expected resource efficiency improvements and ending the landfilling of biodegradable waste by 2028 at the latest. The findings of this review should inform future incineration/EfW capacity decisions and consider the feasibility of phasing out waste exports by 2030. **Primary responsibility: N. Ireland**	2022 Overdue

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