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Boosting low-carbon investment in the UK

A Policy Roadmap

Lead Author: **Nick Molho**

Contributing Author: **Sophie English**

It takes Aviva Investors

AVIVA INVESTORS

Nick Molho

Head of Climate Policy, Aviva Investors

Main responsibilities

Nick is responsible for developing Aviva Investors' public policy positions across key sectors of the economy to accelerate the transition to net-zero emissions. He aims to drive public policy change that will unlock low-carbon investment across all sectors of the economy, thereby facilitating Aviva Investors' gathering of green assets as well as supporting the UK's and other countries' transitions to net-zero emissions. Nick also regularly provides climate and net-zero policy insights to investment and ESG colleagues across Aviva Investors.

Sophie English

Macro Stewardship Analyst, Aviva Investors

Main responsibilities

Sophie English is a Macro Stewardship Analyst within the Aviva Investors Sustainable Finance Centre for Excellence. She supports Nick Molho, Head of Climate Policy, to develop Aviva Investors' public policy positions to accelerate low-carbon investment across key sectors of the economy and support the economy-wide transition to net-zero emissions. She is also responsible for enabling effective communication of macro stewardship activity, through consistent reporting and case study development.

Contents

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Foreword

The transition to net zero presents one of the greatest investment opportunities of our lifetime for the private sector. The change required is equivalent to that of the industrial revolution, but in a timeframe equivalent to the more recent digital revolution! It is big business, with huge implications for existing industries and with huge financing requirements.

This sense of opportunity was evident during my time at the COP28 Climate Summit in Dubai last year, where I was struck by the growing focus on mobilising not just public, but also private, finance to put the world economy on track for net zero. Putting in place the low-carbon infrastructure and solutions to achieve net zero is a major investment opportunity which, with the right policy framework, can deliver significant returns in terms of economic growth, job creation, levelling up and exports.

The final text agreed at COP28 called on countries to strengthen the regulatory, policy and incentive environments to mobilise private finance towards clean technologies and nature restoration and to work together to reform the international financial architecture to achieve these goals.

This *Roadmap* aims to help policymakers identify some of the key policy priorities for investors over the next five years, which could help unlock private investment in low-carbon infrastructure, solutions and businesses at the affordable cost, pace and scale needed to maintain progress towards the UK's 2050 net-zero target. It puts forward both cross-economy and sector specific policy priorities, with recommendations covering sectors such as power, heavy industry, surface transport, buildings, aviation, shipping, nature restoration and engineered carbon removals.

The *Roadmap* reflects our clients' growing desire to increase investment in sustainable businesses and projects which are able to deliver an appropriate level of risk-adjusted returns. Clarity on the forward-looking policy environment will be critical to determining the viability of investments today. The *Roadmap* also reflects how we see our duty in delivering long-term return to our clients, which involves engaging with policymakers to tackle and avoid key systemic risks, such as those relating to climate change, and to enable key investment opportunities, such as those presented by the net-zero transition.

Mark Versey
CEO
Aviva Investors

> *"This Roadmap aims to help policymakers identify some of the key policy priorities for investors over the next five years to help unlock the private investment needed to maintain progress towards the UK's 2050 net-zero target"*

Executive summary

The Climate Change Act requires the UK economy to achieve net-zero emissions by 2050, with successive governments and official oppositions sharing the ambition to make the UK one of the most competitive low-carbon economies in the world. As part of its support for the UK's successful transition to net zero, Aviva was the first major global insurer – and one of the first major financial institutions – to set itself a 2040 net-zero emissions ambition, covering emissions from its operations, supply chains and investment portfolios.[1, 2] This ambition was validated by the Science-based Targets initiative (SBTi) in 2022 and includes interim milestones on the pathway to 2040.[3]

Net zero: A significant economic growth opportunity

The **UK has had a strong start in transitioning to a low-carbon economy:** it reduced its emissions by 48 per cent between 1990 and 2021, while growing its economy by 65 per cent over that same period.[4] Significant investment has been committed in areas such as offshore wind – where the UK will soon be host to the five largest offshore wind farms in the world – electric-vehicle manufacturing and charging infrastructure. Low-carbon innovation projects are taking place across a wide range of sectors including aerospace, green hydrogen production and heavy industry.

48%

Reduction in UK emissions between 1990 and 2021

The *Mission Zero Review*, commissioned by HM Government, concluded that with 90 per cent of world GDP covered by some form of net-zero target, the net-zero transition was ***"the growth opportunity of the 21st century"***.[5] Analysis commissioned by the Climate Change Committee as part of Carbon Budget Six estimated that the annualised resource cost of putting the UK economy on track for net zero would amount to just under one per cent of GDP and that this investment could, with the right policy support in place, result in the level of UK GDP being two per cent higher by 2035 than it would otherwise be, as resources are redirected from fossil-fuel imports to UK investment.[6, 7] Recent research from the Grantham Research Institute at the London School of Economics and the Confederation of British Industry (CBI) supports these findings, with the CBI's 2023 *Green Growth Report* highlighting the potential to increase the size of UK GDP by £37 billion to £57 billion annually by 2030 (a 1.6 per cent to 2.4 per cent increase) through further investment in 27 low-carbon growth areas.[8, 9]

The UK Government's *Green Finance Strategy* estimated that the goods and services necessary to reach global net-zero ambitions would be worth up to £1 trillion to UK businesses between 2023 and 2030. UK exports from low-carbon and renewable energy sectors already grew by 67 per cent between 2020 and 2021, compared to a six per cent increase for total exports.[10]

67%

Growth in UK exports from low carbon and renewable energy sectors between 2020 and 2021

The rationale behind this *Roadmap*: The critical role of private investment to reach net zero

To keep the UK on track for net-zero emissions, the Government's *Green Finance Strategy* estimates that ***"through the late 2020s and 2030s, an additional £50-60 billion capital investment will be required each year".***[11] In addition, the delivery of the UK's nature restoration goals could require between £44 billion and £97 billion of investment over the next ten years.[12] While targeted public funding will have an important role to play in the transition to net zero, **a significant share of this investment will need to come from the private sector**. Private investors will therefore have a critical role to play in delivering a timely, affordable and economically successful transition to net-zero emissions for the UK economy and society.

Clear, ambitious and long-term public policy measures will be essential to Aviva Investors' ability – and that of our financial sector peers – to commit further investment into the decarbonisation of our portfolios and satisfy growing client demand for opportunities to invest in sustainable businesses and projects which are able to deliver an appropriate level of risk-adjusted returns. Based on the UK's welcome progress to date, this *Roadmap* therefore aims to help policymakers identify some of the key policy priorities for investors over the next five years, to unlock the private investment needed to achieve the UK's 2050 target and deliver an economically successful and socially equitable transition to net-zero emissions.

> Public policy measures will be essential to unlock private investment in the transition to net zero

These recommendations build on the increased flexibility and encouragement to grow investment in low-carbon infrastructure and businesses provided by the Solvency II reforms and the Mansion House Compact.[13] A particular focus of this *Roadmap* is to put forward measures to make low-carbon products and services affordable, easily accessible and desirable for households, thereby **supporting a fair transition to net zero** and growing long-term market demand for low-carbon solutions such as insulation, heat pumps and electric vehicles (EVs).

Aviva Investors has had exposure to businesses and infrastructure across a wide range of low-carbon sectors, from renewable electricity, offshore power networks and electric-vehicle charging infrastructure, through to energy efficient buildings and nature restoration projects (see Figure 1). While important levels of investment have been committed in low-carbon power and the electric-vehicle supply chain over the last ten years, it is clear from our experience that **there is an insufficient pipeline of commercially viable low-carbon projects across most sectors of the economy to meet investor demand for investments in low-carbon infrastructure and businesses that can deliver an appropriate level of risk-adjusted returns**.

In the power sector, this has been partly due to a mix of planning delays for grid infrastructure and a mismatch between rising project costs and limited revenues provided by market mechanisms such as Contracts for Differences (CfD), as was seen in the AR5 auction round for new offshore wind projects in September 2023. In other areas, the policy framework is either yet to be fully finalised (energy efficiency in existing buildings; Carbon Capture, Usage and Storage [CCUS]) or at a relatively early stage of development (low-carbon hydrogen, low-carbon shipping and aviation), thereby creating uncertainty around the specific investment and infrastructure needs for each sector, and limiting the pipeline of commercially viable projects that developers – and subsequently investors – can support and scale up.

> This *Roadmap* puts forward a range of public policy solutions to improve market conditions for low-carbon investment

Based on our experience to date, and given our clients' growing interest in low-carbon investment opportunities, **this *Roadmap* puts forward a range of public policy solutions for the next five years to address some of these issues and further improve market conditions to unlock low-carbon investment at greater pace and scale**. The focus of these recommendations is to **unlock private investment** in low-carbon infrastructure, goods, services, supply chains and businesses across the UK economy, **in a way that delivers both an appropriate level of risk-adjusted returns for investors and an affordable cost of finance for developers, businesses and society**. The *Roadmap* offers **cross-economy recommendations** and **recommendations that are specific to eight key sectors of the economy**. This work builds on recommendations put forward by a range of businesses, trade associations, public bodies and academic institutions, to which we have applied our investment expertise and sectoral insights.

Figure 1. **A snapshot of our exposure to the net-zero transition**

Aviva Investors and Aviva have made a wide range of investments across the UK's low-carbon economy. Examples include:

Renewable energy

Aviva Investors has invested around £3 billon to date in renewable energy and associated infrastructure in the UK and Europe. Highlights from Aviva's investments in the sector include a £400 million investment in one of the world's **largest offshore wind farms at Hornsea One** that can power over one million homes (2018), and providing financing towards the acquisition of **offshore transmission assets at the Hornsea Two Offshore Wind Farm** (2023).[14]

Real estate

As of May 2022, we had originated **over £1.04 billon in climate-transition focused real estate loans**, surpassing our 2025 target of £1 billion of loans three years early.[15]

EV-charging infrastructure

Aviva Investors is investing up to **£150 million in the UK and Ireland's EV-charging infrastructure**, including through a commitment to invest up to £110 million in Connected Kerb to support the company's plans to install up to **190,000 on-street EV chargers by 2030** and €30 million in Erapid to develop further sites across its growing EV-charger network.[16, 17]

Buses

Aviva Capital Partners has partnered with Rock Road and the UK Infrastructure Bank to provide a new funding platform for zero-emission buses. The partnership, alongside a debt facility from the UK Infrastructure Bank and HSBC UK, is committing an initial **£100m to fund up to 250 zero-emission buses and associated infrastructure**.[18]

Rail and ports

Aviva plc had invested over **£3 billion in the UK's rail sector** as at the end of 2022, including £150 million in finance towards rail initiatives in the Midlands and West Country.[19] Aviva plc provided **innovative financing to Associated British Ports (ABP)** with a sustainability-linked interest rate swap repack, which offers a discount to ABP on its hedging rate if it meets certain performance indicators, including a significant reduction in its combined Scope 1 and Scope 2 emissions by 2030, and which we believe to be the first of its kind.[20]

Nature restoration

In partnership with Par Equity, **Aviva Investors acquired 6,300 hectares of moorland in the Glen Dye area of West Aberdeenshire, to carry out a major nature restoration project** to restore 1,800 hectares of peatland and deliver native tree planting on over 3,000 hectares, as part of the Climate Transition Real Assets Fund. Around 1.4 million tonnes of carbon emissions should be sequestered during the project's lifetime, with local jobs created in the process.[21]

Innovation

In 2021, Aviva committed to invest **£50 million into venture capital funds focused on emerging technologies to support the transition to net zero**. This has supported investments in three sustainability focused funds including the EIP Frontier Deep Decarbonisation Fund (energy storage, carbon capture, direct air capture and industrial decarbonisation), the Clean Growth Fund (technology platforms offering zero-carbon services), and the Environmental Technologies Fund (future mobility and energy transition).[22]

Source: Aviva Investors, Aviva, 2024.

Unlocking private investment to deliver net zero

Our recommendations can be grouped under **five core areas of action**:

1. Overcoming systemic hurdles to investment.

2. Using limited public funding in a targeted way to de-risk private low-carbon investment.

3. Accelerating the deployment of clean electricity and low-carbon fuels.

4. Creating enduring markets for low-carbon supply chains.

5. Delivering a fair transition and growing market demand for low-carbon goods and services.

1 Overcoming systemic hurdles to investment

The *Roadmap* identifies a range of key actions to overcome systemic issues that are currently slowing or preventing private investment, including:

a. Delivering a net-zero-aligned planning system to cut planning delays and accelerate investment in low-carbon infrastructure projects

As called for by the National Infrastructure Commission, and energy companies and trade groups such as Renewable UK and Energy UK, this should include:

(i) Embedding the net-zero target in the ***National Planning Policy Framework***;

(ii) Providing **local authorities, planning bodies and regulators with additional resourcing** to efficiently process applications, building on the five-year industry programme to increase skills and capacity in Local Planning Authorities recently launched by the British Chamber of Commerce and supported by Aviva;

(iii) Implementing at pace the positive reforms set out in the Government's ***Transmission Acceleration Action Plan and Connections Action Plan*** to speed up the construction of – and connections to – new power transmission and distribution lines. A more efficient planning system is essential in allowing Aviva to increase investments in UK sustainable infrastructure.[23, 24, 25, 26, 27, 28, 29]

> A more efficient planning system is essential in allowing Aviva to increase investments in UK sustainable infrastructure

b. Tackling existing skills gap through implementing a detailed Green Skills Action Plan

As recognised by the Government's Green Jobs Taskforce, a cross-economy and sector specific plan is required to overcome the significant skills gaps which are slowing down low-carbon investment in sectors such as power grids, renewable power, heating, construction, heavy industry and nature restoration.[30] Such a plan should put forward measures to increase the accessibility of STEM skills and broader low-carbon skills in schools and further/higher education. It should also be focused on delivering a "Just Transition", by introducing measures to deliver skills provision and corresponding financial support to workers in high-carbon sectors who are adjusting to changes in their sector or looking for employment opportunities in low-carbon sectors.

c. Deliver a stronger, gradually increasing and more predictable UK carbon price

This could be done through either further reforms to the UK Emissions Trading Scheme (UK ETS) or a linkage agreement with the EU Emissions Trading Scheme (EU ETS) as already contemplated in the UK – EU Trade and Cooperation Agreement.[31]

As highlighted by trade group Energy UK, the UK's low carbon price – which fell to around £35 per tonne of CO_2 in December 2023, compared to a price of just over €70 under the EU ETS at that time – undermines the investment signal in low-carbon infrastructure and could result in UK businesses facing high carbon costs when exporting to the EU under the EU's newly set up Carbon Border Adjustment Mechanism.[32, 33] A linkage between the UK and EU Emissions Trading Schemes is supported by many business groups such as the CBI, Energy UK, the British Chambers of Commerce, the UK Emissions Trading Group, the Energy Intensive Users Group and the Carbon Capture and Storage Association.[34, 35, 36, 37] A linkage between these schemes would improve liquidity, price discovery and predictability of the future carbon-price trajectory and would deliver greater alignment between the EU and UK Carbon Border Adjustment Mechanisms. It could follow the precedent set by the Swiss – EU Emission Trading Schemes Linkage Agreement, in a way which does not undermine the sovereignty of either party.

Carbon price reforms are a key part of supporting low-carbon investment

d. Implementing at pace the 2018 Resources and Waste Strategy to improve access to high-quality secondary materials and commodities across supply chains

Strategies to decarbonise business operations in sectors such as heavy industries, construction, automotive, energy, electronics and retail often require access to high volumes of affordable and high-quality secondary materials. These include recycled materials such as steel, glass, aluminium, rare earth materials and wastes suitable for sustainable fuel production. To deliver these materials at scale, a comprehensive policy framework including product standards, green public procurement, fiscal incentives and consumer engagement is required to drive resource-efficient product design across sectors, retain secondary materials in the economy and unlock investment in material recovery, sorting, recycling and remanufacturing facilities.[38, 39]

2 Using limited public funding to de-risk low-carbon investment

Public funding has a targeted, but important, role to play in stimulating low-carbon investment across the economy. Recognising the Government's limited ability to deploy new public funding in the current economic context, public investment needs to be carefully focused on accelerating low-carbon innovation and on crowding in private investment in areas where market barriers subsist, and where private investment is not yet flowing at the necessary pace and scale. Public funding – which could be delivered through bodies such as the UK Infrastructure Bank and other similar institutions – could be most effective if targeted towards:

Public investment has a targeted but important role to play in stimulating private low-carbon investment across the economy

a. Areas involving emerging technology risk

This could include first-of-a-kind projects involving the electrification of heavy industrial plants (building on the Government's proposed support for the development of new electric arc furnaces in the steel sector), low-carbon hydrogen production and CCUS technology.[40, 41] As highlighted by the impact on the workforce from the closure of coal blast furnaces at the Port Talbot steelworks, this direct investment should form part of a coherent industrial strategy, with a particular focus on delivering positive outcomes for the workforce.

Direct public investment should form part of a coherent industrial strategy

b. Areas where projects are logistically very complex for private investors

This could include targeted public intervention to attract private investment to support the mass energy-efficiency and low-carbon-heat retrofit of the UK's housing and building stock, with all 28 million homes and two million commercial buildings needing to be low carbon by the mid-2030s.

c. Critical infrastructure that is strategic to economy-wide decarbonisation and the growth of essential supply chains

This could include investment in port infrastructure and battery factories to support the growth of the floating offshore wind and EV supply chains.

3 Accelerating the deployment of clean electricity and low-carbon fuels

In several sectors of the economy – such as surface transport, heating, heavy industry, aviation and shipping – investment in low-carbon solutions and infrastructure will only be possible if plentiful supplies of affordable zero-emission electricity and other low-carbon fuels are available in the near to medium term. Key recommendations for the next five years include:

Economy-wide, low-carbon investment relies on plentiful supplies of affordable zero-emission electricity and low-carbon fuels

a. Strengthening policies to ensure that the power sector is fully decarbonised by 2035

As recommended by bodies such as Renewable UK and Energy UK, this includes:

(i) a full implementation of the **power-grid planning reforms highlighted above;**

(ii) **a regular review of the maximum CfD strike prices** and size of the annual auction funding pot **for offshore wind and other renewables** to ensure annual auctions deliver a high volume of commercially viable projects each year;

(iii) the **completion of the Review of Electricity Market Arrangements** and other related policy reforms to further increase investment in low-carbon generation, grid, storage and flexibility infrastructure, and reduce the price of electricity.[42, 43]

b. Accelerating the delivery of low-carbon hydrogen production and the first storage and transport projects

Eleven green hydrogen projects (renewable-energy based) were given the go ahead, backed by £2 billion of Government funding, under Hydrogen Allocation Round 1.[44] The Government has produced a *Hydrogen Production Delivery Roadmap*, setting out how green, blue (gas+ carbon capture) and other types of hydrogen-production projects meeting the UK's Low Carbon Hydrogen Standard will receive funding support through the newly developed Hydrogen Production Business Model and the Net Zero Hydrogen Fund.[45] A Hydrogen Transport and Storage Networks Pathway has also been developed, setting out next steps for the deployment of hydrogen transport and storage infrastructure. Priorities going forward should be to:

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Green hydrogen projects were given the go ahead under Hydrogen Allocation Round 1

(i) **rapidly grow the pipeline of green hydrogen production projects** through annual allocation rounds through to 2030;

(ii) **grow the pipeline of blue hydrogen projects (gas + carbon capture)** by moving ahead with contract allocations under the CCUS Cluster Sequencing Programme;

(iii) **complete by 2025 the business models and contract allocation for the first hydrogen transport and storage infrastructure projects**.[46]

c. Delivering market deployment policies to accelerate the roll out of low-carbon aviation and shipping fuels

On aviation, this should include delivering an effective implementation of the **Sustainable Aviation Fuel (SAF) Mandate set to come into force in January 2025**, which will require a two per cent share of SAF in the UK aviation fuel mix by 2025, increasing to ten per cent in 2030 and eventually 22 per cent in 2040, to grow the supply of SAFs.[47] This should be underpinned by a revenue certainty mechanism and focused guarantees to support the construction of the first SAF plants as recommended by expert advice commissioned by Government and in line with the Government's ambition for five plants to be under construction by 2025.[48, 49]

Deliver an effective implementation of the SAF Mandate, set to come into force in January 2025

On shipping, this should include introducing **a mandate and revenue-guarantee mechanisms to grow the supply of low-carbon fuels** such as hydrogen, ammonia and methanol as envisaged in the Government's 2022 Course to Zero consultation.[50]

4 Creating enduring markets for low-carbon supply chains

There are a range of sectors where low-carbon technologies and business models are either well established or rapidly progressing through the innovation cycle, but where private investment is not yet being deployed at the necessary pace and scale due to a lack of regulatory measures, fiscal incentives and/or market mechanisms. To address this, this *Roadmap* highlights a range of sector-specific recommendations to plug outstanding policy gaps and deliver enduring market frameworks for low-carbon supply chains.

Recommendations include:

a. Buildings

Introduce minimum regulatory standards and corresponding fiscal incentives to drive investment in energy efficiency in the housing stock and deliver an effective implementation of the Clean Heat Market Mechanism scheduled to start in April 2025, to gradually grow the supply – and cut the cost of – low-carbon heating systems and drive job creation across these supply chains.[51]

b. Surface transport

Deliver a robust implementation – and, subject to market trends, a potential tightening – of the Zero Emission Vehicle (ZEV) mandate for cars and vans to grow the supply of zero-emissions vehicles. Consider their use in other parts of the transport sector such as heavy goods vehicles (HGVs) and buses.

> Deliver a robust implementation and potential tightening of the ZEV mandate

c. Heavy industry

Complete all business models for CCUS projects, allocate part of the £20 billion of Government funding announced in the 2023 Budget to allow the first four shortlisted CCUS cluster projects to go ahead, finalise a strategy to facilitate industrial electrification (including through more competitive power prices), and develop a plan for dispersed industrial sites (i.e., sites not located in industrial clusters) in sectors such as glass and cement to help them connect to carbon capture, hydrogen and grid infrastructure.

d. Nature restoration

Introduce a land-use framework overseen by a coordinating body setting out England's strategy to restore nature through more sustainable land use across different economic activities (e.g., food production, biomass production, afforestation etc), with tangible nature restoration commitments set for – and tailored to – different economic sectors; complete the policy detail, option design and payment rates for agri-environment schemes in England, Wales and Scotland; and complete the different guidelines and investment standards required to create a framework for world-leading nature markets in the UK.

> Introduce a land-use framework to coordinate England's strategy to restore nature through more sustainable land use

5 Delivering a fair transition and growing the market demand for low-carbon solutions

Unlocking private investment at scale in low-carbon infrastructure and businesses is only possible if investors can identify long-term market demand for a range of low-carbon goods and services. This in turn can only be delivered if policies are in place across the economy to make low-carbon products and services affordable, practical and easily accessible for households, citizens and businesses around the country.

This *Roadmap* puts forward a range of "demand side" measures to this effect, including:

a. Buildings

Ensure that effective financial support is in place to support the take-up of insulation and low-carbon heat systems for low-income households and social housing, through improvements to schemes such as ECO4. Provide tailored support for other households through fiscal incentives such as VAT and Stamp Duty rebates and by keeping the overall size of the Boiler Upgrade Scheme under review to support a growing uptake of affordable heat pumps, building on the recent £1.5 billion funding increase.[52]

Provide effective financial incentives to support installation of insulation and low-carbon heat systems

b. Transport

Introduce targeted grants to support consumers with the purchase of affordable EV models until they reach upfront cost parity with petrol and diesel vehicles, explore the possibility of applying the same rate of VAT to public and private EV charging to provide affordable EV charging for all groups of consumers,[53] run an awareness-raising campaign to address concerns around range anxiety, and increase the affordability and accessibility of low-carbon transport alternatives such as rail by undertaking a coordinated review of fare pricing and taxation across all transport modes.

c. Heavy industry

Introduce green public-procurement criteria and mandatory low-carbon product standards on intermediate goods (steel, cement) and finished goods (vehicles) to grow the market demand for and cut the cost of low-carbon industrial goods for businesses and retail consumers. Complementing these tools by implementing Government plans for a UK Carbon Border Adjustment Mechanism by 2027 will also help provide a level playing field for UK heavy industries investing in decarbonising their assets and operations (see points on carbon pricing above).

Introduce green public-procurement criteria and mandatory low-carbon product standards to grow demand for low-carbon industrial goods

A more detailed overview of the most important policy recommendations made in this *Roadmap* is set out at the end of this executive summary, with more in-depth recommendations set out in the following sections. A timeline of the key policy recommendations and targets is also set out in Figures 2 and 3.

Navigating the *Roadmap*

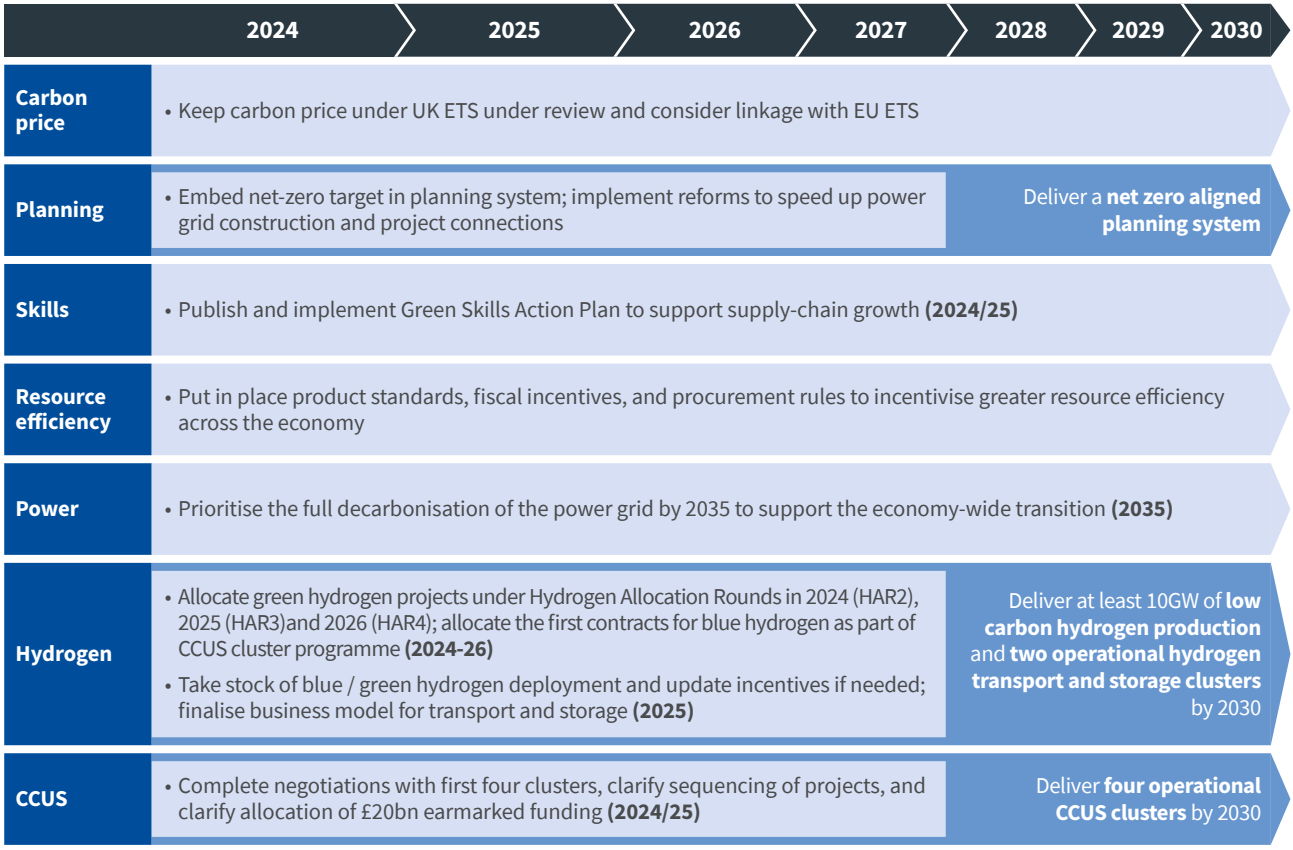
Following the executive summary, this *Roadmap* first puts forward **a range of cross-economy policy levers** to stimulate low-carbon investment across multiple sectors of the UK economy. It then provides **a range of sector specific solutions** to plug existing policy gaps that are currently slowing private investment flows, with a focus on the following sectors and activities: **power, heavy industry** (foundation and energy intensive industries such as steel, cement, chemicals, glass, ceramics), **surface transport** (cars, vans, HGVs, buses and rail), **buildings** (energy efficiency and heat), **aviation, shipping, nature restoration** (through sustainable agricultural and land use practices) and **engineered carbon removals**. Each section of the *Roadmap* contains a table summarising the key public policy solutions to overcome existing challenges and the benefits these solutions can bring in terms of unlocking investment.

This *Roadmap* **does not seek to express technological preferences in the transition to net zero**. It highlights what is required to improve the investment context for the different low-carbon technologies and solutions that currently feature in the scenarios and pathways put forward by the Government and key public bodies such as the Climate Change Committee (CCC). These scenarios contain a wide range of technologies which are at different stages of technical and commercial maturity. We note that the deployment potential for technologies that are not yet widely commercially available – such as low-carbon hydrogen, carbon capture and engineered carbon removals – is subject to a higher degree of uncertainty than for more established technologies such as offshore wind and electric vehicles.

This *Roadmap* highlights what is required to improve the investment context for low-carbon technologies and solutions across the economy

References to new public funding commitments in this *Roadmap* are made on the understanding that UK public finances face important constraints and that the potential to deploy additional public investment in the near-term is therefore limited and needs to be targeted towards the most material market barriers. Other references to public funding in this *Roadmap* refer to existing public funding pots which have either not yet been fully deployed or where there is an investment case to extend these further into the future.

Figure 2. **The *Roadmap's* recommendations in a timeline: Cross economy**



Source: Aviva Investors, April 2024.

Figure 3. **The Roadmap's recommendations in a timeline: Sector-specific**

	2024	2025	2026	2027	2028	2029	2030
Power	• Complete the Review of Electricity Market Arrangements and gradually implement reforms to accelerate investment in renewables, grid, energy storage and flexibility technologies, and cut the cost of electricity **(from 2025)** • Keep CfD strike prices and auction pot sizes under review to maximise volume of commercially viable offshore wind projects				Unlock investment towards a **decarbonised power grid** by 2035 or sooner		
Heavy industry	• Implement British Industry Supercharger package and consider further reforms to cut industrial electricity costs **(2024/25)** • Develop product standards and green public procurement rules to grow the demand for low carbon industrial products **(from 2024)** • Complete design of UK carbon price levy **(2027)**				Decarbonise **heavy industry** and grow low carbon industrial supply chains		
Surface transport	• Implement the ZEV mandate (2024) so that zero-emission vehicles achieve at least 80% of new car sales and 70% of van sales by 2030; double annual installation of charging points; provide targeted grants to support consumers with upfront EV costs **(2024-30)** • Put in place enablers to achieve 75% rail freight growth target; review fare and taxation framework across all transport modes to improve the affordability and grow market demand for low carbon travel options, such as rail				Decarbonise **road transport** and grow zero emission vehicle supply chains		
Buildings	• Implement the Future Homes + Buildings Standard (2025), introduce minimum regulatory energy efficiency standards and fiscal incentives to drive energy efficiency investment in existing homes (2025/26) and review social housing schemes such as ECO4 to support the installation of efficiency and low carbon heat measures **(2025/26)** • Implement a Clean Heat Market Mechanism to grow the supply of low carbon heat solutions and heat pumps, and keep the overall funding pot size in the Boiler Upgrade Scheme under review **(from 2024)**				Drive significant take-up of **energy efficiency** and **low-carbon heat** by 2035		
Aviation	• Accelerate deployment of innovation funding under the Aerospace Technology Institute Programme to support hybrid, hydrogen and electric aircraft **(from 2025)** • Introduce a Sustainable Aviation Fuel (SAF) mandate with strong environmental criteria and a revenue certainty mechanism for SAF production by 2025. Support construction of five SAF plants by 2030 **(2025-30)**				Deliver 10% SAFs in the **aviation** fuel mix by 2030		
Shipping	• Publish a Clean Maritime Plan for the UK shipping sector, with a focus on investment in innovation, a low-carbon fuel mandate, revenue-certainty mechanisms, and investment in shore power infrastructure **(2024/25)** • Implement the new Clean Maritime Plan				Work towards net zero **shipping** by 2050		
Nature restoration	• Implement a co-ordinated Land Use Framework; progress agri-environment schemes in England and devolved nations **(2024/25)** • Develop rules and investment standards under the Nature Markets Framework **(2024-26)** • Implement the Environmental Improvement Plan (EIP) and broaden Environment Act targets **(until 2030)**				Deliver a pipeline of **nature restoration projects** through land use and agriculture		
Engineered removals	• Complete the business models for Greenhouse Gas Removals (GGRs), and clarify the integration with the CCUS Cluster Sequencing Programme and with CCS transport and storage infrastructure **(2024/25)** • Put in place robust sustainability criteria on MRV for negative emissions and on the prioritisation, production, and use of biomass as well as enhanced compliance criteria **(2024-30)**				Capture **5m tonnes** of CO_2 annually from 2030 through engineered removals		

Source: Aviva Investors, April 2024.

Summary of key policy recommendations

Sector and areas of action	Recommendation	Expected benefit and context
Cross-economy		
Tackling **planning delays** (Section 1)	• Embed the **net-zero target across the planning system**, through: (i) regular updates to the **National Planning Policy Framework** and associated **National Policy Statements**; (ii) using the recently created **ministerial planning forum to regularly identify and address planning barriers** to major low-carbon projects; (iii) providing greater resourcing to local and other planning authorities and regulators to support efficient decision-making, building on the industry programme recently launched by the British Chamber of Commerce to increase skills and capacity in Local Planning Authorities.[54, 55]	• Incorporating the net-zero target as a key delivery objective for the planning system – backed by adequate resourcing for planning bodies and regulators – will help accelerate planning consents and unlock investment in critical low-carbon infrastructure projects. • This should happen hand in hand with implementing: (i) the *Transmission Acceleration Action Plan* and *Connections Action Plan* to cut planning and connection delays for power-grid and clean-power infrastructure (see below); (ii) implementing the operational reforms announced in March 2024 to reduce timelines and improve the flexibility of the planning consenting process for nationally significant infrastructure projects.[56]
Directing **public funding** towards market barriers (Section 1)	• **Within the constraints facing UK public finances, deploy targeted public funding to accelerate low-carbon innovation and crowd in private investment in areas where market barriers subsist** and private investment is not yet flowing at the necessary pace and scale. This could include directing a degree of public funding towards three **key pillars**: (i) **areas involving emerging technology risk** (such as first-of-a-kind low carbon industrial plant, CCUS, low-carbon hydrogen); (ii) **projects that are logistically complex for private investors** (such as the mass installation of energy-efficiency measures and low-carbon heat in homes); (iii) **infrastructure that is critical for economy-wide decarbonisation and supply-chain growth** (such as investment in ports and gigafactories to support offshore wind and EV supply-chain growth).	• In light of the constraints facing UK public finances, the potential to deploy new public funding is limited and therefore needs to be targeted at areas where it can have the most material impact in terms of unlocking private low-carbon investment. • Building on welcome commitments in the *2023 Autumn Statement* and *2024 Spring Budget* to invest around £5 billion of public funding into advanced low-carbon manufacturing sectors, including through the £1.1 billion Green Industries Growth Accelerator, **a strategic approach to the deployment of public funding should have the objective of de-risking and crowding in private investment in areas where market barriers are the greatest**. This could include areas involving emerging technologies and business models, highly complex projects, and strategic infrastructure that is essential to support economy-wide decarbonisation and supply chain growth. • This funding could be distributed in a range of ways, including through new or established institutions (such as the UK Infrastructure Bank) and sector-specific investment vehicles.
Strengthening the **UK carbon price** (Section 1)	• Consider **further reforms to the UK ETS to strengthen the carbon price and deliver a more predictable future trajectory**. • As already contemplated in the UK-EU Trade and Co-operation Agreement, options to consider should include **a linkage with the EU ETS**, building on the precedent set by the EU-Swiss Emissions Trading Schemes Linkage Agreement.[57,58] • A linkage between the UK and EU Emissions Trading Schemes has been called for by a number of business groups including the CBI, Energy UK, the British Chambers of Commerce, the UK Emissions Trading Group, the Energy Intensive Users Group and the Carbon Capture and Storage Association.[59,60,61,62]	• Despite the July 2023 amendments to the UK ETS, **the UK carbon price fell significantly in summer and autumn 2023, down to around £35/t in December 2023**, equivalent to approximately half the value of carbon under the EU ETS at that time.[63] This undermines the low-carbon investment signal for investors and could result in UK exporters to the EU facing high carbon costs under the EU's Carbon Border Adjustment Mechanism. • **Further reforms** to tighten the emissions reduction pathway under the UK ETS – **including by means of a linkage** and price convergence with the EU ETS – **could strengthen the carbon price, improve market liquidity and carbon price discovery, provide a predictable pricing trajectory for investors** and help align the UK's and the EU's Carbon Border Adjustment Mechanisms.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Cross-economy		
Increasing the **availability of affordable clean electricity and low-carbon fuels** to support economy-wide decarbonisation (Sections 1, 2, 3, 6 and 7)	• **Electrification: Complete market deployment policies and planning reforms to ensure the power sector is affordably and fully decarbonised by 2035**, with sufficient added capacity to support the electrification of several parts of the economy such as surface transport, heating and heavy industry. *See specific power sector recommendations below.* • **Hydrogen:** (i) **grow the pipeline of green-hydrogen production projects** (based on renewable energy) over the next three years through Hydrogen Allocation Rounds 2 to 4 and through further annual allocation rounds out to 2030; (ii) grow the pipeline of **blue-hydrogen production projects (gas + carbon capture)** through contract allocation under the CCUS cluster sequencing programme; (iii) **carry out an assessment of early progress in 2025** to update the deployment projections and supportive policies for all types of hydrogen production; and (iv) **complete the business models and first projects allocation for hydrogen transport and storage infrastructure by 2025.** *See specific recommendations on heavy industry below.* • **Low-carbon fuels for shipping and aviation:** Complete market deployment policies to **grow the availability of sustainable aviation fuels and low-carbon fuels for shipping** (hydrogen, ammonia, methanol). *See specific recommendations on aviation and shipping below.*	• **Overview:** In sectors such as surface transport, heating, heavy industry, shipping and aviation, **investment in low-carbon solutions will only be possible if plentiful supplies of affordable zero-emissions electricity and other low-carbon fuels are available in the near to medium term**. Policies to accelerate their market deployment and affordability must be prioritised to unlock private investment. • **Hydrogen production:** The Government has **a target of 10GW of low-carbon hydrogen production capacity by 2030**, with 6GW coming from renewable-energy-based "green hydrogen", and 4GW from "blue hydrogen" (produced using natural gas; the carbon generated is captured). The *Hydrogen Production Delivery Roadmap* sets out how green, blue and other types of hydrogen-production projects meeting the UK's Low Carbon Hydrogen Standard will receive funding support through the Hydrogen Production Business Model and the £240 million Net Zero Hydrogen Fund.[64,65,66,67] • **Green-hydrogen production:** Eleven green hydrogen projects (125MW capacity), which were backed by £2 billion of Government funding over 15 years and are expected to unlock £400 million of private investment in the next three years, were given the go-ahead in December 2023 under Hydrogen Allocation Round 1 (HAR1).[68] In February 2024, an extra £21 million of government support for seven new green hydrogen projects was announced.[69] **Under the *Hydrogen Production Delivery Roadmap,* HAR2 (875MW capacity – 2024), and HAR3 and 4 (combined capacity of 1.5GW – 2025 and 2026) are expected to give the go-ahead to a growing pipeline of green-hydrogen production projects**, with the Strategy contemplating potential further annual auctions out to 2030.[70] • **Blue-hydrogen production:** While supported by the same Hydrogen Production Business Model as green-hydrogen projects, blue-hydrogen projects are to be awarded contracts under the CCUS Cluster Sequencing Programme. However, negotiations for the first CCUS cluster projects are still ongoing and **contractual arrangements for the first blue-hydrogen projects have therefore not yet been finalised**. • **Hydrogen transport and storage:** The *Hydrogen Transport and Storage Networks Pathway* aims to develop the first business models for hydrogen storage facilities and associated pipeline infrastructure by 2025, with **two storage sites and pipelines in operation or construction by 2030**.[71] • **Aviation and shipping fuels:** The Government is developing a mandate to set **a ten per cent share of sustainable aviation fuel in the UK aviation fuel mix by 2030**, but market penetration is currently small. The market penetration for sustainable shipping fuels is near zero.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Cross-economy		
Developing strong sustainability criteria for sustainable fuels and biomass (Sections 1, 4, 6, 7 and 9)	• Ensure that policies promoting new sustainable fuels in sectors such as aviation and shipping are subject to **sufficiently stringent emissions reduction requirements** compared to conventional fuels to meet the UK's emissions reduction targets. • Build on the *2023 Biomass Strategy* by: (i) continuing to **refine the UK's strategy on the priority uses of biomass** with a focus on hard-to-abate sectors where alternatives are currently limited; (ii) publishing **a common sustainability framework for the use of biomass** across different economic sectors; (iii) publishing a Low Carbon Fuels Strategy.[72] *See more detail on biomass sustainability considerations in GGR section below*.	• Developing stringent and transparent emissions reduction criteria for sustainable fuels – such as those set to be introduced under the UK SAF Mandate in the aviation sector from January 2025 – is essential to achieve emissions reduction targets and avoid the risk of greenwashing which could tarnish public perceptions of sustainable fuels. • **A coordinated approach to** the **sustainability criteria**, development and use of biomass energy and waste-based fuels **is essential to ensure that investment in these scarce resources is directed towards those industry sectors that need them the most** and where low-carbon alternatives are currently limited.
Strengthening **cross-departmental coordination on net zero policy** making (Section 1)	• Put in place a **Net Zero Delivery Unit** jointly run by Cabinet Office, Department for Energy Security and Net Zero (DESNZ) and HM Treasury to streamline net-zero policymaking across Whitehall. • Include the delivery of **the net-zero target as a core objective in HM Treasury's organisational delivery plan**, with annual updates on progress independently reviewed by the Office for Budget Responsibility (OBR) and the CCC.[73]	• The transition to net-zero emissions will affect all sectors of the economy. **Decisions in one sector (such as power) will have knock-on impacts on others (such as transport, heating and heavy industry)**. Putting in place enduring structures across Whitehall to increase consistency and cross-departmental coordination will deliver a joined up and predictable policy framework for investors.
Addressing low-carbon **skills gaps** (Section 1)	• Put in place and implement **a detailed Green Skills Action Plan** to urgently tackle skills gaps across key economic sectors such as power grids, renewables, construction, heating, heavy industry and nature restoration. • As recommended by the *Green Jobs Taskforce,* the implementation of this plan should include **skilling-up schemes and support measures directed at both**: (i) **the future workforce** with a particular focus on embedding STEM skills and other low-carbon skills across the education system; (ii) **those already in the workforce**, with a focus on providing the necessary financial support and training to workers adjusting to changes in their sectors or transitioning from high-carbon to low-carbon activities.[74]	• The development and implementation of a detailed action plan will help tackle major low-carbon skills gaps (such as on STEM skills), observed in multiple sectors of the economy. This will help unlock investment to grow low-carbon supply chains across the economy, in areas such as power grids, heat pumps, construction and nature restoration. • Directing skills provision measures at both the current and future workforce will help deliver a Just Transition and ensure that a wide cross-section of the workforce is well equipped to benefit from the employment opportunities created by the net-zero transition.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Power – supply side		
Tackling **grid construction and connection** delays (Section 2)	• **Implement at pace the welcome commitments set out in the Government's *Transmission Acceleration Action Plan* to cut construction time for new transmission infrastructure.**[75] Important commitments include implementing a Strategic Spatial Energy Plan, modernising the regulatory and planning approval processes and increasing public engagement to grow support for grid infrastructure. • **In parallel, implement at pace the six key actions outlined in the Government/Office of Gas and Electricity Markets (Ofgem) *Connections Action Plan* to cut grid-connection queue delays for new clean-power projects.**[76] A particular focus should be on prioritising awarding connection dates to those projects that are most strategic and likely to progress quickest.	• Following the *Nick Winser Review,* implementing the regulatory and administrative reforms set out in the *Transmission Acceleration Action Plan* could **halve the construction time for new power-grid infrastructure in the UK from 14 years to seven years**, thereby improving the business case and accelerating investment in grid extensions and reinforcements.[77] • Implementing the grid-connection queue reforms set out in the *Connections Action Plan* could significantly cut the deployment time for large projects such as offshore wind, which in some cases have had connection dates to the grid set ten years out into the future.
Improving the **commercial viability of offshore wind** (Section 2)	• Build on the £1 billion funding pot announced for the AR6 renewables auction round in September 2024 and the recent increase to maximum CfD strike prices for offshore wind and floating offshore wind by **regularly reviewing the overall funding pot and level of strike prices for offshore wind, floating offshore wind and other renewables** to ensure eligible revenues for new projects sufficiently reflect the evolution of the underlying supply chain and finance costs for these projects.[78]	• Regularly reviewing the maximum CfD strike prices and overall auction funding pot is essential to: (i) improve the long-term commercial viability of – and investment case for – new offshore wind projects and other renewables; (ii) to ensure that a growing volume of projects come through annual auctions from 2025 onwards. This will help **plug the capacity gap created by the lack of offshore wind projects supported at the September 2023 AR5 allocation round**.
Power – supply and demand side		
Review of Electricity Market Arrangements (REMA) and additional reforms to deliver more competitive electricity prices (Section 2)	• Build on the March 2024 consultation to complete the **REMA** reforms. Key objectives should be to: (i) accelerate further investment in renewables, flexibility tools, short-duration storage and long-duration storage (such as long-duration electricity storage [LDES] and Hydrogen to Power plants); (ii) reduce system constraint costs; (iii) better reflect the falling cost of renewables in the overall price of electricity.[79,80] • To support investment confidence and as called for by the energy sector, **reforms should be implemented in a way which minimises disruption to low-carbon investment in the near-term** and increases long-term investment certainty.[81] • In parallel with the completion of REMA and as called for by industry groups such as UK Steel, Make UK and the Energy Intensive Users Group, **facilitate the development of additional solutions to provide energy-intensive industrial sectors such as steel, cement and chemicals with greater access to low-cost renewable electricity.**[82] • In addition to implementing the cost reduction measures set out in the *British Industry Supercharger Package,* additional support to heavy industries could include options such as facilitating a growing use of zero-carbon Power Purchase Agreements.[83,84,85]	• Completing the REMA reforms and implementing them in a gradual way will provide greater clarity to investors on the future market conditions for investment in renewables, grid, short- and long-term storage and demand-side response infrastructure. By unlocking this investment at scale, these reforms could further reduce power-sector emissions, improve energy security and have a downward impact on electricity prices, thereby incentivising the broader electrification of the economy. • Broader reforms to deliver a more effective passing through of reduced renewable-energy project costs onto electricity prices will improve the business case for – and accelerate investment in – the affordable electrification of key sectors of the economy, such as steel and cement, and the growing use of heat pumps in homes and buildings. • UK heavy industrial electricity prices were between 25 per cent and 44 per cent higher than the European average in 2019.[86,87] A UK Steel report suggests that in the 2023/2024 fiscal year, UK steel manufacturers paid electricity prices that were 86 per cent higher than their competitors in France and Germany.[88] • The Government introduced a *British Industry Supercharger Package* in April 2024 to provide energy-intensive sectors like steel, paper and chemicals with a degree of compensation for electricity networks, renewable-energy policies and capacity market costs. However, some industry groups believe that the measures will still leave an electricity price competitiveness gap with their European competitors.[89]

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Heavy industry		
Finalising critical **funding arrangements and business models for electrification, CCUS and hydrogen** (Section 3)	• **Electrification:** Building on the electricity market and policy reforms above and the recent call for evidence, finalise a strategy to facilitate **industrial electrification,** including by means of lower industrial power prices.[90] • **CCUS:** Complete the **market framework for initial CCUS projects**, by clarifying the sequencing of the CCUS Cluster Programme, how and when the £20 billion earmarked for CCUS in the *2023 Spring Budget* will be allocated to specific projects and completing the business models for the transport of CO_2. • **Hydrogen:** Clarify the investment opportunity for low-carbon hydrogen production, by: (i) **growing a pipeline of green-hydrogen production projects** over the next three years through Hydrogen Allocation Rounds 2 to 4, and through further annual allocation rounds out to 2030; (ii) growing the pipeline of **blue-hydrogen production projects (gas + carbon capture)** through contract allocation under the CCUS Cluster Sequencing Programme; (iii) **completing the first business models for hydrogen transport and storage by 2025**; and (iv) giving the go-ahead to the first two hydrogen storage and transport projects in 2025 so that these can connect to industrial clusters by the early 2030s. *See detailed recommendations in cross-economy section above.* • As called for by many energy-intensive businesses, put in place **a plan for industrial dispersed sites** in sectors like cement and glass, so that these can ultimately have access to critical carbon capture and storage (CCS) and hydrogen infrastructure that will be primarily located in clusters.[91]	• **Electrification:** The availability of **plentiful volumes of low-carbon electricity will be essential to drive investment in** the full or partial **electrification of sectors such as steel, cement, chemicals, glass and ceramics**. • **CCUS:** £20 billion of funding over the next 20 years was allocated to support the first CCUS projects in the *2023 Spring Budget*.[92] Completing the business model framework, funding allocation timelines for different types of CCS, and negotiations for the first CCUS cluster projects will be essential to drive investment in early projects. • **Hydrogen production:** Growing the pipeline of low-carbon hydrogen production projects through forthcoming Hydrogen Allocation Rounds and the CCUS Cluster Sequencing Programme will help unlock private investment in these projects and meet the Government's target of 10GW of low-carbon hydrogen production capacity (green + blue) by 2030. • **Hydrogen transport and storage:** The *Hydrogen Transport and Storage Networks Pathway* identifies the major power and industrial clusters as likely to be priority sites for hydrogen transport and storage infrastructure to support the decarbonisation of those sites by the early 2030s.[93] To unlock investment at the necessary pace and scale in onshore hydrogen facilities and associated pipelines for those sites, **investors will require completed business models for transport and storage and clarification on chosen projects by around 2025**.
Introducing measures to **grow the demand for low-carbon industrial goods** (Section 3)	• Introduce **demand-side measures** such as **green public-procurement** reform, low-carbon **product standards** and a carefully designed **Carbon Border Adjustment Mechanism (CBAM)** to grow the demand for low-carbon industrial products and create a level playing field for UK businesses. *See also the recommendations on carbon-pricing reform above.*	• **Demand-side measures are essential to create long-term market demand and a level playing field for low-carbon industrial goods.** This will attract long-term private investment in low-carbon industrial supply chains, gradually reducing the need for public funding. The Government has committed to introducing **a UK CBAM by 2027**, with consultation on the scheme's details expected in 2024.[94]
Surface transport		
Providing **stable market signals to the zero-emission vehicles supply chain**: cars, vans, HGVs, buses (Section 4)	• Deliver an **effective implementation and ratcheting up of the ZEV mandate from 2024 onwards**, ensuring compatibility with the target of 100 per cent zero-emission cars and vans sales by 2035 or sooner. Consider implementing **similar schemes for buses and HGVs**. • Closely monitor the learnings from the £200 million zero-emission HGVs pilot projects funded by Government/Innovate UK and **make a rapid and evidence-based decision on the preferred decarbonisation route(s) for HGVs**.[95]	• An effective implementation of the ZEV mandate will **stimulate growing investment in zero-emission vehicles manufacturing, reduce the costs of these vehicles and help grow long-term market demand**. This will have positive knock-on impacts on investment in supply chains and charging infrastructure. • There are currently **three main routes being explored to decarbonise HGVs, each with significant underlying infrastructure requirements**. Accelerating the pace of pilot projects and making early, informed decisions on the preferred decarbonisation pathway(s) could stimulate early private investment in zero-emission HGV supply chains and put UK businesses at the forefront of the global zero-emission HGV market.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Surface transport		
Prioritising the roll-out of **charging infrastructure** (Section 4)	• Complete the **installation of rapid-charging infrastructure** (and supportive power infrastructure) across the **strategic road network**, building on – and increasing the effectiveness of – the existing **Rapid Charging Fund**. • Prioritise the **doubling of annually installed charge points** to support the growth of the EV market. As part of this, explore the possibility of **applying the same rate of VAT to public and private EV charging** to provide affordable EV charging for all groups of consumers, in line with the *Net Zero Review*, and as called for by a range of industry groups including the Society of Motor Manufacturers and Traders and the Fair Charge campaign and backed by industry names such as Jaguar Land Rover and E.ON.[96,97,98,99] • Direct investment to **tackle the lack of charging infrastructure in rural areas** and the **disparities in charging-points coverage between local authorities,** such as through a more rapid delivery of funding already allocated under the **Local Electric Vehicle Infrastructure scheme (LEVI)**, and through an extension of the funding beyond 2025.[100]	• The EV-charging infrastructure network **grew by one third in 2022**. However, an acceleration of the EV-charging infrastructure roll-out across nationally strategic and local roads is necessary to maintain EV-market growth. **The number of annually installed charge points needs to double to keep pace with the projected uptake of EVs.**[101] • Private EV charging is subject to a lower rate of VAT (five per cent) than VAT applicable for public charge points. Applying the same lower rate of VAT to both types of charging will improve the affordability of charging for all consumer groups. • The development at pace of charging infrastructure on both strategic national roads and local road networks is **key to strengthen consumer perception of the reliability of electric cars and vans**, thereby supporting long-term market demand.
Supporting consumer uptake of zero-emission vehicles (Section 4)	• As recently recommended by the House of Lords Environment Committee, introduce **targeted grants to support consumers with the purchase of new, affordable zero-emission vehicle models** until such time as the upfront cost of EVs reaches parity with that of petrol and diesel vehicles.[102] • Work closely with industry to: (i) **introduce additional quality assurance schemes for used EVs** – such as by introducing **a cross-industry battery health standard**; (ii) consider **introducing targeted grants for used EVs** as seen in other markets such as the Netherlands.[103] • **Address consumer concerns around range anxiety** by carrying out **an awareness-raising campaign** on the extent to which electric vehicles can already match consumer needs and current driving patterns.[104]	• Despite recent growth, **the market demand for EVs and investment in EV supply chains are still being held back** due to: (i) the difference between the upfront cost of EVs and that of petrol and diesel vehicles; (i) the limited size of the used EV market; (iii) consumer concerns around range anxiety. • In addition to the downward price pressure which should be achieved through the implementation of the ZEV mandate, **financial support with the purchase cost of new EVs will help maintain steady demand growth until such time as the upfront costs of EVs reach parity with petrol and diesel vehicles**, thereby supporting continued investment in the EV supply chain. • **EVs represented only one per cent of used car sales in 2022**, with concerns around battery lifespan and upfront cost listed as key concerns.[105] Introducing independent quality-assurance standards and targeted grants is key to improve consumer confidence in the used EV market and improve its affordability, thereby growing overall EV market penetration. • An evidence-based awareness raising campaign could go a long way to addressing consumer concerns on range anxiety and supporting growing market penetration for EVs.
Encouraging investment in low-carbon alternatives (Section 4)	• Building on the welcome 75 per cent **rail freight growth target for 2050, develop a long-term plan to enhance the capacity, reliability and affordability of the railway network** to support growth in rail freight and passenger traffic and a shift away from road transport.[106]	• Clear targets and supportive measures to drive a shift from road to rail for passengers and freight will **drive investment in the railway network**, thereby optimising its pivotal role in the transport sector's transition to net zero.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Buildings – energy efficiency and low-carbon heat		
A long-term **policy plan for the decarbonisation of homes and buildings** (Section 5)	• Put forward **a long-term policy plan for the decarbonisation of homes and commercial buildings**, combining: (i) minimum **regulatory energy-efficiency standards** with (ii) **fiscal incentives** to drive the take-up of energy-efficiency and low-carbon heat measures. *See more below on heat.* • Building on the *Future Homes and Buildings Standards Consultation,* complete the **technical details for the Future Home Standard and Future Buildings Standard**, ensuring that all new homes and commercial buildings built from 2025 meet high levels of energy efficiency, renewable electricity low-carbon heat provision and resilience to extreme weather events.[107]	• Around **28 million homes and two million commercial buildings need to be highly energy efficient and equipped with a low-carbon source of heat by the mid-2030s**. A predictable, long-term policy plan will be essential to attract investment at the necessary pace and scale and at a reasonable cost of finance. • A combination of long-term regulatory signals and fiscal incentives is essential to build a predictable market for the growing uptake of energy-efficiency and low-carbon heat measures, thereby driving supply-chain growth, investment in skills and cost reductions.
Decisive interventions to **improve investment clarity for low-carbon heating** (Section 5)	• **Strategic decisions on heat and the role of hydrogen:** Building on the steer provided in the Government's *Future Homes and Buildings Standards Consultation* and as called for by the National Infrastructure Commission, clarify that heat pumps – and in specific areas heat networks – are the default low-carbon heat options for new and existing buildings.[108, 109] Make **a final decision on the limited role of hydrogen in home heating as soon as possible** and well before the current 2026 deadline. • **Heat pumps:** Deliver **an effective implementation of the Clean Heat Market Mechanism from its scheduled start date in 2025 onwards, and gradually increase the minimum targets for the share of heat pumps** in overall boiler sales to grow the availability of heat pumps for households, cut their costs and send a clear supply-chain growth signal.[110] • **Heat pumps and Boiler Upgrade Scheme (BUS):** Building on the recent increases to heat-pump grants and the overall size of the BUS scheme,[111] keep **the overall budget for the BUS scheme under regular review** and consider increasing it if necessary to drive higher heat-pump uptake. Introduce **equivalent schemes for large heat pumps** suitable for commercial buildings. • **Heat networks:** Following the enabling powers under the Energy Act 2023, work with Ofgem to **complete a regulatory framework for heat networks and heat-networks zoning by 2025**.[112] • **Heat networks: Deploy the funding already earmarked until 2028 under the Green Heat Network Fund and Heat Network Efficiency Scheme to accelerate the roll-out of heat networks** and consider a potential extension of that funding beyond 2028 if required. Ensure that policy support for heat pumps does not undermine the commercial case for heat networks where they are the best option.	• **Strategic decisions on heat and the role of hydrogen:** As made clear by the National Infrastructure Commission, the Climate Change Committee and a range of other bodies, there is **ample evidence that electric heat pumps – and in specific areas, heat networks – are the most suitable form of low-carbon heating for the majority of properties, with only a limited role for hydrogen boilers**.[113] The Government's *Future Homes and Buildings Standards Consultation* identifies heat pumps, electrification and low-carbon heat networks as a default option for new homes and buildings. • Bringing forward the decision on the role of hydrogen in heating will clarify the future heating technology mix for investors and accelerate much needed investment in heat-pump and heat-networks supply chains. • **Heat pumps:** The Clean Heat Market Mechanism is due to start in April 2025, mandating large manufacturers meet a growing minimum percentage of heat-pump sales as part of overall boiler sales, starting at six per cent in 2025/2026, and increasing further after that.[114] **An effective implementation and tightening of the Mechanism over time will help investors forecast the growth of the heat-pump manufacturing market in the 2020s**, encourage investment in the supply chain and support job creation. • **Heat pumps and Boiler Upgrade Scheme (BUS):** Regularly reviewing the adequacy of the overall budget for funding schemes such as BUS will improve the affordability of low-emissions heating systems in the near to medium term for households and businesses, support market growth and accelerate cost reductions in the manufacturing of these systems through economies of scale. • **Heat networks:** Finalising a regulatory framework for heat networks and zoning will be essential to drive investment in these networks at the necessary pace and scale. A coordinated approach to low-carbon heat policy is important to support the commercial viability of new heat networks.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Buildings – energy efficiency and low-carbon heat		
A predictable framework for **social housing and public buildings** (Section 5)	• **Review the effectiveness of existing grant schemes for social housing and fuel-poor homes** – such as ECO4 – to increase the uptake of energy-efficiency and low-carbon heat measures. • **Deliver at pace the funding already earmarked under the Public Sector Decarbonisation Scheme** until 2028 to support investment in energy efficiency and low-carbon heating in public buildings, and clarify future funding and policy support beyond that date.[115]	• Schemes like ECO4 currently provide **little support for the installation of low-carbon heat measures relative to gas boilers**. Improving the effectiveness of the grants available for social housing and fuel-poor homes will drive investment in the installation of the best energy-efficiency and low-carbon heat measures in these properties. • Clarity on the funding and policy commitments for the installation of energy-efficiency and low-carbon heat measures in public buildings beyond 2028 will help maintain steady investment flows.
Aviation		
Global mechanisms and carbon pricing to achieve net-zero aviation emissions by 2050 (Section 6)	• Push for **credible global delivery mechanisms** within the International Civil Aviation Organisation (ICAO) to achieve the 2050 global net-zero aviation emissions target. This should include making the case for the global Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to deliver a carbon price that predictably increases in value and covers a growing scope of global aviation emissions over time.	• **Globally agreed delivery policies, underpinned by a strong carbon price covering an increasing scope of emissions, will be essential to accelerate global innovation** and market deployment of low-emission aviation fuels and low-emission aircraft. • A stronger global carbon price with a broader application for aviation will also reduce the current disparity between the higher carbon price under the UK and EU ETS applicable to short-haul flights, and the lower carbon price applicable to long-haul flights under CORSIA.
Completing the **market framework** to create a UK **Sustainable Aviation Fuel (SAF)** supply chain (Section 6)	• Deliver an effective implementation of the **SAF Mandate** from its scheduled start in January 2025, requiring a **gradually increasing share of SAFs in the UK aviation fuel mix** to reach at least ten per cent in 2030, with continued growth out to 2040. • Conclude the consultation and make a decision on the design of a **revenue certainty mechanism** to de-risk investment in the UK's first SAF plants, such as through the preferred option of a CfD-style guaranteed strike price for the production of SAFs and focused guarantees for the first manufacturing projects. • Through the implementation of the SAF mandate and the development of a revenue certainty mechanism, **focus on incentivising a growing share of second-generation waste-based and advanced SAFs** which are less dependent on limited resources. • Look for **opportunities for policy collaboration and alignment** on growing SAF supply chains with international partners such as the US and the EU.	• The Government's proposal for a SAF Mandate – due to be approved by Parliament in summer 2024 – targets **a minimum share of SAF on a blended basis in the UK aviation fuel mix of at least two per cent in 2025, rising to ten per cent in 2030 and 22 per cent in 2040, with a sub-target for advanced Power to Liquids fuels (PtL)**. Implementing the SAF Mandate from early 2025, as planned, is essential to provide near-term clarity to the aviation industry, its supply chain and investors on the expected market growth for SAFs in the UK. This is particularly important for second-generation waste-based and more advanced SAFs where the UK currently has a competitive advantage.[116] • A final decision on the complementary policies to the SAF Mandate is needed to provide a degree of revenue predictability to investors in the first UK SAF plants and overcome challenges around the emerging nature of this industry. • **Using incentives to stimulate investment, growth, and cost reductions in second generation SAFs** (such as waste-based fuels and other advanced fuels such as PtL) **is essential as some of these fuels are less dependent on limited feedstocks** and may in some cases offer greater emissions reduction savings potential. • **The EU, US, UK and other international partners are currently developing different approaches to supporting the growth of the SAF sector**. Collaboration with key international partners will help accelerate the growth of SAF supply chains and help provide a more coherent policy framework for SAF manufacturers, airlines and investors.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Aviation		
Ramping up **innovation in other low-emission aircraft solutions beyond SAFs** (Section 6)	• Deploy at pace the £975 million of **innovation funding** awarded in the *2023 Autumn Statement* to the Aerospace Technology Institute Programme for 2025-2030 to support innovation in a range of hybrid and zero-emission aircraft solutions (fully electric and hydrogen), as well as to improve understanding of the non-CO_2 effects of aviation.[117] • Consider targeted additional funding over that period subject to the evolution of pilot projects.	• Continued research and innovation in other low-carbon aviation solutions beyond SAFs is essential given the early stage of development of the SAF industry, and to provide the sector and investors with a broader range of potential low-emissions investment opportunities.
Creating a market for **credible carbon offsets** Promoting investment in **low-carbon alternatives** to aviation (Section 6)	• Introduce **robust guidelines** to ensure residual emissions from the aviation sector are addressed through investment in **transparent, high-quality and near-permanent nature-based carbon offsets**. • Introduce measures to **encourage growing demand for and investment in low-carbon alternatives to aviation where appropriate.** This could include a coordinated review of pricing and taxation for all transport modes to **improve the affordability, reliability and accessibility of low-carbon alternatives.**	• Adopting clear guidelines for company and voluntary offsetting schemes is essential to **avoid greenwashing and provide market confidence** in the quality of carbon offsets. • Given the challenges facing the market deployment of SAFs and zero-emission aircraft in terms of volume and timescales, introducing a clear strategy to promote demand for – and investment in – viable low-carbon alternatives to aviation (such as rail and video-conferencing technologies) will help reduce the scale of the challenge and drive investment in other low-carbon solutions. • **The long-term price trend for rail travel shows a 32 per cent increase on 2009 levels compared to a ten per cent decrease in the cost of short-haul business flights** over the same period.[118]
Shipping		
Shaping **a coherent global framework for net-zero shipping** (Section 7)	• Play **a proactive role in ongoing consultations and discussions at the UN International Maritime Organisation** (IMO) to encourage achievement of the IMO's "stretch interim emission-reduction targets" for 2030 and 2040, and the **introduction of credible delivery mechanisms** to achieve these targets.	• Putting in place credible global mechanisms to achieve the IMO's stretched interim emissions-reduction targets will accelerate global investment in innovation and market deployment of zero-emission shipping fuels, zero-emission ships and supporting infrastructure. It will increase the credibility of the IMO's mid-century net-zero emissions goal for global shipping.
Publishing and implementing **a comprehensive Clean Maritime Plan for the UK** (Section 7)	• Introduce and implement a revised version of the **UK Clean Maritime Plan**, with policy priorities focused on **four key pillars**: (i) **investment in** "no regret" **shore power infrastructure** in ports; (ii) **innovation and research funding** into different low/zero-emission fuels and shipping technologies; (iii) **market mechanisms to grow the availability of low/zero-emission shipping fuels and technologies:** such as through a low-carbon shipping **fuel mandate**, a revenue-certainty mechanism such as **CfDs** for the manufacturing of these fuels and a potential **phase-out date** for the sale of non-zero-emission ships. (iv) **international collaboration to develop zero-emission shipping routes** with shared low-carbon shipping fuel infrastructure, building on the *COP26 Clydebank Declaration* for Green Shipping Corridors and the £1.5 million International Green Corridor Fund (agreed between the UK, Netherlands, Norway, Ireland and Denmark).[119, 120]	• **Key solutions to decarbonise shipping include battery-electric ships, the use of low- or zero-emission fuels (ammonia, methanol, hydrogen, biofuels) and the use of shore power in ports**. The market penetration of low-emission shipping fuels and zero-emission ships is near zero. The UK and global policy framework for low-carbon shipping is also at an early stage of development. • A coordinated UK Clean Maritime Plan based on these four key pillars will provide the policy framework to attract investment in the innovation and commercialisation of low-emission ships and fuels, support supply-chain development and the development of supportive infrastructure in ports. • The development of international green shipping routes with close trading partners and shared low-carbon fuel infrastructure will be essential to deliver a viable transition to net zero for global shipping.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Nature restoration		
Publishing **a coordinated Land Use Framework** (Section 8)	• Publish **a coordinated Land Use Framework** overseen by a coordinating body setting out England's strategy to restore nature through more sustainable land use across different economic activities (e.g., food production, biomass production, afforestation etc), with tangible nature restoration commitments set for – and tailored to – different economic sectors.[121,122] • Maximise **coordination between UK nations** on nature restoration approaches in agriculture and other land use sectors.	• **England does not have an integrated land use strategy and policy frameworks often differ across devolved nations**. This results in an overall policy framework for nature restoration that is hard to navigate for investors. • An overarching Land Use Framework, backed by sector-specific commitments, will provide investors with clarity on the investment needs, categories of projects and available market mechanisms to **invest in nature restoration at scale**. A coordinated approach with devolved nations will help **create a coherent investment framework** for nature restoration across the UK.
Completing the design of **agri-environment schemes** (Section 8)	• Complete the **policy detail, option design and payment rates for agri-environment schemes** under the Environmental Land Management Schemes (England), Sustainable Farming Scheme (Wales) and Agriculture Bill (Scotland).	• Providing full clarity on the policy design and payment rates for agri-environment schemes across all UK nations is essential to attract investment at scale in nature restoration projects in the agricultural sector.
Implementing the **EIP** and **Environment Act**	• Implement at pace the **key commitments set out under the Environment Act targets and the EIP**, including measures relating to the development of the Nature Recovery Network, Local Nature Recovery Strategies and biodiversity net gain. • Consider **extending the scope of nature restoration targets under the Environment Act**, covering new areas such as soil and peatland restoration.[123] • Oversee the successful operation of the newly introduced, mandatory **biodiversity net gain** requirement for developers and learn lessons for the broader scaling up of nature restoration markets.[124]	• Implementing the policy commitments highlighted in the Environment Act Targets and EIP will help drive growing investment in nature restoration and **achieve the Government's ambition to mobilise at least £500 million of annual private capital by 2027 and over £1 billion by 2030**. • Broadening the scope of targets under the Environment Act can help attract private investment across a broader range of nature restoration projects and markets. • **The biodiversity net gain requirement** introduced in February 2024, pursuant to the Environment Act and EIP, **requires developers to deliver ten per cent improvements for nature on all new housing, commercial and industrial infrastructure projects in England**.
Tackling skills gaps in peatland and woodland restoration (Section 8)	• **Focus the incentives for peatland and woodland restoration on tackling the skills gaps** and lack of workforce availability that are currently slowing down project delivery.	• Tackling the ongoing skills and workforce availability gaps for peatland and woodland restoration is key to growing the project pipeline and unlocking investment at scale.
Develop the **groundwork for nature markets** (Section 8)	• Build on the Government's ***Nature Markets Framework*** and put in place the Framework's market guidelines, market access rules, BSI investment standards and regulatory arrangements to create and grow high-integrity nature markets in the UK.[125]	• Rapidly putting in place the necessary guidelines, rules, investment standards and governance arrangements highlighted in the UK Government's *Nature Markets Framework* will help the UK create world-leading nature markets and attract domestic and global private investment.

Summary of key policy recommendations *(continued)*

Sector and areas of action	Recommendation	Expected benefit and context
Engineered Greenhouse Gas Removals (GGRs)		
Putting in place **a policy framework for GGRs** **Connecting GGRs to CCS infrastructure** and CCS market frameworks. (Section 9)	• **Accelerate the development of a policy framework for GGRs**, such as Direct Air Capture with Carbon Storage (DACCS) and Bioenergy and Carbon Capture and Storage (BECCS). This should include: (i) **completing a business model for GGRs** to provide greater clarity on revenue streams for negative emissions, building on the December 2023 *GGR Business Model Update;*[126] (ii) **clarifying the volume and timing of funding allocation** for early stage GGR projects; (iii) providing GGR projects with **access to the CCUS policy framework and CCS infrastructure**, such as by including GGRs in the early wave of projects to be progressed under the CCUS Cluster Sequencing Programme.	• Urgent development of the policy framework for GGRs will help the UK compete with jurisdictions like the US to attract capital. It is also key to meeting the **target of removing five million tonnes of carbon emissions per year by 2030, as set out in the UK's Nationally Determined Contribution** under the Paris Agreement. • Providing near-term clarity as to how engineered GGR projects are to connect to the CCS network and be included in the CCUS Sequencing Programme is essential to support the technical and commercial viability of early stage BECCS and DACCS plants, and for these projects to be considered by private investors.
Robust guidelines on emissions removals and biomass (Section 9)	• **Negative emissions:** Develop **robust guidelines** for the **monitoring, reporting and verification of emissions removals**, including an independent review of the lifecycle carbon footprint and biodiversity impacts of BECCS projects, going beyond the recent *BECCS Task and Finish Group Report*.[127] • **Biomass sustainability:** Build on the *Biomass Strategy* and recommendations from the National Audit Office (NAO) on biomass sustainability, by:[128,129] (i) further refining the UK's **strategy on the priority uses of biomass**; (ii) developing **a common sustainability framework for the use of biomass** across different economic sectors; (iii) **strengthening criteria on the sustainable sourcing of** domestically produced and imported **biomass**, and **strengthening the compliance process** with these criteria; (iv) developing plans for sustainable domestic biomass production.	• Robust guidelines on monitoring, reporting and verification (MRV) are essential to provide investors, business and the public with confidence regarding the permanent carbon-emissions removals being delivered by GGR projects and avoid risks of greenwashing. • Robust sustainability criteria on the use and sourcing of biomass is essential to prevent unintended negative environmental impacts from the use of biomass in engineered GGR technologies and other sectors.

1. Cross-cutting actions to put the UK economy on track for net zero

There are a range of policy levers that are cross-cutting in nature, and which will have a material impact on attracting low-carbon investment across several economic sectors. These include, for instance, carbon pricing, planning policy, the deployment of targeted public funding, skills development, green-finance reporting and disclosure and policies driving resource-efficiency improvements across sectors.

Investment insights

Michael Grady
Head of Investment Strategy and Chief Economist

For the UK to meet its climate objectives, there needs to be a range of cross-economy policies that can incentivise the necessary investment across the entirety of the energy sector, from producers to end-use consumers. Like all public-policy decisions, there are important detailed cost-benefit and trade-off analyses required to assess the best approach. But as with public policy, these decisions do not occur in a theoretical economic vacuum, and therefore need to account for social and political realities as well. For decades the international economics community advocated for carbon pricing (through taxes or tradeable permits) as the universal approach to tackling decarbonisation. However, international geopolitics have made any agreement impossible, with just a few jurisdictions (amongst them, notably, the UK and the EU) adopting that approach and even there in a limited form.

Looking ahead, the UK should create the right incentives to ensure the necessary investment takes place to: accelerate the expansion of carbon-neutral electricity; incentivise new technologies in clean-tech products, including batteries and components in renewable-energy generation; and subsidise the end-consumer to help achieve a carbon-neutral transport (electric vehicle) and housing (insulation and heating) outcome. This will likely require the full policy toolkit, underpinned by an important fiscal commitment from the Government, including: direct subsidies, tax-credits, public investment, targeted regulations and broad-based carbon pricing.

Investors must always deal with uncertainty and risk. But government policy should not add to that uncertainty. Effective regulations can drive the right incentives and reduce costs, lowering barriers to investment. Reform of planning rules is a prime example here, as is the process for determining the strike price on Contracts for Difference (CfDs) in renewable-energy auctions. But effective regulation should also be accompanied by a material fiscal commitment to support emerging green technologies, to ensure companies working in these areas can undertake the capital expenditure required in their development stage. These policy levers will be crucial to helping deliver much-needed long-term private-sector investment. This report considers many of these policies in more detail in Sections 1 to 9.

As the government has noted, the most important sectors to delivering on decarbonisation are energy production, distribution and storage. We believe these should be the near-term focus of attention for further policy intervention.

Policy priorities

Overview

This section sets out a range of cross-cutting policy priorities to accelerate private low-carbon investment. This includes options for strengthening the low carbon price under the UK Emissions Trading Scheme (UK ETS), the further integration of the net-zero target in the National Planning Policy Framework, priority areas for the use of public funding to help crowd in private sector investment, the implementation of a Green Skills Action Plan to provide the necessary skills and financial support to the workforce to grow low-carbon supply chains, and next steps for developing the UK's green-finance disclosure and reporting regime. This section also sets out priorities to embed a greater focus on resource efficiency and climate adaptation in the UK's net-zero policy framework.

> A range of cross-cutting policy priorities to accelerate private low-carbon investment across different sectors of the economy

Investment in the decarbonisation of several sectors of the economy depends on the availability at scale of affordable clean electricity and low-carbon fuels. This section therefore also sets out high-level policy priorities for accelerating investment in low-carbon power, low-carbon hydrogen, sustainable aviation fuels (SAFs), low-carbon shipping fuels (hydrogen, ammonia, methanol) and the first CCUS projects. These recommendations are then covered in more depth in Sections 2, 3, 5, 6, and 7.

Cross-cutting actions: key policy recommendations

Area of action	Detail of intervention	Expected benefit and context
Tackling planning delays (See more detailed recommendations on power grid planning reforms in Section 2)	• Embed the **net-zero target across the planning system**, through: (i) regular updates to the **National Planning Policy Framework** and associated **National Policy Statements**; (ii) using the recently created **ministerial planning forum to regularly identify and address planning barriers** to major low-carbon projects; (iii) providing **greater resourcing to local and other planning authorities and regulators** to support efficient decision-making, building on the five-year industry programme to increase skills and capacity in Local Planning Authorities recently launched by the British Chamber of Commerce and supported by Aviva.[130,131]	• Incorporating the net-zero target as a key delivery objective for the planning system will help accelerate planning consents and unlock investment in critical low-carbon infrastructure projects. • This should happen hand in hand with implementing: (i) the Transmission Acceleration Action Plan and Connections Action Plan to cut planning and connection delays for power-grid and clean-power infrastructure; (ii) implementing the operational reforms announced in March 2024 to the consenting process for nationally significant infrastructure projects to speed up and improve flexibility in the planning system.[132] • Given the high volume of major low-carbon infrastructure projects expected in the coming years, local authorities, planning bodies and regulators will require increased resources and upskilling.[133]
Tackling skills gaps	• Put in place and implement **a detailed Green Skills Action Plan** to urgently tackle skill gaps across key economic sectors such as power grids, renewables, construction, heating, heavy industry and nature restoration.	• A national Green Skills Action Plan will help identify and address the most important low-carbon skills gaps observed across several sectors of the economy, such as those related to STEM skills and other critical skills (awareness of climate change, carbon and resource constraints, cross-sectoral project management skills, etc.).

Cross-cutting actions: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Tackling skills gaps *(continued)*	• As recommended by the Green Jobs Taskforce, the implementation of this plan should include **skilling up schemes and measures directed at both**: (i) **the future workforce** – with a particular focus on embedding STEM skills and other low-carbon skills (e.g., climate-change awareness) across the education system; (ii) **those already in the workforce** – by providing the financial and skills support needed for workers transitioning from high-carbon to low-carbon activities.[134]	• Directing skills provision measures to both the current and future workforce will help deliver a Just Transition and ensure that a wide cross-section of the workforce is well equipped to take on employment opportunities created by the net-zero transition.
Strengthening the UK carbon price and the integrity of voluntary carbon markets	• Consider **further reforms to the UK ETS to strengthen the carbon price and deliver a more predictable future trajectory.** As already contemplated in the UK-EU Trade and Cooperation Agreement,[135] options should include **a linkage with the EU ETS,** building on the precedent set by the EU-Swiss Emissions Trading Schemes Linkage Agreement. A linkage between the UK and EU Emissions Trading Schemes has been called for by a number of business groups including the CBI,[136] Energy UK,[137] the British Chambers of Commerce,[138] the UK Emissions Trading Group, the Energy Intensive Users Group and the Carbon Capture and Storage Association.[139] • Subject to the potential reform highlighted above, regularly update **a plan for the UK ETS beyond 2030**, to provide clarity on the future emissions cap trajectory, mechanics and sectoral coverage of the UK ETS out to 2050. • Build on existing initiatives to provide clearer **guidance to improve the transparency and standardisation of the growing voluntary carbon markets** in line with the CCC's 2022 recommendations.[140] Consider a potential regulatory intervention and ensure a joined-up approach with the development of the Nature Markets Framework (see Section 8).	• A long-term, predictable, gradually increasing and sector-diverse carbon price will efficiently complement other policy levers to attract low-carbon investment at an affordable cost and at the necessary pace and scale to achieve the net-zero target. • Despite the July 2023 amendments to the UK ETS, the UK carbon price has fallen significantly since summer 2023, down to around £36/t in February 2024, roughly half the value of carbon under the EU ETS at that time.[141,142] • Further reforms to tighten the emissions reduction pathway under the UK ETS – including by means of a linkage and price convergence with the EU ETS – could strengthen the carbon price, improve market liquidity and carbon-price discovery, provide a predictable trajectory for investors and help align the UK and EU's Carbon Border Adjustment Mechanisms. The UK-EU Trade and Cooperation Agreement already commits both the UK and the EU to giving "serious consideration" to linking the carbon pricing schemes, recognising that this may increase their effectiveness.[143] • Greater oversight and certification of voluntary carbon credits will help improve the integrity of these markets and support a targeted use of carbon offsets for sectors where cutting emissions is the hardest (such as aviation and shipping).
Strengthening cross-departmental coordination on net-zero policymaking	• Strengthen cross-departmental coordination on net-zero policymaking across Whitehall. • Key measures should include: (i) creating a **Joint Net Zero Delivery Unit** led by the Cabinet Office, HM Treasury and the Department for Energy Security and Net Zero; (ii) **integrating net zero delivery across HM Treasury's core objectives and functions**; (iii) requiring Government to report to Parliament at each annual fiscal event on the progress made towards net zero followed by **a joint assessment by the CCC and the Office for Budget Responsibility.**[144]	• The transition to net-zero emissions will affect all sectors of the economy. Decisions in one sector (such as power) will have knock-on impacts on others (such as transport, heating and heavy industry). Putting in place enduring structures across Whitehall to increase consistency and cross-departmental coordination will deliver a joined up and predictable policy framework for investors.

Cross-cutting actions: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Increasing the availability of affordable clean electricity to support economy-wide decarbonisation (See also Section 2 for more detail on power recommendations)	• **Market deployment and planning:** Complete and implement planning and market-mechanism reforms to ensure **the power sector is affordably and fully decarbonised by 2035**, with sufficient added capacity to support the electrification of several parts of the economy such as surface transport, heating and heavy industry. • **Review of Electricity Market Arrangements (REMA):** Build on the March 2024 consultation[145] to complete the **REMA** reforms. Key objectives should be to: (i) accelerate further investment in renewables, flexibility tools, short-duration storage and long-duration storage (such as long-duration electricity storage and Hydrogen to Power plants);[146] (ii) reduce system constraint costs; (iii) better reflect the falling cost of renewables in the overall price of electricity. To support investment confidence, and as called for by the energy sector, **reforms should be implemented in a way which minimises disruptions to low-carbon investment in the near-term** and increases long-term investment certainty.[147] • **Electricity price support beyond REMA:** In parallel with REMA, **facilitate the development of additional solutions to provide energy-intensive industrial sectors** (see Section 3) **and vulnerable households** (see Section 5) **with increased access to lower-cost renewable electricity.** This could include facilitating the growing use of zero-carbon Power Purchase Agreements or similar for energy-intensive industries, and the introduction of a social tariff for fuel-poor households.[148, 149, 150] • **Future treatment of policy costs:** Confirm the **Government's long-term approach to permanently remove policy costs from electricity bills** and improve the affordability and competitiveness of electricity prices.[151]	• **Market deployment and planning:** In several sectors of the economy and for households, investment in low-carbon solutions will only be possible if plentiful supplies of affordable zero-emissions electricity are available in the near-to-medium term. • Policies to accelerate the market deployment – and affordability – of clean electricity must therefore be prioritised to unlock low-carbon investment in sectors and solutions such as EVs, electric heat pumps, carbon-capture technology, the production of green (renewable energy-based) hydrogen and the electrification of heavy industrial sectors such as steel and cement. • **REMA:** Completing the REMA reforms and implementing them in a gradual way will provide greater clarity to investors on the future market conditions to invest in renewables, grid, short and long-term storage and demand-side response infrastructure. By unlocking this investment at scale, these reforms could further reduce power-sector emissions, improve energy security and have a downward impact on electricity prices, thereby incentivising the broader electrification of the economy. • **Electricity-price support beyond REMA:** Under current electricity-market arrangements, the price of electricity is mainly determined by the gas price, with gas generators setting the price of electricity 98 per cent of the time in 2021, despite only representing 40 per cent of power generation.[152] These structures are preventing the pass through of lower renewable energy costs to electricity prices and have undermined investment in the electrification of key sectors. Tailored reforms to lower the price of electricity for heavy industries and vulnerable households could help address this. • **Future treatment of policy costs:** Permanently moving policy costs off electricity bills will improve the affordability and competitiveness of electricity prices, thereby providing incentives for fuel switching in the built environment and across a range of economic sectors including heavy industry.
Increasing the availability of affordable low-carbon hydrogen to support economy-wide decarbonisation (See also Section 3 for more detail on heavy industry recommendations and Section 5 for more detail on buildings)	• **Overview:** Building on the positive December 2023 announcements and the go-ahead given to 11 green hydrogen projects under Hydrogen Allocation Round 1, **continue to pursue an ambitious low-carbon hydrogen innovation and commercialisation programme** covering production, transport and storage.[153] • **Production – green hydrogen:** Allocate a growing pipeline of new green-hydrogen projects under Hydrogen Allocation Rounds 2 (2024), 3 (2025) and 4 (2026), and through the delivery of further annual allocation rounds out to 2030, in line with the Hydrogen Production Delivery Roadmap.[154] • **Production – blue hydrogen:** Grow the pipeline of blue-hydrogen production projects (gas + carbon capture) through contract allocation under Tracks 1 and 2 of the CCUS Cluster Sequencing Programme.	• **Overview:** In sectors such as power storage, heavy industry, heavy duty vehicles, aviation and shipping, the availability of affordable low-carbon hydrogen at scale could play an important role in enabling investment in low-carbon infrastructure and solutions. • **Overview:** Completing market deployment policies and the underpinning regulatory framework for the production, transport and storage of hydrogen is essential to unlock private investment across these infrastructure areas. Using learnings from early projects to update these policies will de-risk and improve the attractiveness of these projects for investors. • **Production:** The Government has **a target of achieving 10GW of low-carbon hydrogen production by 2030**, **with 6GW coming from green hydrogen and 4GW coming from blue hydrogen**. There is an **interim target for 1GW each of blue and green production capacity** to be in operation – or construction – **by 2025.**[155]

Cross-cutting actions: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Increasing the availability of affordable low-carbon hydrogen to support economy-wide decarbonisation (See also Section 3 for more detail on heavy industry recommendations and Section 5 for more detail on buildings) *(continued)*	• **Production – learning from early projects:** Use the planned assessment of progress in 2025 from the early market deployment of green and blue hydrogen projects to: (i) **improve understanding of the deployment potential for all types of hydrogen production routes** and the implications for their respective deployment targets; (ii) **to strengthen the policy and market design** to maximise the scale of private investment in low-carbon hydrogen production. • **Transport and storage:** Finalise **business models and the first project allocations for hydrogen production and storage by 2025**, setting out the market mechanisms that will be used to unlock early investment in the first hydrogen pipelines and onshore storage facilities. • **Clarifying the priority uses and geographical scope for hydrogen:** Build on the 2023 Hydrogen Strategy Delivery Update, by **clarifying the priority uses of hydrogen and priority investment needs.**[156] Improve market clarity by identifying sectoral and geographical areas which are not suitable for hydrogen use so that investments in alternative solutions in these areas can proceed.[157]	• The Hydrogen Production Delivery Roadmap sets out how green, blue and other types of hydrogen production projects meeting the UK's Low Carbon Hydrogen Standard will receive funding support through the Hydrogen Production Business Model and the £240 million Net Zero Hydrogen Fund.[158,159,160,161] • **Production – green hydrogen:** A green-hydrogen production business model has now been completed. In December 2023, 11 green-hydrogen production projects totalling 125MW were shortlisted as part of Hydrogen Allocation Round 1 (HAR1).[162] These projects, backed by £2 billion of Government funding over 15 years and £400 million of private investment over the next three years, will receive a guaranteed price for the clean energy they supply. In February 2024, an extra £21 million of government support for seven new green hydrogen projects (800MW capacity) was announced.[163] • **Production – green hydrogen:** The Hydrogen Production Delivery Roadmap plans three further allocation rounds for green-hydrogen projects, with 875GW to be allocated in 2024 (HAR 2), and a combined 1.5GW of new projects to be awarded in 2025/ '26 across HAR 3 and HAR 4, with the Strategy contemplating potential further annual auctions out to 2030.[164] • **Production – blue hydrogen:** While supported by the same Hydrogen Production Business Model as green-hydrogen projects, blue-hydrogen production projects are to be awarded contracts under Tracks 1 and 2 of the CCUS Cluster Sequencing Programme. However, negotiations for the first CCUS cluster projects are still ongoing and contractual and support arrangements for the first blue-hydrogen projects have therefore not yet been finalised. • **Hydrogen transport and storage:** The Government aims to have at **least two storage sites and associated pipeline infrastructure in operation or at least construction by 2030.** The December 2023 Hydrogen Transport and Storage Networks Pathway puts foreword a timeline for the regulatory framework, strategic planning, business model development and early project allocation for hydrogen pipelines and storage infrastructure.[165] The business models for the transport and storage of hydrogen are due to be finalised by 2025, with the first projects being allocated by that same year. • **Priority uses of hydrogen:** Greater clarity on the priority uses of hydrogen – with a particular focus on heavy industry and heavy-duty transport – will provide greater clarity to investors on priority investment needs for the early deployment of hydrogen production, transport and storage infrastructure.
Increasing the availability of affordable low-carbon fuels for aviation and shipping (See Sections 6 and 7 for recommendations on aviation and shipping)	• **Accelerate the implementation of innovation programmes and complete market deployment policies to grow the availability and affordability of low-carbon fuels,** such as SAFs, and low-carbon fuels for shipping (hydrogen, ammonia, methanol).	• The availability of affordable sustainable fuels could be an important solution to cut emissions in "hard-to-abate" transport sectors such as shipping and aviation. • Policies to accelerate innovation and the market deployment – and affordability – of low-carbon fuels such as SAFs, ammonia and methanol could therefore unlock significant low-carbon investment in these sectors.

Cross-cutting actions: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Developing strong sustainability criteria for sustainable fuels and biomass (See also Section 6 for detailed recommendations on the sustainable aviation fuel industry and Section 9 for detailed recommendations on biomass sustainability criteria)	• Ensure that policies promoting new sustainable fuels in sectors such aviation and shipping are subject to **sufficiently stringent emissions-reduction requirements** compared to conventional fuels to meet the UK's emissions-reduction targets. • **Maintain momentum on the electrification of surface transport** and the achievement of the 2035 phase out date for the sale of petrol and diesel cars and vans to free up limited biomass resources for the production of sustainable fuels in hard-to-abate sectors that need them the most. • Build on the 2023 Biomass Strategy by: (i) continuing to **refine the UK's strategy on the priority uses of biomass** with a focus on hard-to-abate sectors where alternatives are currently limited; (ii) publishing **a common sustainability framework for the use of biomass** across different economic sectors; (iii) publishing a Low Carbon Fuels Strategy.[166] • These frameworks and strategies should **increase transparency on the sustainability of biomass and low-carbon fuels** used in different sectors and ensure that **limited bioenergy and waste-based fuels are directed in priority towards hard-to-abate sectors like aviation, shipping and heavy industry** where other low-carbon alternatives are limited.	• Developing stringent and transparent emissions-reduction criteria for sustainable fuels – such as the emissions reductions of 2.7 $MtCO_2e$ in 2030 and 6.3 $MtCO_2e$ in 2040 under the UK SAF Mandate scheduled to be introduced in January 2025 in the aviation sector – is essential to achieve emissions-reduction targets and avoid the risk of greenwashing, which could tarnish public perceptions of sustainable fuels.[167] • Hitting the 2035 phase out target for the sale of petrol and diesel cars and vans would allow the use of waste fat and oil resources to be diverted away from car biodiesel and towards hard-to-abate sectors where required. • A coordinated approach on the sustainability criteria, development and use of biomass energy and waste-based fuels is essential to ensure that investment in these scarce resources is directed towards those industry sectors that need them the most and where low-carbon alternatives are currently limited.
Increasing the availability of CCUS to support the decarbonisation of hard-to-abate sectors (See Section 3 for more details on CCUS recommendations for heavy industry)	• Provide greater clarity on the **timelines for completing the negotiations** for the first cluster projects, **the overall sequencing of the CCUS Cluster Sequencing Programme** and the extent to which engineered removal projects will be included in the CCUS Cluster Sequencing Programme. • Provide **details** of when the £20 **billion of spending** for CCUS committed in the Spring 2023 Budget will be released and how the funding will be split across different types of CCS projects. • Finalise a business model for the transport and storage of CO_2, building on the latest updates and draft heads of terms.[168]	• The availability of CCUS infrastructure at an affordable cost could help unlock investment in low-carbon solutions in sectors such as heavy industry, the manufacturing of low-carbon fuels, and engineered removal technologies. • £20 billion of funding over the next 20 years was allocated to support the first CCUS projects in the 2023 Budget.[169] • Providing greater clarity on the timescales, scope and funding-mechanism details for the CCUS Cluster Sequencing Programme will improve investor confidence in the deliverability of the first four CCUS clusters and the long-term role of CCUS in the UK for a range of applications.

Cross-cutting actions: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Directing **public funding** towards market barriers	• **Within the constrained fiscal environment, deploy targeted public funding to accelerate low-carbon innovation and crowd in private investment in areas where market barriers subsist** and private investment is not yet flowing at the necessary pace and scale. This could include directing a degree of public funding towards three **key pillars**: (i) **Areas involving emerging-technology risk**, such as first-of-a-kind low-carbon industrial plant, CCUS or low-carbon hydrogen; (i) **Projects that are logistically complex for private investors,** such as the mass installation of energy-efficiency measures and low-carbon heat in homes; and (iii) **Infrastructure that is critical for economy-wide decarbonisation and supply-chain growth,** such as investment in ports and gigafactories to support offshore wind and EV supply-chain growth.	• In light of the constraints facing UK public finances, the potential to deploy new public funding is limited and therefore needs to be targeted at areas where it can have the most material impact in terms of unlocking private low-carbon investment. • Building on welcome commitments in the 2023 Autumn Statement and 2024 Spring Budget to invest around £5 billion of public funding into advanced low-carbon manufacturing sectors, including through the £1.1 billion Green Industries Growth Accelerator, a strategic approach to the deployment of public funding and Government-led coordination should have the objective of de-risking and crowding in private investment in areas where market barriers are the greatest. This could include areas involving emerging technologies and business models, highly complex projects and strategic infrastructure that is essential to support economy-wide decarbonisation and supply-chain growth. • This targeted funding could be distributed in a range of ways, including through new or established institutions, such as the UK Infrastructure Bank, and through sector specific investment initiatives such as the Government's recent £200 million investment into zero-emission trucks, delivered in partnership with Innovate UK.[170]
Reporting and disclosure: building a net-zero aligned financial centre	• **Next steps for SDR:** Clarify and provide supportive **guidance on the full scope, next steps and timelines for the implementation of the evolving Sustainability Disclosure Requirements (SDR) framework** across the economy. • **Coordination of disclosure requirements:** This should include **clarifying how different aspects of the framework will interact with one another**, including: the Streamlined Energy and Carbon Reporting, the UK Climate-related Disclosure Regulations, the UK Green Taxonomy, the disclosure and scope of net-zero transition plans (and how these align to countries' Nationally Determined Contributions), the applicability of **International Sustainability Standards Board's standards** in the UK, and the adoption of the **Financial Conduct Authority's (FCA's) Sustainability Labelling regime.**[171,172] • **International operability**: The **finalisation and implementation of the SDR framework**, UK Green Taxonomy, transition plan requirements and the FCA's Sustainability Labelling Regime **should be based on science**, and be as **practical** and **interoperable** as possible with other international reporting and disclosure requirements, such as the EU's Sustainable Finance Disclosure Regulation (SFDR) and the EU taxonomy.	• **Next steps for SDR and coordination of disclosure requirements:** Clear guidance, timelines, clarity of scope, consolidation and international interoperability will deliver a user-friendly, comprehensive and robust sustainable reporting and disclosure regime in the UK. • This will improve transparency of the new regime and send clear signals for further investment in low-carbon infrastructure, products and solutions from domestic and international finance providers. • **Broadening disclosure and reporting requirements:** Climate adaptation and nature restoration are critical to the achievement of the UK's net-zero target and broader environmental goals. Capturing climate adaptation and nature-related information within reporting and disclosure requirements will support the growing allocation of financial flows towards climate resilience measures and nature restoration, alongside net zero.

Cross-cutting actions: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Reporting and disclosure: building a net-zero aligned financial centre *(continued)*	• **Broadening disclosure and reporting requirements:** The UK's evolving green-finance framework should increasingly capture **information related to climate adaptation and nature restoration,** taking into account the final recommendations of the **Taskforce on Nature-related Financial Disclosures** (TNFD).[173] • **Deforestation:** Build on The Glasgow Leaders' Declaration on Forests and Land Use and the Kunming-Montreal Global Biodiversity Framework, by introducing **mandatory deforestation-risk assessment with high-risk sectors for financial institutions**.[174] Bring forward plans to operationalise Schedule 17 of the Environment Act 2021, which would **introduce mandatory due diligence on illegal deforestation in UK supply chains.**[175,176,177]	• **Deforestation:** The UK financial sector directly and indirectly invests and lends towards forest products associated with deforestation risks. Deforestation is one of the largest drivers of biodiversity loss and accounts for 12 per cent of greenhouse-gas emissions. Introducing mandatory due-diligence requirements on assessing deforestation risks would contribute to the UK's position on deforestation under the Forest Risk Commodities Scheme and enable financial services firms to identify, mitigate and re-direct financial flows towards nature positive outcomes. • The UK is a significant consumer of imported commodities linked to deforestation. A study by WWF and RSPB estimated that UK imports of seven "forest risk" commodities, including soy and cocoa, accounted for an overseas land footprint of 88 per cent of the size of the UK every year, with 40 per cent of the footprint in countries with high risk of deforestation, weak governance and poor labour standards.[178] Clarity on the Schedule 17 due-diligence requirements would help businesses and invvestors in preparing to meet these requirements and help tackle deforestation in UK supply chains.[179]
Climate adaptation	• Climate adaptation should be explicitly considered and **fully embedded across the UK's net-zero policy** framework. • Every public funding decision and policy mechanism to incentivise low-carbon investment should ensure that the infrastructure and solutions that are being incentivised in each economic sector are resilient to a changing climate. • **Implement and strengthen the commitments set out in the Government's July 2023 National Adaptation Programme 3 (NAP3),** by incorporating further public funding, policy commitments and technical details to improve the resilience of critical infrastructure, all physical assets and all economic sectors to a changing climate.[180]	• The CCC's March 2023 Progress Report found that **no economic sector is yet well adapted to the risks from climate change**, with insufficient progress made against all 45 adaptation outcomes identified.[181] • NAP3 acknowledges the CCC's concerns but does not yet put forward an overarching, cross-government adaptation strategy and sufficient new policies required to accelerate climate-change preparedness economy-wide. • NAP3 has a welcome focus on some physical assets, such as requiring new schools and hospitals to be built with cooling measures, but it does not do enough to strengthen the resilience of other assets. There is a lack of new legislation or funding included in NAP3 to help protect existing homes against the effects of climate change, despite the fact that a two-degree global temperature rise will put all homes in England and Wales at risk of overheating, particularly those in dense urban areas. • Embedding climate adaptation in the development of net-zero policy, the planning system and the roll out of low-carbon infrastructure – such as wind farms, power networks, EV-charging infrastructure and low-carbon buildings – will ensure these investments are climate resilient, for the long term and avoid the risk of creating stranded assets.

Cross-cutting actions: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Incentivising investment in resource efficiency across the economy	• Building on the positive vision of the 2018 Resources and Waste Strategy, **put in place a detailed resource efficiency action plan** to improve product design, material re-use, remanufacturing, recycling and consumer engagement on resource use and waste prevention across different economic sectors.[182] • As called for by industry groups such as the Aldersgate Group and the Chartered Institution of Wastes Management (CIWM), such a plan could consist of **a range of measures to grow investment in resource-efficient business models**, including the development of **product standards**, as well as **fiscal incentives**, **public engagement** and **green public-procurement criteria** to stimulate demand for resource-efficient products.[183,184,185,186,187,188]	• A detailed and cross-sectoral UK action plan on resource efficiency could grow the demand for and unlock significant investment in resource-efficient product design, waste material collection and re-processing, remanufacturing and recycling. • Investment in resource efficiency across different economic sectors generally requires a set of key policy and market pre-conditions, including the existence of supportive infrastructure (such as collection, recycling and remanufacturing facilities), regulatory standards mandating minimum resource efficiency standards in product design, and policies to grow the demand for resource-efficient goods and services. • Since the publication of the *Resources and Waste Strategy* in 2018, there has been little activity to put in place a policy framework to incentivise greater investment in resource efficiency. Other jurisdictions, such as the EU through its Circular Economy Package, are introducing a range of regulatory tools and incentives to promote greater investment in resource-efficient business models, product manufacturing and infrastructure.

Key takeaways

1. **Planning reforms:** Embed the **net-zero target across the planning system** to speed up the consenting of major low-carbon infrastructure projects.
2. **Carbon price:** Keep the **effectiveness of the UK Emissions Trading Scheme (ETS) under review** and consider **a linkage with the EU ETS** to strengthen and improve long-term visibility of carbon pricing.
3. **Low-carbon energy sources:** Prioritise the development of policies that will **deliver the high volumes of affordable clean electricity and low-carbon fuels** required across the economy.
4. **Skills:** Publish and implement a **Green Skills Action Plan** that provides tailored financial and skills provision support to the workforce and supports growing low-carbon supply chains across different sectors.

2. Power

The power sector produced **48 million tonnes of carbon dioxide emissions ($MtCO_2e$) or 11 per cent of UK emissions in 2022**, but reduced emissions 73 per cent between 1990 and 2021.[189]

Overall investment required in the UK to decarbonise the sector is estimated at between **£275 billion and £375 billion**.[190]

National Grid estimates that at least **70.5GW** of UK installed offshore wind capacity will be required by 2035 for the UK's 2050 net-zero target to be met, compared to the **14GW** currently installed.[191]

Globally, annual clean energy investment needs to increase from **$1.8 trillion in 2023 to $4.5 trillion by 2030**.[192]

The UK's clean energy transition will require the recruitment of around **400,000 workers** between **2020 and 2050**.[193]

If Governments deliver on existing pledges, global employment in clean energy supply chains could increase from **33 million in 2022 to almost 55 million in 2030**.[194]

Investment insights

Luke Mulley
Equity Analyst, Utilities and Energy

Offshore wind and solar will provide the bulk of UK electricity generation in a decarbonised power sector, so incentivising companies to invest in UK auctions remains imperative – both through setting strike prices which meet the acceptable hurdle rates of project developers, and ensuring the auction pot size is sufficient to cover sufficient scale of deployment. This is better understood after the challenges of Auction Round 5 (AR5), but focus will have to be maintained to ensure no further missteps as investors seek certainty and stability.

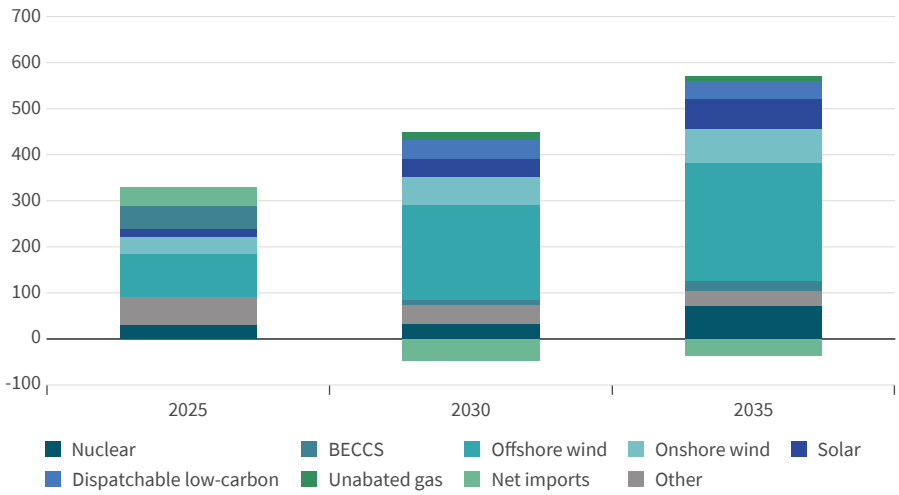
What is perhaps less well understood is the importance of balancing and storage operations to the electric grid required to fully decarbonise the sector. Interconnectors with other countries, battery storage for intra-day balancing and inertia and long-duration energy storage for multi-day balancing will all be critical to ensuring the stability of the electric grid. The electric grid will be in far greater demand in an electrified economy, and this will require more advanced balancing systems. Whilst remuneration and policy incentives for interconnectors and battery storage exist, long-duration energy storage remains the greatest unknown entity within the sector.

The Government currently has an ambition to fully decarbonise the power grid by 2035. Achieving this objective is particularly important in order to support the decarbonisation of several sectors of the economy that will increasingly rely on electricity to cut their emissions, such as heating (via heat pumps), surface transport (via electric vehicles [EVs]) and heavy industry (via the electrification of industrial processes such as electric arc furnaces in the steel sector). The growing reliance of other sectors on electricity is forecast to lead to a 40 per cent to 60 per cent increase in electricity demand from 2021 to 2035 (see Figure 4).[195] The levels of upfront investment required to fully decarbonise the UK power grid are therefore significant, with estimates in the latest REMA consultation ranging from £275 billion to £375 billion by 2035.[196]

40-60%

Increase in electricity demand expected from 2021 to 2035

Figure 4. **Electricity generation mix to 2035 in the Climate Change Committee's Net Zero Balanced Pathway (TWh per year)**



Source: "Delivering a reliable decarbonised power system", Climate Change Committee, March 9, 2023.[197]

Up until recently, the UK had made significant progress in cutting emissions from the power sector, in particular through an accelerated deployment of – and cost reductions in – offshore wind capacity. However, the pace of investment and clean-power infrastructure deployment has slowed in recent years due to planning constraints slowing power-grid infrastructure and onshore-wind deployment, and a mismatch between inflation-driven cost increases on the one hand, and tighter revenue streams under the contract for Difference (CfD) mechanism on the other, which has undermined the commercial viability of new offshore-wind projects.

The pace of investment and clean-power infrastructure deployment has slowed in recent years

No offshore-wind projects submitted a bid at the last annual allocation round (AR5) in September 2023 due to the CfD strike prices being too low, a situation to which the Government has responded through its recent increase to the overall funding pot and levels of strike prices for the next AR6 annual allocation round for new renewable-power projects.

Policy priorities

Overview

Key recommendations in this section include **rapidly implementing the planning and connection reforms set out in the recent *Transmission Acceleration Action Plan*** and ***Connections Action Plan*** to cut the construction time for grid infrastructure from 14 down to seven years and accelerate the connection of new low-carbon projects to the grid.

Other recommendations look at **regularly reviewing the commercial parameters for the annual renewable-energy allocation rounds** – with a particular focus on ensuring the continued commercial viability of **offshore wind** – concluding gradual market reforms under **the Review of Electricity Market Arrangements** to unlock efficient investment in clean generation and flexibility capacity, and implementing **further planning reforms and other support measures to unlock further investment in onshore-wind and solar power**.

> Implement the planning reforms to cut the construction time for grid infrastructure from 14 down to seven years

Power: key policy recommendations

Area of action	Detail of intervention	Expected benefit and context
Overall strategy to guide power sector decarbonisation	• Build on the technology roadmaps published to date by putting forward **a coordinated strategy for the full, affordable and secure decarbonisation of the power sector** by 2035. • Such a strategy should provide: (i) **an overall perspective on the variety of power supply-side investment needs** (at both a centralised and distributed level) including nuclear, renewables and other low-carbon generation; (ii) also **outline broader investment needs and policy priorities for grid infrastructure, interconnection, demand-side response and short-term and long-term power storage** requirements (e.g., lithium-ion batteries, hydrogen to power). • It should also highlight the extent to which investment in **energy-efficiency** improvements in other parts of the economy, such as buildings, transport and heavy industry, could reduce overall investment needs in the power sector.	• A comprehensive strategy would provide investors with **a clear picture of overall investment needs and key interdependencies** to deliver a fully decarbonised, flexible and secure grid by 2035 or sooner. • It would clarify investment needs for a range of low-carbon generation at a centralised and distributed level (on- and offshore wind, solar, large nuclear and Small Modular Reactors, etc.) as well as grid infrastructure, short-term and long-term power storage, interconnection and flexible demand-side response infrastructure. • By highlighting the potential of demand-side response and energy-efficiency measures to reduce demand in sectors heavily reliant on electricity, such a strategy could optimise the overall low-carbon generation and grid infrastructure required to be built.
Grid infrastructure: reform of planning system and connection rules	• **Implement at pace the welcome commitments set out in the Government's *Transmission Acceleration Action Plan* to cut construction time for new transmission infrastructure.**[198] Important commitments include developing and implementing a Strategic Spatial Energy Plan, modernising the regulatory and planning approval processes, the delivery of tailored community benefits, tackling the skills gap facing the power grid sector and increasing public engagement to grow support for grid infrastructure.	• Following the *Nick Winser* Review, **implementing the regulatory and administrative reforms set out in the** Transmission Acceleration Action Plan **could halve the construction time for new power-grid infrastructure in the UK from 14 down to seven years**, thereby improving the business case and accelerating investment in grid extensions and reinforcements.[199] • Given the engineering skills gaps faced by the UK and the power sector, skills provision must form part of the implementation of the *Transmission Acceleration Action Plan* alongside regulatory and administrative measures.[200]

Power: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Grid infrastructure: reform of planning system and connection rules *(continued)*	• **In parallel, implement at pace the six key actions outlined in the Government and Office of Gas and Electricity Markets (Ofgem) *Connections Action Plan* to cut grid-connection queue delays for new clean-power projects.**[201] A particular focus should be on awarding connection dates in priority to those projects that are most strategic and likely to progress quickest. • Put in place **a partnership with industry to grow manufacturing capacity and supply-chain resilience** to overcome constraints on the supply of electricity cables and electricity converters. This should be in addition to Ofgem incentivising Transmission Owners to enter into long-term supply chain contracts for new grid infrastructure and components.	• Implementing the grid-connection queue reforms set out in the *Connections Action Plan* could significantly cut the deployment time for large projects such as offshore wind, which in some cases have had connection dates to the grid set ten years into the future.[202] • Global **supply chains** for the manufacturing of electricity cables and converter stations are becoming increasingly **constrained**.[203] A plan to strengthen manufacturing capacity and supply-chain resilience is essential for electricity-cable and electricity-converter stations to keep pace with power-sector decarbonisation and renewable-energy deployment targets.
Onshore wind: review of planning rules	• Build on the September 2023 Ministerial Statement by introducing further planning reforms to **treat onshore-wind projects on a par with other types of infrastructure and energy-generation projects**, to improve the chances of these projects getting through the planning system.[204] • Provide clarity on the areas in England that are suitable for the siting of onshore-wind projects. • Design a new, locally tailored approach to community benefit-schemes to maximise the development of new onshore-wind projects in areas where there is local support.[205] This should go hand in hand with increased public engagement on the role of onshore wind.	• Since 2015, the planning system has imposed significant barriers on the development of onshore wind projects in England, with **only two wind turbines installed in England in 2022**.[206] The picture is more positive in Scotland. • A recent Ministerial Statement has removed the ability of one individual to block planning applications.[207] However, **onshore remains treated differently to other types of infrastructure and energy assets**, with limited rights of appeal and a lack of clarity on the potential siting of onshore-wind projects in England.[208] • **Investment conditions for onshore wind in England can be improved by treating onshore wind on par with other infrastructure projects**, providing clarity on potential areas to site these projects, and improving community-benefit schemes and engagement on the need for onshore-wind infrastructure.
Solar power: long-term strategy	• Building on the work of the Solar Taskforce, publish and implement an **action plan to deliver the Government's target of 70GW of solar capacity by 2035**, with supportive measures tailored to the different opportunities to install solar power (ground mounted solar, domestic and industrial rooftops etc.)[209]	• A clear action plan accompanied by tailored measures for different types of solar development will improve the investment case for new solar capacity in a range of contexts (residential premises, commercial premises, industrial premises and large solar projects).
Offshore wind: review of commercial support	• Build on the £1 billion funding pot announced for the AR6 renewables auction round in September 2024 and the recent increase to maximum CfD strike prices for offshore wind and floating offshore wind, by **regularly reviewing the overall funding pot and level of CfD strike prices for offshore wind, floating offshore wind, and other renewables** to ensure eligible revenues for new projects sufficiently reflect the evolution of the underlying supply-chain and finance costs.[210]	• The Government has **a target of 50GW of installed offshore-wind capacity by 2030**, with circa 14GW installed as of 2023. • Rising interest rates and increasing commodities and supply-chain costs increased the cost of new offshore-wind projects by around 40 per cent between 2021 and 2023.[211] **No offshore-wind projects submitted bids at the annual AR5 renewable-energy auction in September 2023**, on the basis that the auction ceiling price was too low.

Power: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
Offshore wind: review of commercial support *(continued)*	• Build on the £160 million of public funding to improve **port infrastructure** to support the floating offshore-wind supply chain, by deploying additional public investment towards infrastructure needed to expand the UK's offshore-wind supply chain and ease bottlenecks.[212]	• **Regular reviews of the commercial parameters and overall funding pot for renewable-energy auctions will help**: (i) **support the long-term commercial viability of offshore wind** and other renewable projects; (ii) ensure that a growing volume of projects come through annual auctions from 2025 onwards. This will help plug the capacity gap created by the absence of any offshore-wind projects supported at the September 2023 AR5 allocation round. • Targeting public investment towards infrastructure to support the growth of the UK's offshore-wind supply chain will be key to reduce supply-chain bottlenecks and price spikes.
Improving the investment context for short- and long-duration power storage	• As part of and in parallel with the Review of Electricity Market Arrangements (REMA): (i) ensure that reforms to the UK Capacity Market incentivise growing investment in short-duration power storage; (ii) put forward bespoke policies to incentivise investment in a pipeline of commercially viable long-duration storage projects (such as long-duration electricity storage and hydrogen to power), as recently called for by the House of Lords Science and Technology Committee.[213] • To incentivise investment in long-duration storage,[214] continue to progress proposals for a cap-and-floor mechanism for long-duration electricity storage and for a dispatchable power agreement business model for hydrogen to power.[215]	• The Government estimates that the electricity system could require up to 55GW of short-duration flexibility and between 30 and 50GW of long-duration flexibility by 2035 to ensure a secure supply of electricity as the grid decarbonises.[216] • While a growing number of short-duration storage projects (such as projects involving batteries) are being incentivised through the UK's Capacity Market mechanism, market conditions for investment in long-duration energy-storage solutions are more challenging due to the technology uncertainty, high capital costs and revenue uncertainty currently linked with these projects. • Building on the Government's recent consultations, progressing supportive policies and market mechanisms to overcome these barriers is essential to attract private investment towards long-term storage projects such as Long Duration Electricity Storage (LDES) and Hydrogen to Power. Increasing long-duration power storage capacity will be essential as the electricity system decarbonises and a growing proportion of supply depends on the weather.[217]
Review of electricity-market arrangements: finalising policy reforms to accelerate investment in renewables and broader grid infrastructure (See also demand-side policy recommendations in Sections 1, 3 and 5)	• **REMA:** Make final decisions on REMA reforms and begin their implementation from 2025 onwards. Key objectives should be to: (i) accelerate further investment in renewables, flexibility tools, short-duration storage and long-duration storage (such as long-duration electricity storage and Hydrogen to Power plants);[218] (ii) reduce system constraint costs; (iii) better reflect the falling cost of renewables in the overall price of electricity. • As called for by the energy sector, **reforms should be implemented in a way which does not disrupt low-carbon investment in the near-term** and increases long-term investment certainty.[219]	• Following the first REMA consultation in summer 2022, the second round of market-reform proposals under REMA were put forward for consultation in March 2024,with reforms to be finalised by mid-2025.[220] Proposed reforms are focused on passing through the value of a lower-cost, renewables-based system to consumers, incentivising and cutting the cost of further investment in renewables through CfD reforms, and growing investment in flexibility, resilience and system security tools. Policy development for REMA is intended to be concluded by mid-2025, with implementation of reforms starting in 2025. • Completing the REMA reforms and implementing them in a gradual way will provide greater clarity to investors on the future market conditions to invest in renewables, grid, short and long-term power storage and demand-side response infrastructure. • By unlocking this investment at scale, these reforms could also have a downward impact on electricity prices, thereby incentivising the broader electrification of the economy.

Power: key policy recommendations *(continued)*

Area of action	Detail of intervention	Expected benefit and context
New nuclear: clarifying the future policy framework for large projects and Small Modular Reactors (SMRs)	• Clarify expectations on the respective role, feasibility and parameters for public and private investment for future large new nuclear plants. • Building on the Nuclear Regulated Asset Base Model Regulations 2023, continue to develop a Regulated Asset Base Model to attract private investment in both large nuclear projects and Small Modular Reactors (SMRs). • continue to progress auctions for the first waves of SMR projects and support these auctions with targeted public investment in UK-based SMR supply chains. • continue the development of a robust framework to adequately address the long-term management of high-level radioactive wastes.	• Given the complexity of large new nuclear projects, a strategic policy decision on the respective role, feasibility and parameters for public and private investment is needed to determine future funding models for these large projects. • A regulated asset base model provides private investors with greater predictability on future returns and offers a more appropriate risk allocation for private investors. • SMRs are at an early stage of commercial deployment. Clear visibility on both the volume of SMR projects to come out of upcoming auctions and on the corresponding revenue streams will help attract private investors in early-stage SMR projects. Support for UK-based supply-chain businesses could help the UK develop a competitive advantage in the still nascent SMR manufacturing sector. • A long-term, comprehensive policy framework to adequately address the management of high-level radioactive wastes is essential to avoid negative environmental consequences from new nuclear projects and provide investors with confidence as to the environmental integrity of new projects.

Key takeaways

1. **Planning and connection reform:** Implement at pace **planning and connection reforms** to speed the construction and connection of new low-carbon power projects to grid infrastructure.
2. **Revenue predictability – offshore wind:** Keep the **strike prices and overall funding pot for future renewable-energy allocation rounds under review** to ensure the continued commercial viability of offshore-wind projects and grow the pipeline of new investable projects.
3. **Market reform:** Complete the **Review of Electricity Market Arrangements** (REMA) to unlock efficient investment in clean-power generation, flexibility and storage capacity, with positive knock-on impacts on electricity prices.

3. Heavy industry (steel, cement, chemicals, glass, ceramics)

The sector produced **63 million tonnes of carbon dioxide emissions ($MtCO_2e$) or 14 per cent of UK emissions in 2022**. Emissions reduced **17 per cent between 2014 and 2022**, partially due to an output decline of four per cent between 2021 and 2022.[221, 222]

Industrial clusters produced emissions of **37.6 $MtCO_2e$ in 2018**.[223]

Dispersed industrial sites produced emissions of **33.6 $MtCO_2e$ in 2018**.[224]

Emerging green heavy industry businesses are expected to grow by **20 per cent per year** from **£1.7 billion** turnover today and decarbonising the sector with the right policy support could increase GVA from **£152 billion today** to **£235 billion by 2050.**[225, 226]

Heavy industry currently supports **1.4 million jobs** across the UK. Every direct job in industry creates **two** more jobs across the economy.[227]

Of heavy industry GVA, **28 per cent** is generated in the North of England.[228]

Investment insights

Darryl Murphy
Managing Director, Head of Infrastructure Debt

The decarbonisation of UK heavy industry is very much dependent on affordable electrification of the UK energy market and investment into two key nascent markets: carbon capture, utilisation and storage (CCUS) and hydrogen. These are both emerging technologies which will be required to be delivered at scale and hence present two major challenges to investors: technology and delivery risk, and longer-term revenue and market risk.

As a result, financial investors will be looking for a combination of the capability of industrial sponsors to bring forward these technologies alongside government-policy incentives or capital. The UK has a great opportunity to show global leadership in these sectors, but the challenge remains the pace of delivery. In order to address the challenge for investors of long-term market uncertainty, the UK is adapting the tried and tested models used in regulated utilities and renewables to raise capital: the regulated asset base model and the Contract for Difference (CfD) support mechanism. This is a positive step to build on the success of these models in other sectors.

The role of the UK Infrastructure Bank will also be critical at the early stages of development in these sectors, in working with institutional investors to 'crowd in' capital. There is no doubt there is a strong demand from investors to invest into these sectors and, with the right level of support, the capital should be readily available.

Heavy industries such as steel, cement, glass, chemicals and ceramics are critical foundation industries and significant employers in regions around the UK. They also have a key role to play in building a competitive, low-carbon manufacturing base in the UK as the global economy transitions to net zero.

Contributing around 14 per cent of the UK's total emissions in 2022, heavy industries have a complex challenge ahead of them to decarbonise, with several options involving technologies or processes that are still in development and with significant upfront capital costs. Some of the key options include greater investment in energy and resource efficiency (near term), use of electrification or low-carbon hydrogen as key input fuels (instead of coal or gas), and, in some cases, the installation of carbon capture and storage technology (CCS).

14%

Of the UK's total emissions in 2022 came from heavy industry

The decarbonisation of heavy industries is a growing area of focus for policymakers. For instance, the Industrial Energy Transformation Fund aims to support energy-efficiency and low-carbon technology investments in heavy industry with up to £500 million of funding. The Government has introduced a British Industry Supercharger Package to reduce electricity costs for some industries, is providing financial support towards new electric-arc furnaces in the UK, is proceeding with annual allocation rounds to grow the production of green hydrogen and has committed in principle some £20 billion of funding in the Spring 2023 Budget for the next 20 years to support investment in the first CCUS cluster projects.

However, the policy framework to decarbonise heavy industries is yet to be finalised, with some areas such as hydrogen transport and storage at an early stage of development. Dispersed industrial sites, which are not located in clusters and are common in industries such as glass, steel and cement currently have limited policy support to decarbonise. Investment in low-carbon industrial plants remains therefore limited.

Policy priorities

Overview

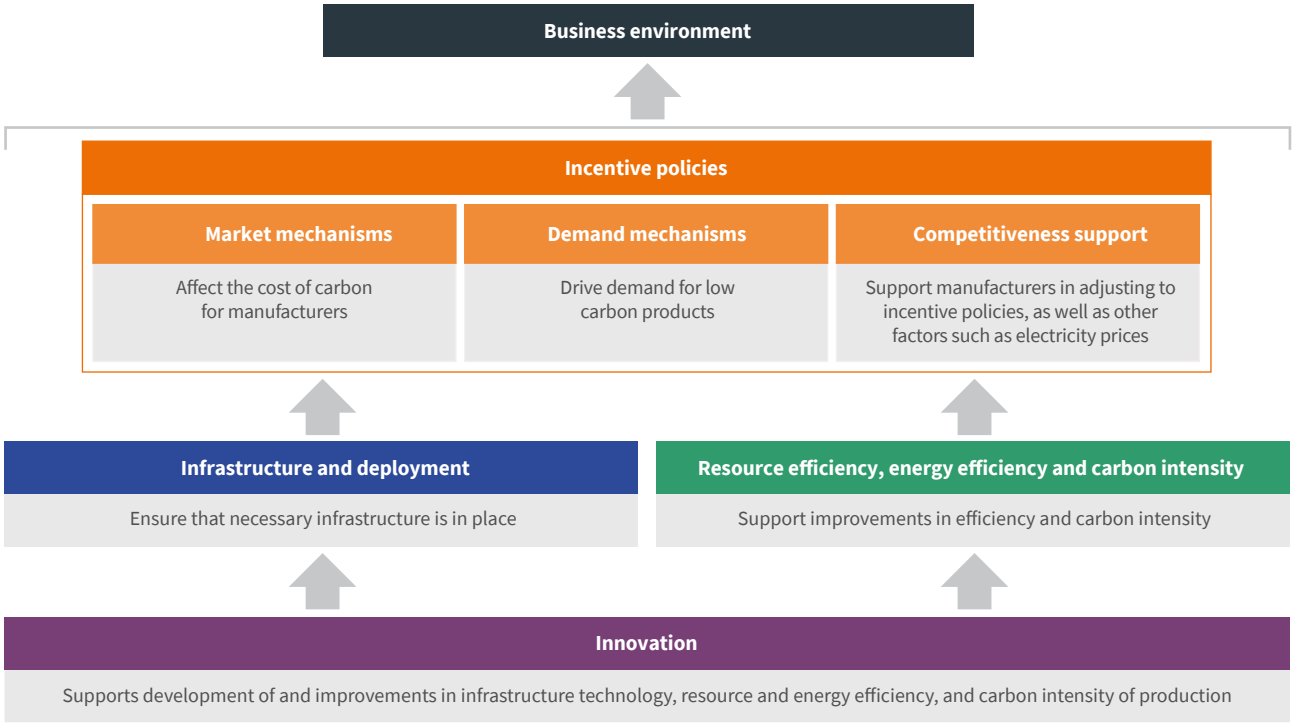
As illustrated in Figure 5, the policy framework to unlock private investment in low-carbon industrial assets and processes requires a range of different interventions. Key recommendations put forward in this section include:

- **Electrification:** Implement commitments under the British Industry Supercharger Package to reduce UK industrial electricity prices to make electrification more affordable and consider additional measures (such as through supporting the growth of zero-carbon Power Purchase Agreements) to allow heavy industries to benefit more directly from the falling costs of renewable electricity.
- **CCUS:** Complete the policy framework for CCUS (such as on CO_2 transport), clarify the sequencing for the first projects under the CCUS Cluster Sequencing Programme, and determine how the £20 billion of supportive funding is to be deployed.
- **Hydrogen:** Continue to deliver annual allocation rounds for green-hydrogen production projects (renewable-energy based) out to 2030, allocate the first contracts for blue-hydrogen projects (gas + CCS) under the CCUS Cluster Sequencing Programme, and complete the business models for the transport and storage of hydrogen by 2025.
- **Dispersed industrial sites:** Develop a bespoke strategy to connect industrial dispersed sites to the electricity, hydrogen and CO_2 transport infrastructure being developed in industrial clusters and to which dispersed sites will also need access in order to attract investment in their own decarbonisation efforts.
- **Growing market demand:** Grow the market demand for low-carbon industrial products through measures including low-carbon product standards, green public-procurement criteria and the implementation of a UK carbon price levy by 2027.

Allow heavy industries to benefit more directly from the falling costs of renewable electricity

Determine how the £20 billion of supportive funding for CCUS is to be deployed

Figure 5. **Policy options to decarbonise heavy industry**



Note: All of these policies contribute to the overall business environment and the possibilities and incentives for decarbonisation.
Source: "Accelerating the decarbonisation of industrial clusters and dispersed sites", Frontier Economics, September 2021.[229]

Heavy industry: key policy recommendations

Type of intervention	Detail of intervention	Expected benefit
Supply-side: energy and resource efficiency (See also recommendations in Section 1 on cross-cutting issues and in Section 5 on building materials)	• **Allocate funding under the £500 million Industrial Energy Transformation Fund at pace** to scale up energy efficiency and low-carbon investment across heavy industry.[230] • Building on the 2018 *Resources and Waste Strategy*, **publish a resource-efficiency action plan** to incentivise greater investment in resource-efficient industrial product design, waste-material collection and re-processing, remanufacturing, recycling and growing demand for resource-efficient products.[231] • This action plan should include measures such as **product standards that drive greater degrees of resource efficiency**, **fiscal incentives** to incentivise the collection and sale of waste materials (such as scrap steel) back into the UK market, **and a set of demand-side measures** (such as product standards and fiscal incentives) to grow market demand for resource-efficient intermediate and finished products.[232,233] *See below for more detail on product standards.*	• A comprehensive policy framework on industrial energy and resource efficiency can unlock significant private investment in energy and resource-efficiency processes across heavy industry. • A comprehensive resource-efficiency framework has been called for by several business groups, including the Aldersgate Group, the Chartered Institution of Waste Management (CIWM) and manufacturing trade bodies. Such a framework could drive investment in more resource-efficient product design processes, waste material collection and reprocessing, remanufacturing, and recycling. • Such a framework could also improve supply-chain resilience for UK businesses for key commodities and deliver efficiencies that will reduce the size of the decarbonisation challenge for heavy industry.

Heavy industry: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit
Supply-side: availability of CCUS (See additional detail on CCUS in Section 1 on cross-economy enablers and additional detail on the link between CCUS and engineered removals in Section 9)	• As called for by a range of energy and industrial businesses as well as the Carbon Capture and Storage Association, provide **clarity on the timing and sequencing** of the CCUS Cluster Sequencing Programme.[234] • This should include **clarity on the timings and arrangements for the release of funds** as part of HM Government's £20 billion CCUS spending commitment announced at the Spring 2023 Budget and **details of how the £20 billion is to be allocated across different types of CCUS projects.**[235] • Building on recent updates, finalise the industrial carbon-capture business models, with a focus on addressing outstanding issues around free carbon allowances, metering and the monitoring of CO_2.[236]	• £20 billion of funding over the next 20 years was allocated to support the first CCUS projects in the 2023 Budget.[237] Clarity on the timing and allocation strategy for the £20 billion of funding will accelerate investment in the first CCUS cluster projects and will have positive knock-on impacts on the commercialisation of – and investment in – subsequent projects. • Finalisation of all the underpinning CCUS business models and negotiations for the first CCUS cluster projects will provide investors with clarity on the market mechanisms and framework to invest in early CCUS projects.
Supply side: availability of low-carbon hydrogen (See additional detail on hydrogen in Section 1 on cross-economy enablers)	• **Hydrogen production:** (i) continue to roll out **a growing pipeline of green-hydrogen production projects** over the next three years through Hydrogen Allocation Rounds 2 to 4 and through the delivery of further annual allocation rounds out to 2030; (ii) grow the **pipeline of blue-hydrogen production projects** (gas + carbon capture) through contract allocation under Tracks 1 and 2 of the CCUS Cluster Sequencing Programme; (iii) **use the planned 2025 progress assessment to update deployment projections** for all hydrogen-production routes and to inform a potential strengthening of market deployment policies.[238] • **Hydrogen transport and storage:** By 2025: (i) put in place the first business models for hydrogen transport and storage; (ii) confirm the first project allocation for hydrogen onshore-storage facilities and associated pipeline infrastructure directed at large industrial clusters.[239] • Progress work to consider how to deliver **hydrogen needs for industrial dispersed sites** (see below). • Seek opportunities to collaborate on the development of international low-carbon hydrogen markets with key international partners, such as the EU.	• Following the green-hydrogen projects announced at HAR1 in December 2023, **giving the go-ahead to a growing pipeline of green-hydrogen projects in the next three allocation rounds will unlock early investment** and accelerate learnings from early deployment. • Allocating the first blue-hydrogen production contracts under the CCUS Cluster Sequencing Programme will start to provide a pipeline of commercially viable projects for investors to support. • A planned assessment of progress for the first hydrogen-production projects is due in 2025. This needs to inform the relative deployment potential for all types of hydrogen production and strengthen market mechanisms if needed. This will help clarify the investment opportunity in all types of hydrogen production and de-risk private investment in further projects. • The *Hydrogen Transport and Storage Networks Pathway* identifies power and industrial clusters as likely to be priority sites for hydrogen transport and storage infrastructure to support the decarbonisation of those sites by the early 2030s.[240] To unlock investment at the necessary pace and scale in onshore-hydrogen facilities and associated pipelines for those sites, investors will require completed business models for transport and storage and clarification on chosen projects by around 2025. • The UK signed the *Joint Declaration of Intent on establishing a United Kingdom – Germany hydrogen partnership* in September 2023 to accelerate the development of an international hydrogen industry, and the Scottish Government has committed a £200,000 investment to research and build the case for infrastructure investment for hydrogen exports to Germany.[241, 242, 243] Growing international collaboration opportunities for UK hydrogen producers will help to increase private investment flows into low-carbon hydrogen technologies and businesses.

Heavy industry: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit
Supply side: electrification	• Complete the **Review of Electricity Market Arrangements (REMA)** with a view to incentivising further investment in renewable generation, flexibility, short- and long-duration storage, and delivering more competitive electricity prices in the process. • In parallel with REMA, and as called for by industry groups such as Make UK and UK Steel, implement **the electricity cost-reduction measures in the British Industry Supercharger Package and** introduce **supplementary measures** where necessary **to help energy-intensive sectors benefit more directly from the lower costs of renewable electricity**.[244] This could include facilitating a growing use of zero-carbon Power Purchase Agreements.[245] • Building on REMA, wider policy reforms, and the recent call for evidence, finalise a strategy to facilitate industrial electrification, including by means of improving the competitiveness of industrial electricity prices by **moving policy costs off electricity bills.**[246]	• UK heavy industrial electricity prices were between 25 per cent and 44 per cent higher than the European average in 2019.[247,248]A UK Steel report suggests that in the 2023/2024 fiscal year, UK steel manufacturers paid electricity prices that were 86 per cent higher than their competitors in France and Germany (£113/MWh for UK steel manufacturers versus £61/MWh for their French and German counterparts).[249,250] • The Government introduced a British Industry Supercharger Package in April 2024. This aims to provide a degree of cost compensation to businesses in sectors like steel, paper and chemicals for costs relating to networks, renewable-energy support policies and the capacity market. However, groups such as UK Steel believe that UK heavy industries will still pay more for their electricity than European competitors. • Reforming market arrangements to make industrial electricity prices more competitive and providing heavy industries with better access to low-cost renewable electricity could significantly improve the business case for investment in industrial electrification in sectors such as steel, cement, glass and chemicals. • More competitive electricity prices will also support investment in electricity intensive carbon-capture technology and the production of green hydrogen, both of which can help cut emissions in industry. • Moving policy costs off electricity bills has been supported by a range of energy-intensive businesses and trade groups.[251]
Supply-side: dispersed industrial sites	• Develop a **comprehensive strategy to accelerate the decarbonisation of dispersed sites** for industries like cement, glass and steel, building on the 12 early projects supported under the £6 million Local Industrial Decarbonisation Plans.[252,253] • This should include details on how these sites are to access low-carbon solutions, such as electrification, carbon-capture and transport infrastructure, and hydrogen-transport infrastructure, which are expected to be primarily developed in industrial clusters in the first instance.	• A comprehensive strategy on dispersed industrial sites will be key to attract low-carbon investment to these sites. These sites are common in sectors like cement, steel and glass and represent around half of UK industrial emissions. • Outside of the initial projects supported under the Local Industrial Decarbonisation Plans competition, there are limited policies in place to incentivise investment in the decarbonisation of dispersed sites. Plans to demonstrate and scale up carbon capture and transport infrastructure outside of industrial clusters are at a very early stage, and so are the plans to connect these sites to hydrogen transport and storage infrastructure.
Targeted public funding for first-of-a kind plants (See public funding recommendation in Section 1 on cross-cutting solutions)	• Build on the £500 million of public investment for an electric-arc furnace steel plant at Port Talbot, and similar support being considered for British Steel's Scunthorpe and Teesside plants, by deploying **targeted public funding to crowd in private investment in first-of-a-kind low-carbon plants** in other heavy-industrial sectors such as cement, glass and ceramics.[254,255,256,257] • In light of the job losses that have been announced at the Port Talbot steelworks, public funding should be deployed as part of **a coherent industrial strategy** and with an eye to **delivering positive outcomes for the workforce**.	• The Government has awarded a £500 million support package to Tata Steel for the development of a £1.25 billion electric-arc furnace at Port Talbot, with a similar level of support expected for British Steel to develop two green electric-arc furnaces at its sites in Scunthorpe and Teesside (total project costs estimated at around £1.25 billion). • Targeted public funding in first-of-a-kind, low-carbon heavy-industrial plants could be an effective way of de-risking and crowding in private investment in these plants, with positive knock-on impacts on private investment in subsequent projects. • To be effective, this support must form part of a broader industrial strategy to support the development of a competitive low-carbon industrial base in the UK and should provide material consideration to the needs and prospects of the workforce on the affected sites.

Heavy industry: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit
Growing the demand for low-carbon industrial products	• Develop **mandatory product standards to drive down embodied and lifecycle emissions in finished products** (e.g., buildings, vehicles) **and intermediate industrial goods** (e.g., steel, cement). Take an escalator approach to grow the ambition of these standards over time.[258] Consider ways of accelerating their development by collaborating with– or building on – standards that have been put in place in other jurisdictions. • Put in place **a Green Public Procurement Strategy**, by introducing criteria to incentivise the public procurement of low-carbon and resource-efficient infrastructure, products and services. • In line with recent EU policy developments and building on the Government's December 2023 commitment, **implement a UK Carbon Border Adjustment Mechanism (CBAM)** to support the growth of a market for low-carbon industrial products while preventing potential competitive distortions from higher-carbon and lower-cost imports.[259] • See also the recommendations on carbon-pricing reform above and the potential implications this could have on the UK and EU CBAMs.	• Predictable demand-side policies will grow long-term market demand for low-carbon industrial products such as green steel/cement, thereby improving the business case for investing in low-carbon industrial production processes. • The UK Government spent £306 billion on public procurement in 2020/2021, with previous years including a large share on industrial products in the construction and defence sectors.[260, 261] Greening public-procurement criteria will therefore send a powerful market signal for low-carbon investment in heavy industry. • Other demand-side measures – such as product standards and CBAMs – are also essential to provide a level playing field for those heavy industries investing in the decarbonisation of their plants and which face competition from higher-carbon and potentially cheaper imports. • The **EU recently adopted a CBAM, which began its transitional phase on October 1, 2023**. It aims to ensure that the carbon price paid on imports of industrial products is equal to the carbon price paid on products manufactured in the EU.[262] Its initial focus is on carbon-intensive industries most at risk of "carbon leakage": cement, iron, steel, aluminium, fertilisers, electricity and hydrogen. • In December 2023, the UK Government announced it would implement a similar UK carbon border-price levy from 2027, with consultations on the detail of the mechanism in 2024. Its proposed coverage differs slightly to that of the EU CBAM (by, for instance, not including electricity), and includes iron, steel, aluminium, ceramics and cement.

Key takeaways

1. **Electrification:** Implement the British Industry Supercharger Package **reforms to cut the price of electricity for heavy industry** and consider further policies to make investment in electrification more affordable for heavy-industrial sectors.
2. **Market mechanisms for Carbon Capture, Usage & Storage (CCUS) and hydrogen:** Complete the **business models and allocation of funding for the first CCUS cluster projects**, grow the pipeline of green- and blue-hydrogen production projects through annual allocation rounds (green hydrogen) and contract allocation under the CCUS Cluster Sequencing Programme (blue hydrogen) and complete business models for the transport and storage of hydrogen.
3. **Dispersed sites:** Develop **a plan to connect dispersed industrial sites** to the electricity grid, CO_2 transport and hydrogen transport and storage infrastructure they need to decarbonise.
4. **Demand-side measures:** Grow the **market demand for low-carbon industrial products** through mandatory product standards, green public procurement and implementation of the UK carbon-price levy by 2027.

4. Surface transport (cars, vans, HGVs, rail)

The sector produced **105 million tonnes of carbon dioxide emissions ($MtCO_2e$) or 23 per cent of UK emissions** in 2022.[263]

The Government's Carbon Budget Delivery Plan indicates a cut in surface transport emissions of **58 per cent** by 2035, relative to 2022.[264, 265]

The Climate Change Committee recommends a reduction of **69 per cent** by 2035, relative to 2022.[266]

The investment requirement to decarbonise road transport in the UK is estimated to be around **£140 billion** by 2035.[267]

Manufacturing zero-emission vehicles in the UK could support **72,000 jobs**, worth up to **£9.7 billion GVA** by 2050.[268]

Investment insights

Edward Kevis
Global Equity Fund Manager, Liquid Markets

Martin McCudden
Senior Credit Research Analyst, Liquid Markets

Accelerating investment in low-emissions surface transport requires tackling five key challenges. These include ensuring that the right charging infrastructure and underpinning power-grid infrastructure is in place, reducing the upfront cost of zero-emission vehicles, growing a secondary market for used electric vehicles (EVs), addressing consumer range anxiety, and identifying the right technological options in areas such as trucks where solutions are more nascent.

A comprehensive range of policy solutions are required to address these challenges and strengthen market signals to grow investment in low-emissions transport. This includes accelerating the pace at which the UK's EV-charging infrastructure is developed in line with the strengthening of the Zero Emission Vehicles (ZEV) mandate out to 2035. This needs to work hand in hand with fully decarbonising and reinforcing the power grid to support such a rapid deployment of charging infrastructure.

To support a growing uptake of zero-emission vehicles, consumers should be provided with further financial support while the upfront cost differential between EVs and petrol/diesel vehicles remains significant. Introducing quality-assurance guarantees to increase confidence in used EVs will also be important to grow the second-hand market and open the EV market up to a broader range of consumers. Beyond upfront affordability, consumer confidence could also be improved through targeted public awareness campaigns highlighting the increased range capability of EVs and the fact that EVs will often offer a range that is compatible with the majority of journeys that consumers tend to make on a day-to-day basis.

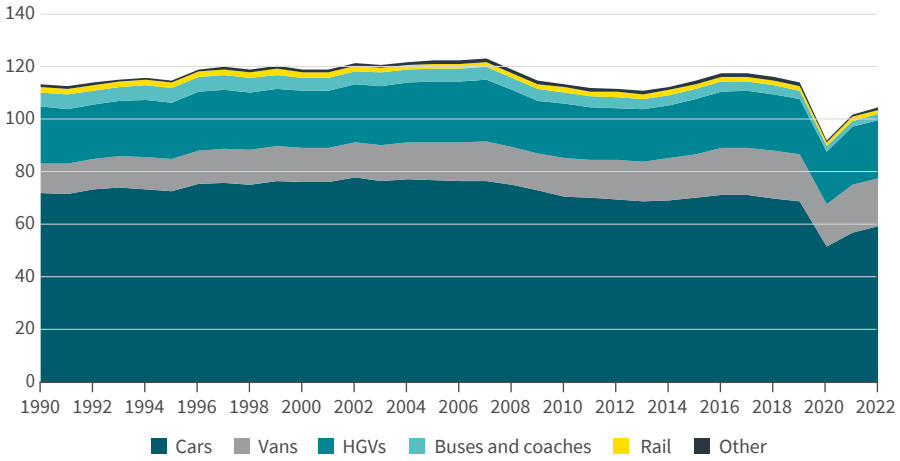
Finally, proceeding at pace with innovation trials covering a range of different zero-emission vehicle options for heavy goods vehicles (HGVs) will help identify the most promising technological options in the near-term and inform the design of the necessary incentives and regulatory tools to grow the market for zero-emission trucks.

Surface transport emissions – including emissions from cars, vans, buses, HGVs and rail – **represented around 23 per cent of total UK emissions in 2022** (Figure 6). Recent market trends show that a shift is occurring from petrol and diesel vehicles towards zero-emission vehicles, and in particular EVs. However, this differs significantly across different types of vehicles and much work remains to be done to grow these markets at scale.

EVs represented 17 per cent of new car sales in 2022 (with an 18 per cent to 19 per cent market share expected for 2023) but represented only six per cent of new van sales in that same year. Innovation and commercialisation of zero-emission buses is gathering pace and a range of pilot projects for zero-emission HGVs are also underway.

23%
Of total UK emissions came from surface transport in 2022

Figure 7. **UK surface transport emissions, 1990-2022 ($MtCO_2e$)**



Source: "Progress in reducing emissions: 2023 Report to Parliament", Climate Change Committee, June 2023.[269]

Policy priorities

Overview

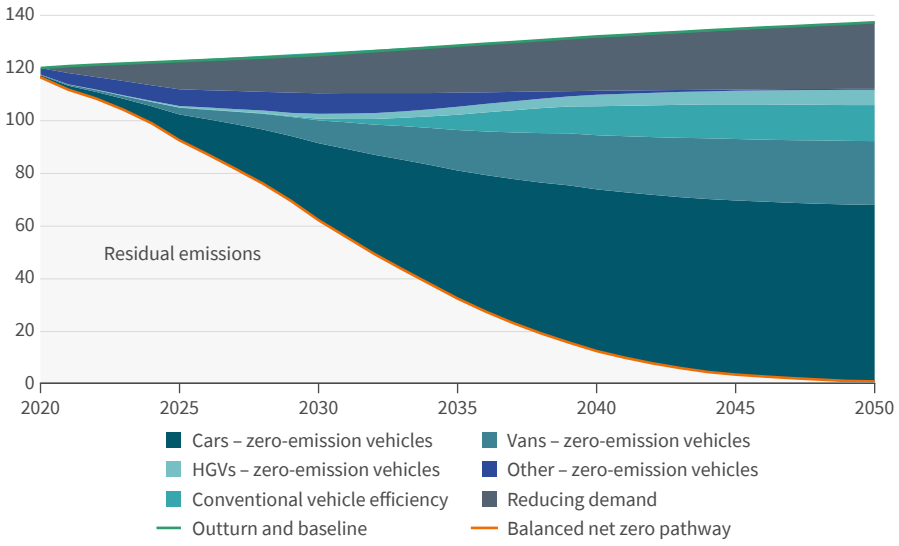
Looking ahead, **a number of challenges remain to be addressed to accelerate investment in low-carbon travel options** (Figure 7). These include the need to take **a more system-wide approach to transport infrastructure** decisions, tackling the barriers slowing the growth of the EV market around cost, charging infrastructure and range anxiety, the early stage of development for zero-emission vehicles in areas such as HGVs, and the need to improve and maintain the capacity and affordability of low-carbon travel options such as rail, buses and active travel.

There is a need to take a more system-wide approach to transport infrastructure decisions

Key recommendations made in this section include making regular updates to the 2021 Transport Decarbonisation Plan as part of **developing a more integrated transport strategy for the UK**, implementing – and potentially strengthening – the ZEV mandate to achieve 100 per cent sales of zero-emission cars and vans by 2035 or sooner, **accelerating the delivery of existing and new funding to roll out charging infrastructure** in nationally strategic and local roads, and **providing consumers with additional support to purchase new and used EVs**. A range of additional measures are put forward to grow investment in zero-emission vehicles in the **bus and HGV sectors**, with additional measures focused on **driving investment in the capacity and affordability of the rail network and active travel infrastructure**.

Develop a more integrated transport strategy

Figure 8. **Projected sources of emissions reductions in the surface transport sector, 2020-2050 ($MtCO_2e$)**



Source: "The Sixth Carbon Budget: Surface Transport", Climate Change Committee, December 2020.[270]

Surface transport: key policy recommendations

Type of intervention	Detail of intervention	Expected benefit and context
Systemic approach to decarbonisation	• Take a system-wide view of future policy and public infrastructure funding decisions in the transport sector, such as by **regularly updating and strengthening the 2021 *Transport Decarbonisation Plan***.[271]	• Greater coordination of policy and public funding decisions will ensure that new infrastructure choices optimise environmental and economic returns and provide greater visibility on the UK's low-carbon transport infrastructure investment needs. • The ***Transport Decarbonisation Plan*** provided a system-wide view of decarbonisation options across the transport sector. However, investment and policy decisions are still often taken on a mode-by-mode basis.
Decarbonisation of cars	• Deliver an **effective implementation and ratcheting up of the ZEV mandate from 2024**, ensuring compatibility with the target of having at least 80 per cent of zero-emission vehicle sales as part of overall sales by 2030, and 100 per cent by 2035.	• The sale of battery electric vehicles in the UK represented 17 per cent of new car sales in 2022, with an estimate of 18 per cent to 19 per cent for 2023.[272, 273] • A ZEV mandate was introduced in January 2024. This requires manufacturers to sell an increasing proportion of zero-emission cars (mainly EVs) as part of their overall sales as follows: 22 per cent in 2024, 80 per cent by 2030 and 100 per cent by 2035.[274]

Surface transport: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Decarbonisation of cars *(continued)*	• **Consider tightening the trajectory** under the ZEV mandate **depending on market trends**.	• Manufacturers will face fines of £15,000 per car for each vehicle they are short of their ZEV target, once exemptions are accounted for.[275] • The effective implementation – and potential tightening of – the ZEV mandate will stimulate growing investment in zero-emission vehicle manufacturing, reduce the costs of these vehicles and help to grow long-term market demand. This will have positive knock-on impacts on investment in supply chains and charging infrastructure.
Decarbonisation of light vans	• Deliver an **effective implementation and ratcheting up of the ZEV mandate for vans from 2024**, ensuring compatibility with the target of having at least 70 per cent of zero-emission vehicle sales as part of overall sales by 2030, and 100 per cent by 2035.	• Zero-emission vans accounted for only a six per cent share of overall van sales in 2022.[276] • A ZEV mandate for light vans was introduced in January 2024. This requires manufacturers to sell an increasing proportion of zero-emission vans as part of their overall sales as follows: ten per cent in 2024, 34 per cent in 2027, 70 per cent in 2030 and 100 per cent in 2035. Manufacturers will face fines of £18,000 per van for each vehicle they are short of their ZEV target, once exemptions are accounted for.[277] • The effective implementation of the ZEV mandate for vans is key to attract investment in zero-emission van supply chains and charging infrastructure at the necessary pace and scale.
EV-charging infrastructure	• **Complete the installation of rapid-charging infrastructure** (and the underlying power infrastructure) **across the strategic road network**, building on – and increasing the effectiveness of – the existing Rapid Charging Fund.[278] • Prioritise the **doubling of annually installed charge points** to support the growth of the EV market. As part of this, explore the possibility of **applying the same rate of VAT to public and private EV charging** to provide affordable EV charging for all groups of consumers, in line with the Net Zero Review and as called for by a range of industry groups, including the Society of Motor Manufacturers and Traders and the Fair Charge campaign and backed by industry names such as Jaguar Land Rover and E.ON.[279, 280, 281, 282] • Accelerate the delivery of funding already allocated under the £400 million Local Electric Vehicle Infrastructure (LEVI) scheme to **support local authorities with the roll-out of off-street parking**, with a particular focus on reducing unequal coverage between local authorities. **Consider extending the LEVI scheme for a further three years beyond its end date in 2025**, with a particular focus on areas with poor charging infrastructure coverage, as recently recommended by the House of Lords Environment and Climate Change Committee.[283, 284] • Implement **regulations to guarantee 99 per cent reliability and high accessibility of charge points** for EV drivers (up from 92 per cent today).[285]	• The charging infrastructure network grew by one third in 2022. However, an acceleration of the EV-charging infrastructure roll-out across nationally strategic and local roads is necessary. The number of annually installed charge points needs to double to keep pace with the projected uptake of EVs.[286] • Private EV charging is subject to a lower rate of VAT (five per cent) than VAT applicable for public charge points, which results in higher operating costs for EV drivers without access to private parking. Applying the same lower rate of VAT to both types of charging will improve the affordability of charging for all consumer groups. • There are significant disparities in the deployment of local road network charging infrastructure, with the top 20 per cent of local authorities averaging 133 charge points per 100,000 population, compared to just 20 charge points per 100,000 population for the bottom 20 per cent of local authorities.[287] • The rapid deployment of charging infrastructure is fundamental to the continued growth of the EV market, the delivery of the ZEV mandate and 2035 targets, and to strengthen positive consumer perception of electric cars and vans, thereby supporting the growth of long-term market demand. • Regulations guaranteeing a high degree of reliability and accessibility of charge points is essential to build consumer confidence and grow the market share of electric vehicles.

Surface transport: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Supporting consumer uptake of zero-emission vehicles	• As recently recommended by the House of Lords Environment Committee, consider introducing **targeted grants to support consumers with the purchase of new, affordable zero-emission vehicle models** until such time as the upfront cost of EVs reaches parity with that of petrol and diesel vehicles.[288] Such grants should reduce over time as the cost differential between EVs and petrol/diesel vehicles reduces. • Build consumer confidence in – and grow – the used EV market, by: (i) working closely with industry and organisations such as the AA/RAC to **introduce additional quality-assurance schemes for second-hand EVs** – such as by introducing **a cross-industry battery-health standard**; (ii) considering **the introduction of targeted grants for used EVs**, as seen in other markets such as the Netherlands.[289] • **Address consumer concerns around range anxiety** by carrying out **an awareness-raising campaign** on the extent to which EVs can already match consumer needs and current driving patterns.[290]	• Despite recent growth, the market demand for EVs and investment in EV supply chains are still being held back due to: (i) the difference between the upfront cost of EVs and that of petrol and diesel vehicles (ii) the limited size of the used EV market (iii) consumer concerns around range anxiety. • In addition to the downward price pressure which should be achieved through the implementation of the ZEV mandate, financial support with the purchase cost of new EVs will help maintain steady demand growth until such time as the upfront costs of EVs reaches cost parity with petrol and diesel vehicles, thereby supporting continued investment in EV manufacturing and underpinning supply chains. As a potential alternative to new purchase grants, the Society of Motor Manufacturers and Traders (SMMT) has called for a halving of VAT on new EVs for three years to reduce the purchase price for consumers.[291] • According to the SMMT, EVs represented only one per cent of used car sales in 2022. In a survey led by the Green Finance Institute, 62 per cent of consumers who said they would not buy a used EV listed concerns around battery lifespan as a key factor, with 27 per cent highlighting the high upfront costs of used EVs as a factor.[292] • Introducing independent quality-assurance schemes is key to improve consumer confidence in the used EV market, thereby growing their market penetration. Targeted grants as seen in the Netherlands could also support consumers overcome the cost barrier. • An evidence-based awareness raising campaign could go a long way to address consumer concerns on range anxiety and support growing market penetration for EVs.
Driving greater resource efficiency and resilience in the EV supply chain	• As part of the UK's implementation of the *Resources and Waste Strategy*, develop a plan to incentivise greater resource efficiency in the design of electric vehicles and their components – especially batteries – and to grow the UK's supply chain capability for the recycling and re-use of key components such as batteries and tyres.[293]	• A resilient supply chain that can guarantee the long-term availability of key metals (e.g., sustainably sourced lithium, nickel, manganese, iron etc.) and manufacturing processes required for EV production will be essential to the UK's ability to meet its zero-emission vehicles ambition. • Requiring improved design for key EV components such as batteries to facilitate end of life recycling and using regulatory and/or fiscal tools to stimulate private investment in the UK's recycling and remanufacturing supply chain for these components is key to improving supply-chain resilience and reducing the environmental impact from EV manufacturing.

Surface transport: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Decarbonisation of heavy goods vehicles (HGVs)	• **Closely monitor the learnings from the £200 million zero-emission HGV pilot projects** funded by Government/Innovate UK.[294] **Make a rapid and evidence-based decision on the preferred decarbonisation route(s) for HGVs** well within the term of the next Parliament. • Put in place a zero-emission HGV infrastructure strategy in 2024 or soon thereafter, as outlined in current Government plans, and introduce targeted financial incentives to **support early movers** in the zero-emission HGV market.[295] • Building on the Government's ambition to end the sale of new light (below or equal to 26 tonnes) non-zero emission HGVs by 2035, and all new HGVs by 2040, consult on **a new regulatory framework to grow the share of zero-emission HGVs and phase out the sale of non-zero emission HGVs** in the UK, learning from the implementation of the ZEV mandate for cars and light vans.[296,297]	• The Government launched the ***Future of Freight Plan*** in 2022, with the ambition to deliver a net-zero freight and logistics sector by 2050.[298] At COP26, the Government announced an ambition to phase out the sale of non-zero-emission light HGVs (equal to or below 26 tonnes) by 2035, and phase out the sale of all non-zero emission HGVs by 2040.[299] • There are **three main options** that are currently being explored **for the decarbonisation of HGVs:** large electric battery vehicles, electrification by means of overhead lines or hydrogen fuel cell technology. Some retailers and freight operators are also exploring the potential of low-carbon liquid fuels such as biomethane for their HGV fleet. Given the significant underlying infrastructure needs for each option, a limited number of preferred pathways needs to be identified. • Making early, informed decisions on the preferred decarbonisation pathway(s) for HGVs could stimulate early private investment in zero-emission HGV supply chains and put UK businesses ahead of global competition in the development of the zero-emission HGV market. • Combined with preferred decarbonisation pathway(s), a regulatory framework to grow minimum sales of zero-emission HGVs and ultimately phase out the sale of non-zero-emission HGVs will support growing investment in zero-emission HGV supply chains and the underpinning recharging and refuelling infrastructure.
Decarbonisation of and growth in bus usage	• **Rapidly deliver the funding available under the Zero-Emission Buses Regional Areas schemes** to grow market demand for zero-emission buses, including in rural areas.[300] • Consider introducing **a phase-out date for the sale of non-zero-emission buses** and **a supportive zero-emission bus mandate**. • Building on the £2 bus-fare cap, consider options to maintain the long-term affordability of local bus transport to maximise passenger uptake (see *also recommendations on modal shifts*).	• The Government announced £129 million of funding to support local transport authorities purchase zero-emission buses, with a particular focus on more remote/rural areas.[301] • In parallel with the approach taken with cars and vans, a mandate to grow the supply of zero-emission buses and ultimately phase out the sale of non-zero-emission buses will de-risk and accelerate investment in the zero-emission bus market and its underpinning infrastructure. • Long-term measures to drive the affordability of local bus transport will increase passenger demand and strengthen the market signal for zero-emission buses.
Road taxation reform	• Launch **a cross-party taskforce – backed by extensive public consultation – to put forward proposals for a new, socially progressive road taxation regime** to replace fuel duty and vehicle excise duty, as recommended by the House of Lords Environment and Climate Committee and the House of Commons Transport Committee.[302,303] • Progress work on developing and implementing a new road taxation system over the term of the next Parliament.	• A new road taxation system will be essential to provide adequate revenues to HM Treasury and support the economic viability of a road transport system based predominantly on electric/zero-emissions vehicles. It should be developed in a way which does not unduly penalise drivers on lower incomes driving longer distances. • A cross-party approach – backed by significant public consultation – will ensure long-term buy-in for a new road taxation system.

Surface transport: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Decarbonisation of and growth in rail use	• Put in place enablers to achieve the 75 per cent **rail freight growth target by 2050,** with a particular focus on continuing to invest in rail-network capacity, rail-freight capacity and innovation in rail freight, thereby delivering a shift away from road freight transport.[304,305] • Based on the 2023 rail-passenger price cap, develop **a long-term plan to support** the **affordability and reliability of rail-passenger transport** to boost passenger use. • Publish **a coordinated plan to fully electrify and enhance the railway network** in line with the 2050 net-zero emissions rail network target, while preparing the network for a growth in freight and passenger traffic.	• Despite a recent cap on rail-fare increases, the cost of rail travel remains comparatively high relative to other forms of transport.[306] • Clear targets and supportive measures to incentivise a shift for passenger and freight travel from road to rail will help grow demand for rail travel and cut surface transport emissions. • A clear plan to fully electrify and enhance the railway network will be essential to drive investment in low-carbon railway infrastructure and in the reinforcements needed to meet future demand. Only 2.2km of track was electrified in 2021/2022.[307]
Driving investment in active travel infrastructure and shared mobility solutions	• Building on past strategies and funding commitments, **introduce a coordinated plan to drive greater uptake and investment in active travel, public transport and mobility service solutions** (e.g., car sharing). • Use the Department for Transport's local transport plan guidance to **support local authorities in identifying the potential for take up and investment in active travel, public transport and shared mobility services** in their area. • **Consider increases to the budget of Active Travel England** to support continued investment by local authorities in local active travel plans and infrastructure.[308]	• CCC analysis suggests that an important proportion of emissions cuts in surface transport could be achieved by policy measures that encourage a shift towards active travel, public transport and mobility services such as car sharing. • A coordinated strategy and funding approach to active travel, public transport and shared mobility will help clarify the investment opportunity in low-carbon travel alternatives to individual car use. • Local authorities require appropriate national policy and funding support to develop adequate low-carbon transport plans at a local level, to then attract private investment.

Key takeaways

1. **System-wide strategy:** Develop and implement an **increasingly integrated transport strategy across all travel modes** to drive investment that will deliver the best economic and environmental returns.
2. **EVs:** Implement and ratchet up **the Zero Emission Vehicle (ZEV) mandate to reach 100 per cent zero-emission car and van sales by 2035**, backed by additional support for consumers through targeted grants for new and used EVs, industry standards on battery health for used EVs, and awareness-raising campaigns to tackle consumer range anxiety.
3. **Charging infrastructure:** Accelerate the delivery of – and extend – the **funding for rapid-charging infrastructure** across the strategic road network (Rapid Charging Fund) and for local roads (Local Electric Vehicle Infrastructure Scheme).
4. **Other vehicles:** Accelerate **innovation funding** and consider **replicating the ZEV mandate** and other incentives to accelerate investment in the commercialisation of zero-emission buses and HGVs.

5. Buildings (energy efficiency and heat)

The sector produced **76 million tonnes of carbon dioxide emissions ($MtCO_2e$), or 17 per cent of UK emissions** in 2022, with no substantive reductions since 2010.[309]

Over **28 million homes** and **two million non-residential buildings** must achieve high levels of energy efficiency and have access to a low-carbon heat source by 2035.[310]

The Government is aiming for **600,000** heat pump installations per year by 2028. This may require **£28 billion of cumulative investment** across the supply chain up to 2028.[311]

Improving the energy efficiency of every building in the UK that needs retrofitting may create **between 120,000 and 230,000** new construction jobs by 2030.[312]

The Government estimates that **300,000 heat pumps** could be manufactured per year in the UK by 2028.[313]

Investment insights

Mikhaila Crosby
Sustainability Research & Policy Associate Director, Private Markets

Our investment in the buildings sector includes:

- **As of May 2022, Aviva Investors had originated over £1.04 billion in climate-transition focused real estate loans, surpassing our 2025 target of £1 billion in loans three years early.**[314]
- **Aviva plc has committed to reduce our real estate investment portfolio greenhouse-gas emissions by 57 per cent per square metre by 2030, from a 2019 baseline.**[315]
- **Aviva Investors has provided almost £800 million of financing to housing associations across the UK on behalf of its investors since June 2020.**[316]

The most important challenges facing low-carbon investment in the UK's built environment are centred around minimum energy-efficiency (and performance) standards, the significant shortage of trained retrofit assessors and low-carbon technology installers and a lack of infrastructure for clean heat.

In relation to minimum energy-efficiency standards (MEES), there remains insufficient focus on tightening regulatory minimum standards for commercial buildings, as the proposal to implement an EPC B target for the privately rented commercial sector by 2030 is now overdue. There are also issues around the lack of rigorous enforcement of such standards and questions as to whether local authorities have the resources to be able to act on non-compliant assets.

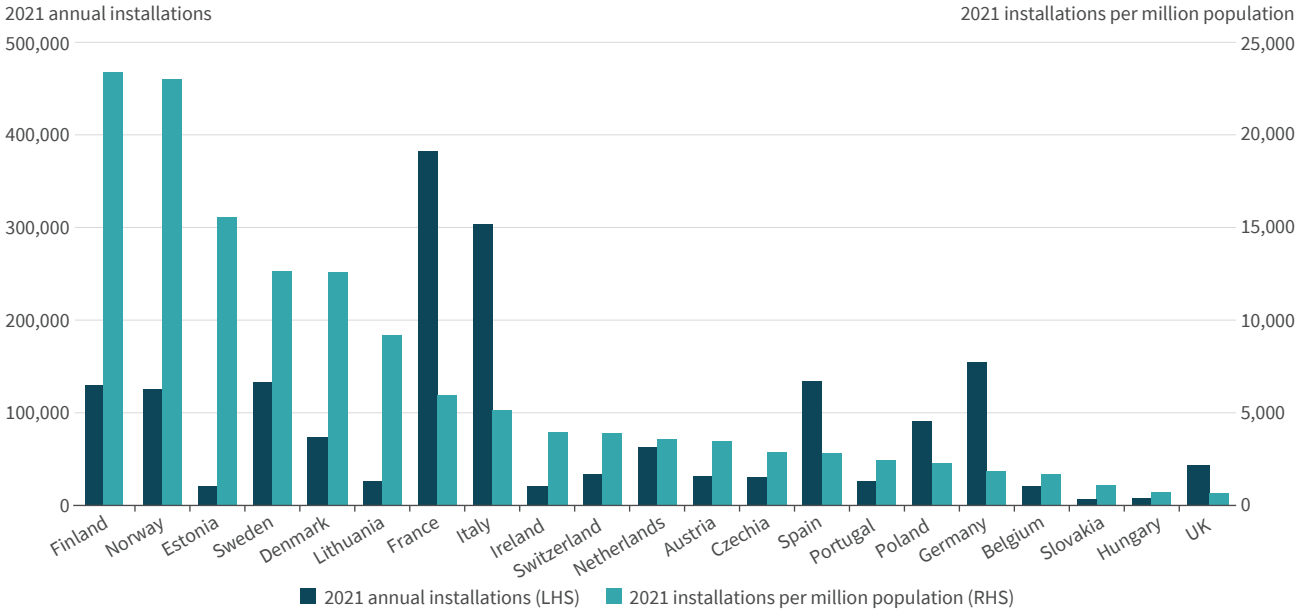
In the residential sector, the withdrawal of proposals to tighten the MEES for privately rented accommodation from EPC E to EPC C by 2025 for new tenancies, and by 2028 for existing tenancies, is also making the investment case for energy-efficiency solutions in privately rented properties more complex. A performance-based energy-efficiency rating system would provide much-needed clarity on the investment needs of buildings so that owners are able to optimise the energy-efficiency measures they undertake. Ultimately, what is needed most is a consistent regulatory approach, combined with fiscal incentives, to enable increased private investment in energy-efficiency improvements within both commercial and residential real estate.

Investment insights *(continued)*

The skills gap is an issue in both non-residential and residential buildings. Conversations we have had across the supply chain indicate workforce shortages and lack of investment in skills for retrofit assessments and heat-pump installation are obstacles in relation to improving and maintaining existing building stock, let alone delivering new net-zero or low-carbon buildings. Tackling the skills gap will be critical to support increased investment in energy-efficiency and heat-pump installations, and in the underlying supply chain. It would not only help enable the decarbonisation of the UK's built environment, but would also support businesses, tenants and renters/property owners reduce their energy bills during this period of high inflation and an energy-affordability crisis.

Finally, there is a need to carefully manage and plan the uptake of clean heat over the next 20 years. Currently the working solutions for clean heat are heat pumps or, where available, heat networks. To make sure these solutions are fully realisable across our portfolio, we require investment in the electricity network to ensure that there is capacity for heat-pump connections. We also need training and upskilling of the workforce so that our supply chains are comfortable designing and specifying these solutions and are able to deliver them in the most cost-effective way. Heat networks need to be better regulated so that users are not locked into high energy costs. If hydrogen is to be a third clean-heat option for buildings, it needs to be made clear where this option is most suitable.

Figure 9. **State of the market: Heat pump sales across Europe (2021)**



Source: "Progress in reducing emissions: 2023 Report to Parliament", Climate Change Committee, June 2023.[317]

The UK has around 28 million homes and two million commercial buildings, representing the second highest-emitting UK sector in 2022. As part of meeting the UK's carbon budgets, the sector requires significant investment in the installation of energy-efficiency measures and low-carbon heat systems at scale in new and existing homes and commercial buildings over the next ten years.

The wide array of different homes and non-domestic buildings, the sheer number of households and property owners involved and the significant infrastructure required to replace heating systems make the challenge of driving low-carbon investment in the sector particularly complex. Only limited emissions reductions have occurred since 2010 according to the Climate Change Committee (CCC), with the roll-out of low-carbon heating systems still significantly below target (Figure 8).[318]

The built environment was the second highest-emitting UK sector in 2022

While some important incentives are in place – such as the Boiler Upgrade Scheme to drive heat-pump uptake – and new policies are in development to deliver a lower-carbon building stock – such as the Future Homes and Buildings Standards – further work is required to deliver the fully comprehensive policy framework that will attract private investment at scale in energy-efficiency and low-carbon heat measures across all types of properties and buildings.

Policy priorities

Overview

This section sets out a range of policy recommendations including regulatory tools, market mechanisms and fiscal incentives – to drive investment in the installation of energy-efficiency and low-carbon heat measures across a range of property types. Key recommendations include:

- **Low-carbon heating:**
  - (i) Make a strategic decision in the near future on the relative role of heat pumps, heat networks and hydrogen;
  - (ii) Grow the market uptake of heat pumps and cut their costs to households through a regular review of the support provided under the Boiler Upgrade Scheme and by introducing a market mechanism to grow the supply of heat pumps year on year;
  - (iii) Complete the regulatory framework for low-carbon heat networks;
  - (iv) Ensure that incentives for heat pumps do not undermine the development of heat networks in areas where these are the best option.

Policy focus should be on growing the market uptake of heat pumps and cutting their costs

- **Existing homes and social housing:** Introduce a coherent framework of minimum regulatory energy-efficiency standards and fiscal incentives – as currently being consulted on as part of Scotland's Heat in Buildings Bill – to drive investment in energy-efficiency measures in owner-occupied and privately rented homes and improve the efficiency of existing schemes such as ECO4 in supporting the installation of energy-efficiency and low-carbon heat measures in social housing.[319]
- **New homes and commercial buildings:** Strengthen and implement the technical details for the Future Homes and Buildings Standards, so that all new homes and buildings built from 2025 operate at high levels of energy efficiency, with low-carbon heating and improved resilience to extreme weather events.
- **Public-sector buildings:** Maintain clarity on the long-term levels of funding available to support energy-efficiency and low-carbon heat installation in public buildings.

Buildings: key policy recommendations

Type of intervention	Detail of intervention	Expected benefit and context
Low-carbon heat: strategic decisions - all properties	• **Overall strategic decisions (1):** Building on the positive steer provided in the *Future Homes and Buildings Standards Consultation*, and as called for by the National Infrastructure Commission, confirm **that heat pumps and electrification should, in most cases, be the default low-carbon heat option** for new and existing homes and buildings, except for areas suitable for heat networks.[320,321] • **Overall strategic decisions (2):** Confirm the **suitability of low-carbon heat networks for specific areas.** Ensure that policy support for heat pumps does not undermine the commercial case for low-carbon heat networks where they are the best option. • **Overall strategic decisions (3):** Make a **decision on the limited role of hydrogen** in heating **well ahead of** the current **2026** deadline.[322,323] • **Heat pumps:** Deliver **an effective implementation and gradual tightening of the** heat-pump sales targets under the **Clean Heat Market Mechanism** from its scheduled start date in April 2025 to improve the availability and affordability of heat pumps for households and support supply-chain growth.[324] • **Heat networks (1):** Building on enabling powers under the Energy Act 2023, work with The Office of Gas and Electricity Markets (Ofgem) to **complete a regulatory framework for heat networks and heat-networks zoning by 2025**.[325] • **Heat networks (2): Deploy the funding already earmarked until 2028 under the Green Heat Network Fund and Heat Network Efficiency Scheme to accelerate the roll-out of heat networks,** and consider a potential extension of that funding beyond 2028 if required. Encourage the use of waste heat to feed into heat networks and close existing loopholes to ensure all networks – including privately funded ones – are supported by a low-carbon heat source.	• **Overall strategic decisions:** There is ample evidence that electric heat pumps – and in specific areas, heat networks – are the most suitable form of low-carbon heating for the majority of properties, with only a limited role for hydrogen boilers. The Government's Future Homes and Buildings Standards Consultation identifies heat pumps, electrification and low-carbon heat networks as a default option for new homes and buildings. • **Overall strategic decisions:** Making a decision on the limited role of hydrogen in heating will clarify the future heating technology mix for investors, clarify the market demand for different low-carbon heat options and accelerate much-needed investment in heat-pump and heat-networks supply chains. • **Heat pumps – context: 72,000 heat pumps were installed in the UK in 2022 and 60,244 heat pumps were sold in 2023.** This compares to the CCC's targets of 130,000 installations for 2022 and 145,000 for 2023, and a Government target of 600,000 annual heat pump installations by 2028.[326,327] • **Heat pumps:** The Clean Heat Market Mechanism is due to start in April 2025, mandating large manufacturers to meet six per cent of heat-pump sales as part of overall boiler sales in Year 1, and increasing further after that.[328] An effective implementation and tightening of the Mechanism over time will help investors more accurately forecast the growth of the heat-pump manufacturing market in the 2020s, thereby encouraging investment in the supply chain. • **Heat networks:** Finalising a comprehensive regulatory framework for heat networks and heat-networks zoning will be essential to drive investment in low-carbon heat networks at the necessary pace and scale.
Low-carbon heat: growing the availability and affordability of heat pumps – all properties	• **Regular review of Boiler Upgrade Scheme (BUS):** Building on the recent increases to heat-pump grants and the overall size of the BUS, keep **the overall budget for the BUS under regular review and** consider future increases if necessary to increase take-up.[329] • **Implementation of Clean Heat Market Mechanism:** Ensure that the implementation of the **Clean Heat Market Mechanism comes with a focus on driving down the upfront cost of heat pumps**, together with increasing their availability. • **Heat pumps in commercial buildings:** Consider **potential interventions to grow the market availability of large heat pumps for commercial buildings.** This could include introducing equivalent funding and market mechanisms to the Boiler Upgrade Scheme and Clean Heat Market Mechanism but tailored to larger heat pumps.	• **BUS:** Regularly reviewing the adequacy of the overall budget for the BUS will help make the purchase of heat pumps affordable and accessible in the near to medium term for a growing number of households, and accelerate cost reductions in the manufacturing of these systems through economies of scale. • **Clean Heat Market Mechanism:** By targeting both a growth and cost reduction in heat pump sales, the Clean Heat Market Mechanism can play a key role in improving their affordability for households. • **Heat pumps in commercial buildings:** There is currently not a mature market for the provision of larger heat pumps for commercial buildings.[330] The BUS and the Clean Heat Market Mechanism are tailored to growing the manufacturing and uptake of heat pumps suitable for homes and small non-residential premises. Tailoring these market mechanisms for larger buildings could help stimulate increased investment, manufacturing, and take-up of large heat pumps for commercial buildings.

Buildings: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Low-carbon heat: affordability of electricity prices for households (See Section 1 for more detail on electricity-market reforms)	• Beyond the completion of the Review of Electricity Market Arrangement (REMA) reforms, put forward an **enduring solution to remove policy costs from electricity bills** to improve their affordability and competitiveness.[331] • Consider **introducing further policies such as a social tariff to cut electricity prices for fuel-poor households,** as called for by several consumer groups, the Aldersgate Group and UCL.[332]	• Reforms to reduce and improve the competitiveness of electricity prices are essential to make the operational costs of heat pumps affordable as well as more favourable relative to gas boilers.
Existing homes: an energy-efficiency policy framework for non-fuel-poor homes and privately rented properties	• Put forward **a coordinated and long-term policy plan** for non-fuel-poor homes which combines: (i) binding energy-efficiency regulatory targets; (ii) corresponding fiscal incentives to drive the long-term uptake of energy-efficiency and low-carbon heat measures. • Building on the commitments of the 2017 Clean Growth Strategy, **set an energy-efficiency regulatory target of at least EPC Band C for owner-occupied homes by 2035** and tighten the Minimum Energy Efficiency Standards to EPC Band C for privately rented properties by 2030 at the latest. • **Fiscal incentives** to drive the take-up of energy-efficiency measures could include stamp-duty rebates, VAT reductions for energy-efficiency products and incentives for households undergoing efficiency improvements.[333, 334]	• Around 28 million homes and two million commercial buildings need to be highly energy efficient and equipped with a low-carbon source of heat by the mid-2030s. • The proportion of homes in the highest three energy-efficiency rating brackets increased from 19 per cent in 2012 to 48 per cent in 2022.[335] However, the investment and infrastructure requirements to bring the whole building stock to high levels of energy efficiency is significant, and requires a predictable, long-term policy plan. • A combination of long-term regulatory signals and fiscal incentives is essential to build a predictable market signal for the growing uptake of energy-efficiency and heat, thereby driving supply-chain growth, investment in skills and cost reductions.
Access to finance for energy-efficiency improvements in homes	• **Access to low-interest finance:** Work with the UK Infrastructure Bank to **provide zero per cent or low-interest loans to homeowners** to support energy-efficiency improvements.[336] Work with financial regulators, the Green Finance Institute and lenders to **grow the market for green mortgages**, providing preferential rates for homes that are energy efficient or with planned improvement works. • **Access to finance - aggregation:** Support schemes to **aggregate homeowner demand for the installation of energy-efficiency and low-carbon heat measures**. This could follow the example of the Solar Together Initiative, supported by several local authorities, which is focused on boosting and cutting the costs of solar-panel installations.[337]	• **Access to low-interest finance:** Access to low-interest loans/finance is key to make energy-efficiency and low-carbon heat improvements attractive to homeowners and grow market demand. • **Access to finance - aggregation:** Schemes to aggregate demand for low-carbon heat and energy-efficiency measures can cut costs for homeowners through "group buying" and could also be used as a platform to attract financing from larger investors.
Social housing and fuel-poor homes: Energy-efficiency and low-carbon heat	• The **effectiveness of funding schemes for social housing – in particular ECO 4 – should be reviewed** to increase the delivery of energy-efficiency measures and increase the focus on low-carbon heat installation over gas boilers. • Consult on the **introduction of tighter minimum regulatory energy-efficiency standards** in social housing.	• The are a range of funding schemes to support energy-efficiency and low-carbon heat investment in social housing and fuel-poor homes, including: the Social Housing Decarbonisation Fund, the Home Upgrade Grant (HUG), Local Authority Delivery (LAD) and the fourth round of the Energy Company Obligation (ECO 4).[338, 339, 340, 341] • However, energy-efficiency and heat-pump installation under these schemes remains below target.[342] Increasing the effectiveness of these schemes will be critical to grow investment in energy-efficiency and low-carbon heat measures. • Tighter regulatory standards on the energy efficiency of social housing will create predictable market demand for the installation of further energy-efficiency measures in social housing.

Buildings: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
New homes: Energy efficiency and low-carbon heat	• Building on the *Future Homes and Buildings Standards Consultation* and as called for by groups such as the UK Green Building Council and Green Homes Alliance, **complete and implement the technical details for the Future Home Standard (FHS)** to ensure that all new homes built from 2025 deliver high levels of energy efficiency, low-carbon heat, renewable electricity and resilience to extreme-weather events.[343,344] • Set an **end date for the connection of new homes to the gas grid,** thereby protecting households from expensive future boiler-replacement costs and ensuring consistency with the FHS objective of delivering homes equipped with low-carbon heat technologies at the outset.[345]	• The *Future Homes and Buildings Standards Consultation* sets more ambitious requirements for energy efficiency and heating for new homes and non-domestic buildings, effective from 2025. It presents heat pumps, electrification and – in specific cases, low-carbon heat networks – as the default heating options for new homes and buildings.[346] • A range of factors are still under consideration, including the degree of ambition to be mandated for the installation of rooftop solar panels and the measurements to be used to confirm compliance with the standard. Embodied carbon emissions in homes and buildings, water efficiency, flood prevention and sustainable drainage are currently out of scope. • If underpinned by clear and ambitious technical details and an end date for the connection of new homes to the gas grid, the implementation of the Future Home Standard will send a clear signal on the scale of energy-efficiency, low-carbon heat and climate-adaptation measures required in new homes and buildings. This, in turn, will provide market clarity on the necessary investments required in the underlying supply chains.
Existing commercial buildings: Energy efficiency	• Introduce ambitious **minimum regulatory energy-efficiency standards paired with fiscal incentives** to drive the uptake of energy-efficiency and low-carbon heat measures in commercial buildings (owner-occupied and privately rented). • Confirm the details for the implementation of a minimum regulatory energy-efficiency standard of EPC Band B by 2030 for privately rented commercial buildings.	• The Government is yet to publish a response to its consultation on implementing a 2030 EPC Band B target for the privately rented commercial sector.[347] There is currently no comprehensive framework to drive the installation of energy-efficiency and low-carbon heat measures in owner-occupied commercial buildings. • A combination of long-term regulatory signals and fiscal incentives is essential to build a predictable market signal for the growing uptake of energy-efficiency and low-carbon heat measures, thereby driving supply-chain growth, investment in skills and cost reductions.
New commercial buildings: energy efficiency and heat	• Building on the *Future Homes and Buildings Standards Consultation*, complete the **technical details and implement the Future Buildings Standard** (FBS) to ensure that all new buildings built from 2025 deliver high levels of energy efficiency, low-carbon heat, renewable electricity and resilience to extreme-weather events.[348] • Set an **end date for the connection of new buildings to the gas grid**, thereby protecting businesses from expensive heating-system replacement costs and ensuring consistency with the FBS objective of delivering buildings equipped with low-carbon heat technologies at the outset.	• See details provided above on the *Future Homes and Buildings Standards Consultation*. • If underpinned by clear and ambitious technical details, and an end date for the connection of new buildings to the gas grid, the implementation of the FBS could send a strong market signal for the scale of energy-efficiency, low-carbon heat and climate-adaptation measures required in new buildings. This, in turn, will provide market clarity on the necessary investments required in the underlying supply chains.
Public-sector buildings: energy efficiency and heat	• Deliver at pace the funding already earmarked under the Public Sector Decarbonisation Scheme until 2028 to support investment in energy efficiency and low-carbon heating in public buildings, and clarify future funding and policy support beyond that date.	• The Government targets 75 per cent emissions cuts in public sector buildings by 2037 relative to 2017. As part of the **Public Sector Decarbonisation Scheme,** the Government committed £2.5 billion of funding for the period 2020/2021 to 2024/2025 to support the installation of energy-efficiency and low-carbon heat measures, with a further £1.17 billion for the years 2025/2026 to 2027/2028.[349,350] • Clarity of support available under the Scheme beyond 2028 will help maintain momentum in the investment, supply-chain growth and installation of energy-efficiency and low-carbon heat measures in public-sector buildings.

Buildings: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Cross-cutting: strategic decisions on energy efficiency	• Implement **proposals in the near-term to better reflect real-life energy performance of homes and buildings and the utilisation of heating and cooling systems and smart technologies in energy-efficiency ratings,** such as **EPCs**, and other **public information tools**. This could be based on two key pillars. • First, it could build on the Government's consultation to replace the Standard Assessment Procedure for Buildings with a new Home Energy Model. • Second, it could also build on the proposals in the *Future Homes and Buildings Standards* consultation to increase developers' take-up of post-occupancy performance testing in new homes – with the potential to eventually make this mandatory.[351, 352]	• Improving the way in which energy-efficiency ratings such as EPCs reflect the real-life performance of buildings would clarify the investment needs to optimise energy efficiency in buildings. • The Home Energy Model consultation proposes to replace the Standard Assessment Procedure for buildings with a more real-time energy-efficiency assessment model, which would initially inform the assessment of new buildings delivery of EPCs. The proposed model would better capture the dynamic energy performance of key energy systems and low-carbon heating and cooling technologies in buildings. • The *Future Homes and Buildings Standards Consultation* proposes to ask all developers to voluntarily carry out post-occupancy performance testing and make the results publicly available. Developers that agree to performance test their homes and that meet a threshold for good performance may be authorised to use a new government-endorsed Future Homes Standard brand.[353] • Widespread post-occupancy energy performance testing will help to robustly quantify the energy-performance gap between the design and occupancy stage, thereby helping identify the key energy-efficiency investments needed to improve the energy performance of new homes.[354]
Cross-cutting: climate adaptation	• Consult on **options to include climate-adaptation support measures as part of the overall energy-efficiency and low-carbon heat incentives** being introduced for different types of properties, including as part of the forthcoming implementation of the Future Homes and Buildings Standards. This should include measures to ensure properties are resilient to current and future extreme-weather events, such as flooding and overheating.	• Climate-adaptation measures are poorly integrated in the energy-efficiency and low-carbon heat policy framework for buildings. These measures were largely out of the scope of the recent *Future Homes and Building Standards Consultation*.[355] • Risks to properties from extreme-weather events are increasing, with a 10.7 per cent increase in the number of residential properties in England at high risk of surface flooding since 2020.[356] National standards on climate-adaptation measures would help to drive private investment into innovation and delivery of resilient homes and reduce the long-term cost to the public. • Joining up the installation of climate-adaptation measures with that of energy-efficiency and low-carbon heat measures will be cost-efficient and maximise the resilience of all types of properties to extreme-weather events.
Cross-cutting: embodied carbon (See also the recommendations in Section 1 on cross-cutting issues and Section 3 on resource-efficient industrial products)	• Consult on **proposals to monitor and drive a reduction in embodied-carbon emissions** in the construction of new homes and buildings, in line with recent call from 11 built environment organisations, the Part Z campaign supported by over 100 companies, and the Aldersgate Group.[357, 358, 359] • This could include: (i) the development of legal limits in building regulations for embodied-carbon emissions of major building projects; (ii) the development of **mandatory product standards to gradually improve the resource-efficiency and carbon intensity of industrial products** used in construction, such as steel, cement and glass *(see Section 3 for more detail on this recommendation).*	• Embodied carbon related to the production and use of construction materials accounts for around ten per cent of the UK's total emissions per year.[360] • A process to monitor the evolution of embodied carbon in the construction of new major building projects, backed by legal limits set in building regulations and minimum product standards for key construction materials, will help unlock greater investment in construction processes with low embodied carbon and in the sourcing and manufacturing of low-carbon and resource-efficient construction materials.

Buildings: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Cross-cutting: skills	• The implementation of the Government's **Green Skills Action Plan** should scale up the provision of training for energy-efficiency retrofit assessors and heat-pump installers, with approaches tailored to those still in education and those already in the workforce. • **Government and industry should collaborate on future skills development in the wider construction industry** to ensure that climate targets for new and existing building stock can be delivered.[361]	• Tackling the significant skills gap in energy-efficiency assessors, heat-pump installers and other parts of the construction industry is critical to unlock increased investment in energy-efficiency, heat-pump and other low-carbon solution installations and their underlying supply chains.[362]
Cross-cutting: public awareness	• Set up a targeted campaign to **grow public awareness of available funding schemes** (Boiler Upgrade Scheme, Great British Insulation Scheme etc.) **and information services** (such as the recently launched Energy Advice Service) **to support and guide homeowners** with the installation of energy-efficiency and low-carbon heat measures in homes.	• Measures to grow public awareness and acceptability are essential to increase the take-up of existing support schemes and establish predictable, long-term demand for energy-efficiency and low-carbon heat measures.

Key takeaways

1. **Heating:** Make a rapid, strategic decision that **heat pumps and low-carbon district heating networks** are the most suitable solution for low-carbon heating, using grant schemes and a market mechanism to grow the supply, cut the costs and grow market demand for heat pumps.
2. **Existing homes:** Combine minimum – and gradually tightening – regulatory **energy-efficiency standards and fiscal incentives to drive investment in energy efficiency** in existing homes, and improve the efficiency of social housing schemes such as ECO4.
3. **New homes and buildings:** Complete ambitious technical details for – and implement – **the Future Homes and Buildings Standards** to ensure that investment in new homes and buildings built from 2025 delivers high levels of performance in terms of energy efficiency, low-carbon heat, renewable electricity, and extreme-weather resilience.

6. Aviation

The sector produced **29 million tonnes of carbon dioxide emissions ($MtCO_2e$) or seven per cent of UK emissions** in 2022, which remains **25 per cent lower** than pre-pandemic levels in 2019.[363]

Global aviation emissions accounted for **two per cent** of global energy-related emissions, and are growing faster than road, rail or shipping emissions.[364] The UK's per person emissions for international flights ranked **11th** highest in the world in 2021.[365]

The Government is aiming to reduce UK aviation emissions by **49 per cent** by 2050, relative to 2019 levels, with removals for the remaining **19 $MtCO_2e$**.[366]

The Climate Change Committee estimates that additional investment requirements in efficiencies and hybrid aircraft to be in the region of **£390 million** per year by 2035 and **£570 million** per year by 2050.[367]

A sustainable aviation fuel industry could generate up to **£2.7 billion GVA** from UK production and global exports and support up to **520,000 jobs** by 2035.[368, 369]

Rapid UK investment in zero-emission hydrogen aircraft could see the UK securing **19 per cent** of the global aerospace industry (worth **£178 billion** per year by 2050) and support **60,000 jobs** by 2050.[370, 371]

Investment insights

Sora Utzinger
Head of ESG Integration, Equities

Joshua French
Global Equity Research Analyst

Investing in sustainable aviation fuels (SAFs) and low-carbon aviation solutions presents several investment challenges. The SAF industry, still in its infancy, is considered high-risk due to a nascent policy framework and the competitive global feedstock market. Research and development in the field have pivoted in recent years from electricity-based solutions to hydrogen and SAFs, in recognition of the limitations of current battery technology for large aircraft. However, scalability remains a significant issue, as seen in minimal SAF production compared to total jet fuel consumption, and is hindered by limited refinery capacity and high production costs.

The maturity of production conversion types for SAFs also poses a challenge. While HEFA-SPK is the most technically mature pathway, expanding into other feedstock types like agricultural residues and municipal solid wastes requires new supply chains and appears, for now, to be a more expensive solution versus HEFA. Additionally, the development of electrofuels (Power-to-Liquid), though technically viable, is currently hampered by their high production cost compared to traditional kerosene.

From a policy perspective, several interventions could address these challenges. The UK's planned implementation of a SAF mandate backed by a revenue certainty mechanism could help stimulate SAF demand in line with clear sustainability and emissions criteria. Enhancing international collaboration for standardising and deploying low-emission fuels and aircraft is also vital. Reforming carbon pricing could incentivise the growth of low-emission fuels. Investing in and promoting low-carbon transport alternatives, like rail and virtual conferencing, and developing a credible market for high-quality carbon offsets are other crucial steps. These interventions, when combined with recognition of the cost and yield advantages of different SAF production methods like HEFA-SPK and ATJ, could significantly advance the sector towards achieving low-carbon aviation goals.

The aviation sector's emissions are a relatively small part of UK and global overall emissions, but they are growing rapidly. Driving low-carbon investment in the sector is particularly challenging, given the early stage of development of different low-carbon solutions and the intrinsically global nature of the sector.

Potential technological solutions to cut emissions in aviation include:

(i) Further improving near-term fuel efficiencies;

(ii) Growing the use of SAFs – an objective that currently benefits from strong cross-industry consensus;

(iii) Developing hybrid electric aircraft;

(iv) Developing zero-emission hydrogen or battery-electric aircraft.

Other measures such as driving investment in viable low-carbon alternatives to aviation, and putting in place an environmentally robust carbon-offsetting framework to deal with residual emissions, are also likely to have a role to play.

The aviation sector's emissions, although currently small, are growing rapidly

A global and domestic policy framework to incentivise investment in low-carbon aviation fuels and technologies has begun to emerge in recent years. Globally, and thanks in part to UK leadership, **the International Civil Aviation Organisation (ICAO) committed to a 2050 net-zero target for the global aviation sector**, albeit the global support mechanisms to deliver this ambition are as yet unclear, as evidenced by the very low carbon price under ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).[372] The aviation sector is subject to both the UK and EU Emissions Trading Schemes (ETS), under which airlines will no longer receive free emissions allowances from 2026.

In the UK, the Government published **a *Jet Zero Strategy*, which sets a goal for UK international aviation emissions to reach net zero by 2050, with a 2040 net-zero target for domestic aviation and airport operations**.[373] The Strategy relies heavily on technological solutions to achieve these objectives (see Figure 9), with a particular focus on the rapid deployment of SAFs and, to a lesser extent, some innovation support for zero-emission aircraft, albeit early innovation trials have had limited success so far.

The UK has confirmed the introduction of a SAF Mandate in January 2025, which targets a two per cent share of SAFs in the UK aviation fuel mix by 2025, increasing to ten per cent in 2030 and 22 per cent in 2040, with an objective of having **five domestic SAF plants under construction by 2025** and in operation by 2030. *Philip New's Independent Report on SAFs*, commissioned by the UK Government, recently highlighted that a range of challenges need to be overcome to grow a domestic SAF industry.[374] These include the emerging nature of the industry, the high capital cost involved (£500 million to £1 billion per SAF plant), its high reliance on debt financing (with low risk tolerance), global competition for feedstock and investment and constrained UK construction capacity.

The International Civil Aviation Organisation has committed to net-zero global aviation emissions by 2050

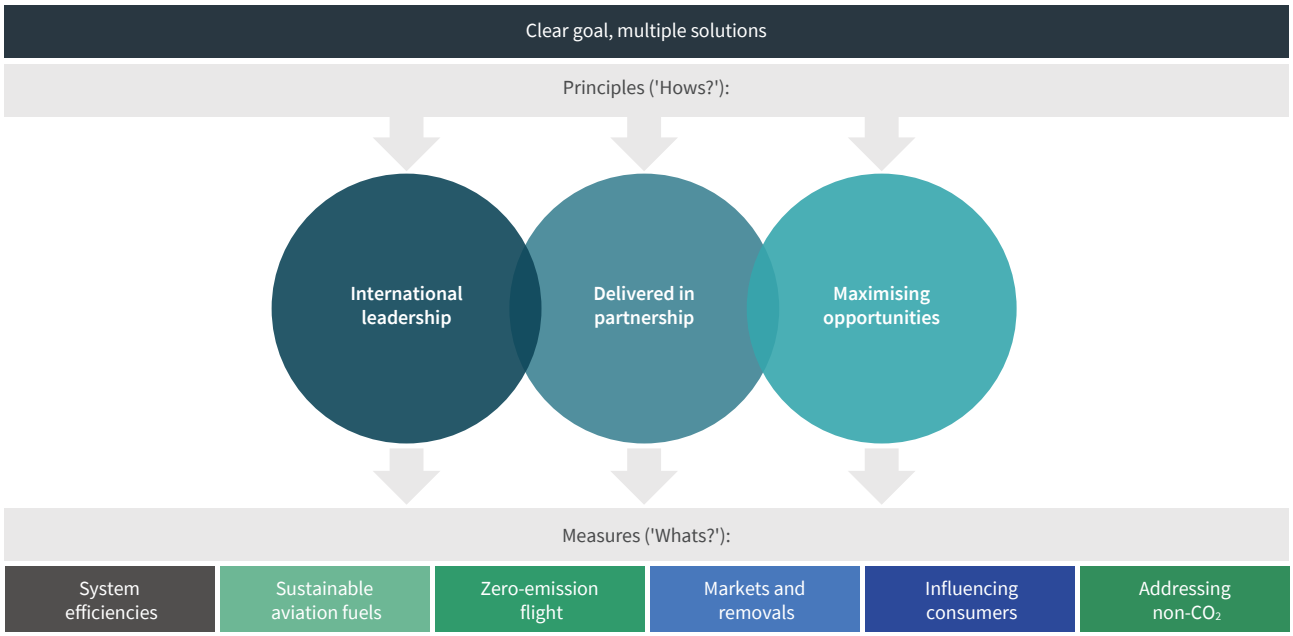
Policy priorities

Overview

This section sets out a range of recommendations to unlock investment in low-carbon aviation solutions at a global and domestic level. These include **using the UK's influence within ICAO to shape tangible global delivery measures and strengthen CORSIA** to reach ICAO's 2050 net-zero goal; **strengthening near-term domestic policy levers such as on fuel efficiency and carbon pricing**; delivering an effective implementation of **a UK SAF Mandate** set to be introduced in January 2025 with robust environmental criteria, and making a decision on the design of **a revenue certainty mechanism** currently under consultation to drive investment in the first SAF plants to meet the SAF fuel mix targets under the mandate; accelerating funding allocation to **scale up innovation projects in zero-emission aircraft**; and developing a robust framework to support **investment in high-quality and permanent carbon offsets** towards decarbonisation efforts.

> Implement a UK SAF Mandate with robust environmental criteria and a revenue certainty mechanism

Figure 10. **The UK Government's priority levers to decarbonise aviation**



Source: "Jet Zero Strategy: Delivering net zero aviation by 2050", Department for Transport, July 2022.[375]

Aviation key policy recommendations

Type of intervention	Detail of intervention	Expected benefit and context
Global ambition, delivery mechanisms and carbon pricing	• Use the UK Government's influential position on the ICAO to **push for credible global delivery policies, standards and mechanisms** to put the international aviation sector on track for ICAO's 2050 net-zero target.[376] • This should include maintaining **a proactive role in making the case for CORSIA** to deliver a carbon price under the scheme that predictably increases in value and covers a growing scope of global aviation emissions over time, in line with ICAO's 2050 net-zero target.[377]	• It is **currently unclear what global mechanisms will be put in place under ICAO** to achieve the 2050 net-zero goal for international aviation. It is also unclear how the carbon price under CORSIA will be strengthened to support the ICAO 2050 goal. • Aviation is an intrinsically globalised economic sector and the pace of emissions reductions will therefore partly depend on a range of international factors. In addition to supportive domestic measures, **international collaboration, globally agreed delivery policies, and a growing global carbon price under CORSIA,** covering an increasing scope of global aviation emissions, **are key to accelerating investment** in innovation and commercialisation of low-emission aircraft and aviation fuels.

Aviation: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Global ambition, delivery mechanisms and carbon pricing *(continued)*	• Increase UK participation in **international collaboration** on innovation, standardisation and market deployment of low-emission aviation fuels and aircrafts.	• A stronger and broader global carbon price for aviation will also reduce the current disparity between the higher carbon price under the UK and EU ETS applicable to short-haul flights, and the lower carbon price applicable to long-haul flights under CORSIA.
UK carbon pricing (See Section 1 for more detailed recommendations on the UK ETS and potential linkage with the EU ETS)	• Regularly **review the carbon price under the UK ETS – and consider a potential linkage with the EU ETS** – to ensure it is sufficiently high to incentivise investment in innovation and commercialisation of low-emission aircraft and low-emission fuels.	• Emissions from the UK aviation sector are subject to the UK ETS. The July 2023 UK ETS review confirmed that the aviation sector will no longer receive free emission allowances from 2026 and that the overall trajectory of the scheme would align with the UK's net-zero target.[378,379] However, the price of carbon under the UK scheme is currently significantly below that of the EU. • A sufficiently high, predictable and gradually increasing carbon price under the UK ETS is essential to drive investment in low-carbon aircraft and aviation fuels. It can also drive growing demand and investment in viable low-carbon alternatives to aviation where appropriate.
Supply side: driving near-term energy-efficiency improvements	• Set out **measures** in the next revision of the *Jet Zero Strategy* **to increase the rate of near-term efficiency improvements**, covering key factors such as fleet renewal, airspace management modernisation, airport operations, aircraft loading and refuelling practices.	• The *Jet Zero Strategy* targets two per cent fuel-efficiency improvements year on year.[380] This compares with a historical trend of 1.5 per cent of annual efficiency improvements. It is unclear how this gap in ambition is to be tackled.[381] • Clarity on the policy and industry measures to improve efficiency across the aviation sector will provide investors with a clearer perspective on opportunities to invest in projects and solutions to improve near-term efficiency.
Supply side: growing the supply of SAFs – market creation	• **Government ambitions for SAFs – mandate:** To support the achievement of the ten per cent SAF target in the UK aviation fuel mix by 2030, deliver an effective implementation of the **UK SAF Mandate** from January 1, 2025, requiring a two per cent share of SAFs in the UK aviation fuel mix in 2025, increasing to ten per cent in 2030. • **Growing market share for SAFs – revenue certainty mechanisms:** Complement the upcoming SAF mandate with **additional policy tools** as recommended by the Government-commissioned *Philip New's Independent Report on SAFs*.[382] Key measures could include: (i) introducing a revenue-certainty mechanism for SAF manufacturers, such as **a guaranteed strike price under contracts for Differences** akin to those used in the offshore-wind sector;[383] (ii) providing **focused guarantees** to fast track the construction of a limited number of promising early SAF plant projects.	• **Role of SAFs:** The CCC estimates that a growing take-up of SAFs could deliver 67 per cent of the necessary emissions cuts from the aviation sector over the 6th Carbon Budget period (2032-37) and there is a cross-industry consensus that SAFs have an important role to play in the decarbonisation of aviation.[384,385] • **Government ambitions for SAFs:** The 2022 *Jet Zero Strategy* set out ambitious technological goals for decarbonising aviation, based on a rapid growth in the manufacturing and take-up of SAFs.[386] The **Government's SAF Mandate,** due to be approved by Parliament in summer 2024 and implemented in January 2025, sets a minimum two per cent share for SAFs in the UK aviation fuel mix in 2025, rising to ten per cent in 2030, and 22 per cent in 2040.[387] • **Government ambitions for SAFs:** The Government aims to have **five SAF producing plants under construction in the UK by 2025**, with £165 million of funding announced to support five projects under the Advanced Fuel Fund.[388]

Aviation: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Supply side: growing the supply of SAFs – market creation *(continued)*	• **Supporting the growth of second generation SAFs:** Through the implementation of the UK SAF Mandate and underpinning revenue certainty mechanism, **incentivise a growing share in the aviation fuel mix for second-generation SAFs**, such as waste-based fuels and more advanced fuels such as Power to Liquids that are less dependent on limited feedstocks. • **Growing the SAF Market – international collaboration:** Look for **opportunities to collaborate with other leading players such as the US and the EU on the development of SAFs** to ensure as much commonality as possible in terms of standards and market mechanisms to support supply-chain growth, accelerate the market deployment of SAFs, help attract international investment and support cross-border trading. • **Interaction with CCUS framework:** Ensure that the growing market demand for SAFs is reflected in the policy framework for carbon capture, storage and utilisation (CCUS) infrastructure, given the role of CCUS in supporting the availability of low-emissions SAFs.	• **Market challenges facing the SAF sector:** *Philip New's Independent Report on SAFs* highlights the following **key barriers to investment in a UK SAF supply chain**: (i) the **emerging status** of both the SAF industry and supportive policy framework; (ii) the **high reliance on debt financing** (with low risk tolerance); (iii) **competition for feedstock** across different sectors of the economy and internationally; (iv) competition for investment in SAFs coming from other jurisdictions such as the US and the EU; (v) **stretched UK construction capability**.[389] • **Improving market conditions for SAFs – mandate: Ensuring an effective delivery of the SAF Mandate from 2025 will be essential to provide near-term clarity to the aviation industry**, its underpinning supply chain and investors on the expected market growth for SAFs in the UK. This is particularly important for second generation SAFs where the UK has a competitive advantage (see below).[390] • **Improving market conditions for SAFs – revenue clarity:** A SAF mandate alone is unlikely to achieve the UK's ambitious target of ten per cent SAF in aviation fuels by 2030. **Additional incentives** to provide a degree of **revenue predictability and guarantees** for the first domestic SAF manufacturing plants will be important if the UK is to unlock the investment required to meet its high ambitions in the near-term.[391] The Government recently released a consultation on a plan to introduce a long-term revenue certainty mechanism to support domestic SAF production and has committed to introduce this by 2026.[392,393] • **Incentivising the growth of second generation SAFs:** Using incentives through the SAF Mandate and revenue certainty mechanisms to simulate investment, growth and cost reductions in second generation SAFs (such as waste based fuels and other advanced fuels such as Power to Liquids) is essential as some of these fuels are less dependent on limited feedstocks and may in some cases offer greater emissions reduction savings potential. • The SAF Mandate begins to address this by putting forward a gradually tightening cap for the use of hydroprocessed esters and fatty acids (HEFA), down to 33 per cent of SAF production by 2040. HEFA is currently the main commercially available SAF but is dependent on the availability of limited feedstocks. A sub-target to grow the share of advanced – but currently more expensive – Power to Liquids fuels is also being introduced under the SAF Mandate. • **Growing the SAF Market – international collaboration:** The EU, US, UK and other international partners are currently developing different policy approaches and market mechanisms to supporting the growth of the SAF sector. Collaboration with key international partners will help accelerate the growth of SAF supply chains and help provide a more coherent policy framework for SAF manufacturers, airlines and investors.

Aviation: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Supply side: growing the supply of SAFs – sustainability considerations (See also Section 1 for greater detail on cross-cutting recommendations on sustainable fuels across all transport modes and Section 9 for more detail on biomass sustainability)	• Monitor the implementation of the SAF Mandate to ensure it delivers tangible **emissions reductions** compared to the use of conventional fuels, in line with the Government's emissions-reduction trajectory.	• Monitoring the implementation of the SAF Mandate is essential to achieve the required emissions cuts in the sector and avoid the risk of greenwashing, which could tarnish public perceptions of the SAF industry.
Supply side: innovation in hybrid and zero-emissions aircraft	• Deploy at pace the £975 million of **innovation funding** awarded in the 2023 Autumn Statement to the Aerospace Technology Institute Programme[394] for 2025-'30 to support innovation in a range of hybrid and zero-emission aircraft solutions (fully electric and hydrogen), as well as to improve understanding of the non-CO_2 effects of aviation. Consider targeted additional funding over that period subject to the evolution of pilot projects. • Use the ongoing innovation funding to **scope out the most suitable application for hybrid electric and zero-emission** (hydrogen, fully electric) **aircraft**.	• Given the potential constraints on the speed of deployment of a SAF supply chain, **continued research into and innovation in other low-carbon aviation solutions is essential** to keep emissions reductions on track and provide the sector and investors with a broader range of potential low-emissions investment opportunities. • The development of **hybrid, fully electric and hydrogen planes is still at an early stage**. The Department for Transport's projection estimates a small potential market penetration for hybrid electric planes by 2050, with no market penetration for fully electric or hydrogen planes by that date.[395] • However, under ambitious innovation and market-deployment scenarios, these alternative solutions could potentially play a role in reducing aviation emissions alongside the scaling-up of SAFs, especially for short-haul flights.
Promoting investment in low-carbon alternatives to aviation (See Section 4 on surface transport for more detailed recommendations on rail)	• As part of an update to the Transport Decarbonisation Plan, carry out a **coordinated review of ticket pricing structures and associated taxation for all modes of passenger transport.** Put forward proposals to significantly improve the relative price competitiveness of low-carbon travel alternatives such as rail. • In parallel with a review of pricing structures, take **an integrated approach to new transport infrastructure decisions** with a particular focus on making low-carbon transport modes, such as rail, increasingly reliable and affordable. • Put forward a strategy to support the continued **growth in the business uptake of virtual communication and conferencing technologies**, so that these can increasingly act as a viable alternative to business flights where appropriate.	• There are **few incentives in place to encourage a growing uptake of low-carbon alternatives to aviation**. The long-term price trend for rail travel shows a 32 per cent increase on 2009 levels compared to a ten per cent decrease in the cost of short-haul business flights over the same period.[396] • A holistic and coordinated approach to transport pricing, covering all key transport modes, can provide pricing structures that reflect the UK's decarbonisation goals, drive passenger demand towards low-carbon transport options and grow the market for low-carbon travel infrastructure and solutions. • Developing more coherent pricing structures across different transport modes needs to be underpinned by an integrated approach to transport infrastructure investment decisions which improves the capacity and reliability of low-carbon transport options such as rail. • A strategy to improve and grow the use of virtual communication technologies could drive further investment in the sector and could, in some appropriate circumstances, provide a viable alternative to business flights.

Aviation: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Residual emissions: developing a credible market for use of high-quality offsets – (See also Section 9 for more detailed recommendations on GGR technologies)	• **Near-term**: use the CCC's recent recommendations on voluntary carbon markets to **develop clear guidelines for the use of offsetting schemes in the aviation sector**.[397] This should set out clear monitoring, reporting and verification criteria and should focus on promoting high-quality and long-lived offset schemes. • **Medium-term**: complete the policy **and market framework to accelerate** the development and **deployment of permanent GGR technologies** (such as Direct Air Capture). • **Medium to long-term**: if and once permanent GGRs are available at scale, encourage their use by the aviation sector for offsetting residual emissions.	• While the focus should be to maximise emissions reductions at source through technological solutions and where appropriate, the promotion of low-carbon alternatives to aviation, **the aviation sector will continue to have residual emissions out to 2050 (circa 19MtCO$_2$e), which require high-quality and permanent offsetting.** • The **market for carbon offsets is rapidly growing**: the number of seat-kms flown by airlines associated with a carbon offset increased from 23 per cent in 2021 to 32 per cent in 2022.[398] • Most carbon-offsetting schemes are **currently voluntary and of varying credibility** and the development of a policy framework for permanent GGRs, such as Direct Air Capture, is in its infancy.[399] • **Near-term:** adopting clear guidelines for company and voluntary offsetting schemes is essential to avoid greenwashing, provide market confidence, and attract investment in robust carbon offset projects. • **Medium-term:** supporting continued innovation and developing clear market mechanisms for the deployment of permanent GGR technologies will be essential to drive investment in GGRs and provide a reliable solution to residual aviation emissions.

Key takeaways

1. **Global role:** Use the UK's influence to **strengthen global policies – including the carbon price under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) – to achieve The International Civil Aviation Organisation's (ICAO) 2050 net-zero emissions target** for global aviation.
2. **Growing a SAF industry:** Deliver an effective implementation of the **Sustainable Aviation Fuel (SAF) Mandate from January 2025, backed by robust environmental criteria and a revenue-certainty mechanism** to drive investment to achieve ten per cent SAFs in the UK aviation fuel mix by 2030, working closely with international partners in the process. Focus on incentivising the growth of **second generation SAFs**.
3. **Low-carbon innovation:** Accelerate – and potentially scale up – funding delivery under the Aerospace Technology Institute Programme towards **innovation in zero-emission aircraft,** such as hybrid, full electric and hydrogen.
4. **Credible carbon offsets:** Strengthen the policy framework and standards to drive investment in permanent, high-quality carbon offsets and prevent greenwashing.

7. Shipping

The sector produced **12 million tonnes of carbon dioxide emissions ($MtCO_2e$) or three per cent of UK emissions** in 2022, which remains **12 per cent lower** than pre-pandemic levels in 2019.[400]

Global shipping emissions accounted for **two per cent** of global energy-related emissions.[401]

UK shipping demand has decreased, with a **one per cent annual average decrease** in domestic shipping activity from 2012 to 2021.[402]

In 2019, the domestic maritime sector supported around **227,000** jobs in the UK.[403] The transition could safeguard these jobs and create new opportunities.[404]

The Government estimates that the economic benefits to the UK across 11 key emission reduction options for the shipping sector could reach **$650–$890 million** per year by the middle of the century.[405]

The Government estimates that **billions of pounds** of capital investment will be required in both vessels and port infrastructure to decarbonise the industry.[406]

Investment insights

Sora Utzinger
Head of ESG Integration, Equities

The shipping sector is confronting significant challenges and exploring various solutions in its journey towards decarbonisation. The International Maritime Organization (IMO) has set ambitious targets, including a 50 per cent reduction in carbon emissions by 2050. This goal acknowledges that unlike road transport, the decarbonisation route for global shipping was previously undefined.

Several fuels are being considered for this transition. Electrification may be feasible for short-haul vessels, but for long-haul shipping, biofuels, methanol and ammonia are viewed as more viable options. Each of these fuels has its unique challenges. Ammonia, while emitting no CO_2 when produced from renewable hydrogen, faces issues due to its low density, potentially impacting cargo space and profitability. Methanol is chemically similar to marine fuel oil, sharing infrastructure and potentially safety standards, but producing green methanol cost-effectively remains a challenge. It typically involves gasifying biomass or municipal solid waste, with new technologies incorporating green hydrogen to enhance efficiency.

A significant hurdle for both bio-methanol and ammonia is feedstock availability. The global demand for marine fuel in 2050 is projected to be immense, requiring substantial amounts of biomass or green hydrogen. This demand places pressure on the limited global biomass supply, which is also sought after by other sectors like aviation.

Geographic distribution of biomass and hydrogen feedstock adds another layer of complexity. Major bunkering hubs worldwide vary in their access to green hydrogen and biogenic carbon, influencing their ability to supply green fuels. Ports with better access to these resources could be more advantageous in providing green fuels. This is where decisive policy interventions would add tremendous benefits; notably with respect to dedicating sufficient innovation funding to the development of new low-carbon fuel networks and infrastructure upgrades (particularly around access to electrification).

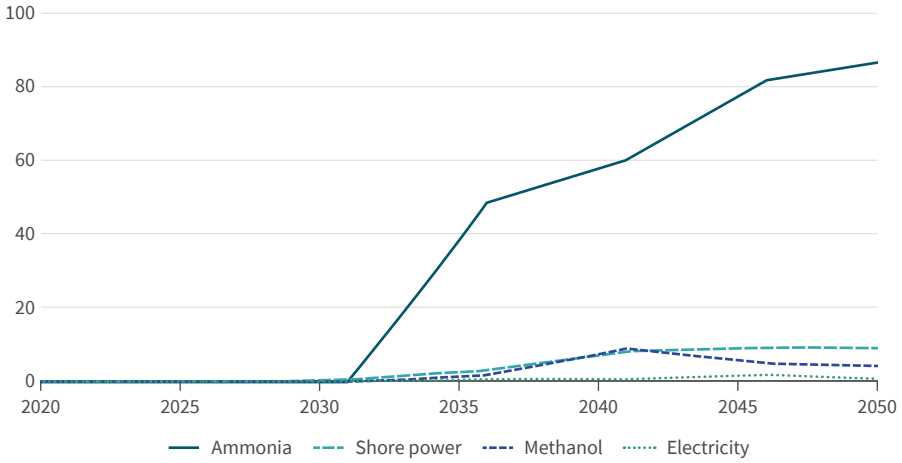
Investors in the shipping sector's transition to net-zero emissions must navigate challenges related to the choice of alternative fuels, feedstock availability, production costs and geographic disparities in resource distribution. This is why we believe the sector is likely to see a mix of fuel options, including bio-methanol and ammonia, each contributing to the broader goal of decarbonisation.

The shipping sector is a relatively small part of UK emissions (three per cent in 2022) and these have been slowly declining in recent years, but remain nonetheless important. The sector is particularly complex to decarbonise in technical terms, geopolitical terms (given the intrinsically global nature of the industry) and investment terms (given the high capital and operational costs involved in low-carbon shipping solutions). **The main solutions**, depicted in Figure 10, to decarbonise vessel emissions in the shipping sector include **battery electrification**, the use of **zero- or low-emission fuels** (such as ammonia, methanol, hydrogen and biofuels), and the **use of onshore power while ships are in port**.

3%

Of UK emissions in 2022 came from the shipping sector

Figure 11. **Future energy demand for local-carbon shipping (per cent)**



Source: "UK domestic maritime decarbonisation: Plotting the course to zero", Department for Transport, July 2022.[407]

Investment in electrification and low-emission fuels for shipping is currently near zero

Investment in – and **the usage of** – **electrification and low-emission fuels in the shipping sector is currently near zero for a range of reasons: maritime fuel pricing** does not reflect the emissions intensity of existing fuels, the **role and costs of the different low-carbon technologies and fuels remain uncertain** given their emerging status, and the **availability of fuels** such as ammonia and methanol are dependent on the success of other Government policies such as the achievement of the 10GW low-carbon hydrogen-production target for 2030. The decarbonisation of vessel and port infrastructure is also likely to entail **substantial upfront capital investment and operational costs**, will require a significant level of **cross-industry cooperation and international cooperation** (such as in developing the infrastructure required to support global "green shipping routes"), and introduces **new health and safety implications** which will require new safety regulations and investment in workforce skills.

Policies need to tackle the challenge presented by high capital and operational costs

The policy framework to incentivise low-carbon shipping **is at an early stage of development**. The IMO recently agreed **a goal to reach net-zero emissions for the global shipping sector "close to 2050",** with three interim targets, including a ten per cent target for use of zero- or low-emission fuels by 2030, a minimum emissions-reduction target of 20 per cent by 2030 ("stretching to 30 per cent"), and 70 per cent by 2040 ("stretching to 80 per cent").[408] The IMO plans to consult on global policies to achieve these ambitions throughout 2024/2025. In the UK, the 2022 *Course to Zero Consultation* sets out a range of pathways and high-level policy options to reach net-zero UK shipping by 2050.[409] These emissions pathways and policies are due to be developed and firmed up in an upcoming *Clean Maritime Plan*. The shipping sector is also due to be subject to the UK Emissions Trading Scheme (UK ETS) from 2026, albeit the carbon price under the UK ETS is currently much lower than under the equivalent EU scheme.

Policy priorities

Overview

This section puts forward a range of policy recommendations at a global and domestic level to grow investment in low-carbon shipping infrastructure, fuels and solutions. At a global level, these include the UK using its influence within the IMO to **shape ambitious global policy mechanisms in line with the IMO's stretching interim targets** and putting in place **international agreements** to develop key low-carbon infrastructure **to support global "green shipping routes"**.

At a domestic level, recommendations include regularly reviewing the **robustness of the carbon-price signal and trajectory under the UK ETS** and introducing/implementing **a new** and comprehensive **UK Clean Maritime Plan**. Key priorities for such a plan should include incentivising **investment in shore power infrastructure** in ports, growing **innovation funding** in battery-electric ships and a range of low-carbon shipping fuels, introducing **a mandate and revenue certainty mechanism to grow the supply of low-carbon shipping fuels**, and consulting on **a potential phase-out date** for the sale of non-zero emission ships.

> Recommendations include a new and comprehensive UK Clean Maritime Plan

Shipping: key policy recommendations

Type of intervention	Detail of intervention	Expected benefit and context
International: moving from ambition to delivery	• Play a **proactive role in ongoing discussions at the IMO** to encourage the global shipping industry to aim for the stretching interim emissions-reduction targets agreed at the July 2023 IMO summit. • Play a **proactive role in ongoing IMO consultations** to ensure that the technical and economic measures agreed by the IMO are sufficiently effective to meet the IMO's interim targets. • Continue to **collaborate with other major shipping nations on innovation and other measures to promote green shipping**. These could include building on the COP26 *Clydebank Declaration for Green Shipping Corridors* and the £1.5 million International Green Corridor Fund by establishing green shipping routes with shared low-carbon fuel infrastructure with international partners such as the US, Denmark, the Netherlands, Ireland and Norway.[410,411]	• The **IMO** revised its Greenhouse Gas Reduction Strategy in July 2023, with **a new goal of reaching net-zero greenhouse gas emissions for international shipping "close to 2050".**[412] • This is supported by **three interim targets**: (i) a ten per cent target for the use of zero- or low-emissions fuels in international shipping by 2030; (ii) a minimum 20 per cent emissions-reduction target ("stretching to 30 per cent") by 2030; (iii) a minimum 70 per cent emissions-reduction target ("stretching for 80 per cent") by 2040. • The **IMO is consulting** throughout 2024/2025 **on the development of a "basket of measures" to deliver these targets**. These measures will include: (i) a **"technical element"**, aimed at growing the share of low-carbon fuels in the shipping-fuel mix; (ii) an **"economic element"** such as carbon pricing aimed at pricing shipping emissions. • Aiming for the IMO's "stretching" interim targets will send a stronger market signal to accelerate innovation, collaboration and investment in low-carbon shipping technologies and fuels. • By adopting sufficiently ambitious technical and economic "instruments", the IMO will send a clear signal to the global shipping sector to grow the market for low-carbon technologies and fuels. This could create significant export opportunities for the UK maritime sector. • The development of international green shipping routes with supportive low-carbon fuel infrastructure will be essential to deliver a viable transition to net zero for the global shipping sector. This requires building on and extending the research and collaboration announced as part of the International Green Corridor Fund jointly funded by the UK, Denmark and the Netherlands.

Shipping: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
UK carbon pricing (See Section 1 for more details on reforms to the UK ETS and a potential linkage with the EU ETS)	• Regularly **review the carbon price under the UK ETS – and consider a potential linkage with the EU ETS** – to ensure it is sufficiently high to incentivise investment in innovation and commercialisation of low-emission ships and low-emission fuels.	• **Shipping emissions have been subject to the EU ETS from January 2024.**[413] As part of the Fit for 55 Package, EU regulations are to set an 80 per cent reduction target for the carbon intensity of shipping fuels by 2050, and all passenger and container ships are to use shore power while at major EU ports from 2030 unless they are zero emissions.[414] • The **latest revision to the UK ETS confirmed that domestic shipping emissions would be included in the scheme from 2026** and that the overall trajectory of the scheme would be reset to align with the UK's net-zero target.[415] However, the price of carbon under the UK ETS is currently significantly lower than under the EU ETS.[416] • A sufficiently high, predictable and gradually increasing carbon price under the UK ETS is essential to drive investment in low-carbon shipping technologies and fuels.
A UK strategy for maritime decarbonisation	• **Publish and implement a revised Clean Maritime Plan** in 2024 or early 2025 to provide a comprehensive overview of the public funding, regulatory measures, market incentives and demand-side measures to be introduced to drive the UK maritime sector's transition to net zero.	• The **UK's policy strategy** for decarbonising the domestic maritime sector is **at an early stage of development**. The Government's *Maritime 2050* and *Clean Maritime Plan* publications in 2019 set out a vision where "zero emission ships are commonplace globally" in 2050, with the UK playing a leading role in this transition.[417,418] • Following the 2021 *Transport Decarbonisation Plan,* the Government issued its ***Course to Zero* consultation** in 2022.[419,420] This set out a range of pathways and potential measures to reach net-zero emissions for the UK domestic maritime sector by 2050. This is due to result in **a revised *Clean Maritime Plan*, setting indicative interim targets for the sector**, with a focus on UK domestic maritime vessels. • Given the early stage of development of zero-emission shipping technologies and low-emission fuels, **a comprehensive public-policy strategy is urgently needed to attract early private investment**.
Removing key barriers to investment: sending a clear signal for zero-emission shipping	• The Clean Maritime Plan should consult on a **phase-out date for the sale of non-zero emission ships.**	• Building on the approach taken on road transport, a phase-out date would provide a clear market signal to the supply chain and investment community on the growing market demand for zero-emission ships, low-emission fuels and supportive infrastructure. • Given the long asset lives of shipping vessels, new high-carbon shipping vessels will lock in emissions for several decades.
Removing key barriers to investment: low-carbon fuels (See also Section 1 for greater detail on cross-cutting recommendations on sustainable fuels across all transport modes and Section 9 for more on biomass sustainability)	• Dedicate sufficient **innovation funding to accelerate research into the viability and development of different low-carbon fuels** for the shipping sector. • Prioritise the achievement of the **Hydrogen Strategy's** target of generating at least 10 GW of low-carbon hydrogen by 2030, given the importance of low-carbon hydrogen for the manufacturing of low-emission shipping fuels such as ammonia.[421]	• The scaling up and accelerated delivery of innovation funding is essential to reduce uncertainties as to the viability and potential of different technologies and fuels. • Given the reliance on hydrogen availability for the manufacturing of several green shipping fuels (ammonia, methanol), a growing domestic supply of low-carbon hydrogen will be important to unlock investment in sustainable shipping fuels.

Shipping: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Removing key barriers to investment: low-carbon fuels (See also Section 1 for greater detail on cross-cutting recommendations on sustainable fuels across all transport modes and Section 9 for more on biomass sustainability) *(continued)*	• Publish a **Low-carbon Fuels Strategy,** clarifying the most appropriate low-carbon fuels for shipping, and ensuring that **the use of limited sustainable biomass resources is prioritised** for hard-to-abate sectors such as shipping. • Introduce a **mandate to grow the share of low-carbon fuels** in the UK shipping-fuel mix, backed by **robust emissions-reduction and environmental criteria.**[422] • Consider **revenue certainty mechanisms – such as Contracts for Difference** – to grow the supply of zero/low emission fuels.	• Given the need for low-carbon fuels across different sectors (aviation, heavy goods vehicles, shipping etc.), a clear strategy prioritising the use of different fuels for specific sectors is important to provide industry and investor clarity. • A binding low-carbon fuel mandate with robust environmental criteria would provide investor clarity on the market demand growth for different low-carbon shipping fuels and would safeguard against the risk of greenwashing. • Market incentives providing minimum price guarantees will be essential in reducing early investment risk in the development of plants producing low-carbon shipping fuels and the associated supply chain.
Removing key barriers to investment: electrification and port infrastructure	• Dedicate sufficient innovation funding to accelerate **R&D into battery-electric ships.** • Continue **market reforms to reduce the price of electricity** in the UK (see Sections 1 and 2). • Prioritise the **roll-out of shore power infrastructure** at UK ports in the near-term.	• Similar to other economic sectors, reducing electricity prices will be essential to make electrification an affordable option for the shipping sector. • Upgrading UK ports with adequate shore power infrastructure is a low-regret investment as it will be needed across a range of emissions-reduction pathways.
Introducing demand-side measures	• The updated Clean Maritime Plan should provide clarity on the **potential role of demand-side measures and low-carbon alternatives** (such as those being trialled under the Freight Innovation Fund) to reduce shipping emissions.[423]	• Integrating demand-side measures and low-carbon alternatives in the Government's maritime decarbonisation strategy will help optimise the cost of decarbonising the sector. • This will also provide investors with a clear picture of investment needs in demand-side management tools and, where viable, low-carbon alternatives to shipping.

Key takeaways

1. **Global role:** Shape **ambitious global policy mechanisms – including a global carbon price for global shipping – in line with the International Maritime Organization's (IMO) stretching emissions-reduction targets** for 2030 and 2040, and deliver international agreements to support global green shipping routes.
2. **Domestic no-regret measures and innovation:** Incentivise investment in **shore power infrastructure in ports** and grow innovation funding in **battery-electric ships and low-carbon shipping fuels** (near-term).
3. **Domestic low-carbon fuel market:** Put in place a **mandate and revenue certainty mechanism** to grow the supply and share of low-carbon fuels in the UK shipping-fuel mix, with updates to safety regulations and skills provision to reflect the characteristics of these new fuels (mid-term).

8. Driving nature restoration through land use and agriculture

The sector produced **49 million tonnes of carbon dioxide emissions ($MtCO_2e$) or 11 per cent of UK emissions** in 2022 (**48 $MtCO_2e$** from agriculture and **1 $MtCO_2e$** from land use), with emissions remaining largely flat over the last decade.[424]

The Government aims to attract **£500 million** of annual private investment into nature restoration in England by 2027, rising to over **£1 billion** by 2030. The Government estimates the UK's nature-related goals could require between **£44–£97 billion** of investment in the next ten years.[425, 426]

Around **half of global GDP** relies on ecosystem services provided by the natural environment.[427, 428]

Globally, there is estimated to be a biodiversity restoration finance gap of **$700 billion** per year.[429]

COP15 resulted in the Kunming-Montreal Global Biodiversity Framework, which included an agreement to mobilise **$200 billion** per year from public and private sources to invest in biodiversity restoration and **$30 billion** per year in international financial assistance for developing nations.[430]

By 2024, the UK Government expects England's collection and packaging reforms to support **21,000** jobs, its flood defence programme to support **10,000** jobs, and the Nature for Climate Fund tree planting and peatland restoration projects to support up to **3,400** jobs.[431]

Investment insights

Investment at scale in high-integrity nature-restoration projects within the UK is largely currently tied to co-benefit opportunities within voluntary carbon markets, although the recently launched biodiversity compliance market (BNG) helps to facilitate uptake. A framework for voluntary nature markets that includes how farmers and land managers can access nature, as well as strong, credible and nationally agreed standards which demonstrate additionality, will ultimately support an increased uptake from investors.

Further development on the Framework for Nature Markets will result in private investment aligning with global goals such as the Kunming Montreal Global Biodiversity Framework (GBF), but also with national policies and commitments, which is fundamental for achieving net zero and nature-related commitments.

In the absence of an equivalent structure for investors, investment is limited to first movers who will benefit once an equivalent market for nature is developed. Alongside this, the updating of accounting standards and tax regulation to clarify appropriate recognition of nature credits will catalyse and simplify investing in nature as a standalone asset class.

Greta Talbot-Jones
Director, Natural Capital

Kiran Sehra
Nature Specialist

Aviva's and Aviva Investors' investments and partnerships in nature restoration include:

- Aviva's £100 million budget to begin to create nature-based carbon removals by 2030.[432]
- Aviva's £38 million partnership with the Wildlife Trusts to help fund the creation of new temperate rainforests in the UK; carbon sequestration will be one of the outcomes, along with biodiversity enhancement, improved air quality, and other social and local economic benefits.[433]
- Through our Aviva Investors Climate Transition Real Assets Fund, we plan to deliver a significant woodland creation and peatland restoration scheme across 6,300 hectares of Scottish moorland in the Glen Dye area of West Aberdeenshire. Over the lifetime of the project, an estimated 1.4 million tonnes of carbon will be locked up.[434]

Agricultural and land-use-related emissions currently represent around **11 per cent of UK emissions**, with no significant reduction over the last decade. Reducing these emissions is not only important for the sector to play its part in putting the UK on a pathway to net zero; there is also a growing investment demand for nature-restoration projects from multiple hard-to-abate sectors of the economy (such as aviation, shipping and heavy industry) to deliver high-quality long-term carbon credits to offset their residual emissions. The key role of nature restoration, through sustainable land use and agricultural practices, in contributing to the effort to reach net zero, adapt to climate change, enhance and protect biodiversity and support long-term economic prosperity was internationally recognised at the Convention on Biological Diversity COP15 Summit in December 2022.

11%

Of UK emissions in 2022 come from agriculture and land-use

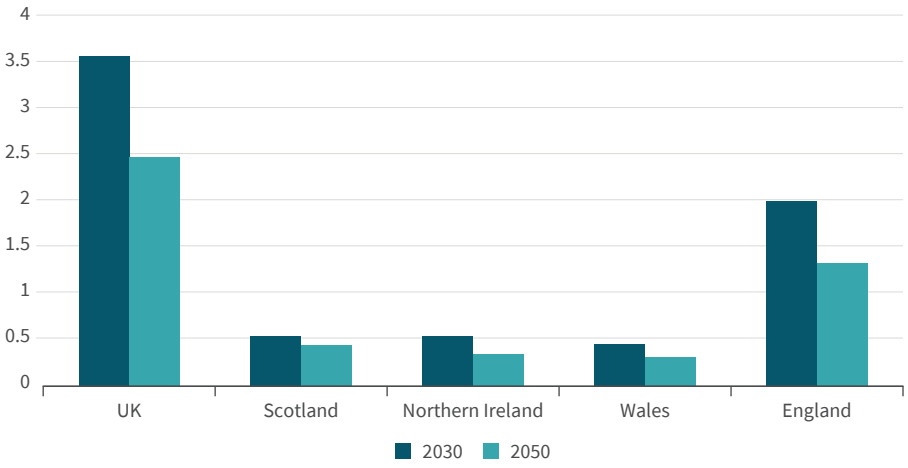
The summit resulted in the Kunming-Montreal GBF, which pledges to halt and reverse biodiversity loss by 2030, with four core biodiversity restoration goals by 2050 and 23 interim targets and actions by 2030. With the UK having played an important supporting role in delivering the GBF agreement, and following the UK's departure from the EU, the Westminster Government and devolved nations are gradually introducing **a nature restoration policy framework in the UK**, with equivalent steps being taken in devolved nations.

This includes for instance the ***Agriculture Act***, which introduces a range of *Environmental Land Management Schemes* (ELMs) to reward farmers in England for delivering a specific set of nature restoration improvements, with similar agri-environment schemes existing or being developed in Scotland and Wales. **The *Environment Act 2021* also sets a range of long-term, legally binding environmental-improvement targets** for England, covering air quality, biodiversity, marine-protected areas and woodland creation, backed by **the 2023 Environmental Improvement Plan (EIP)** which **sets out a range of near-term interim targets** and policy measures to achieve these. **The Government has an ambition to attract £500 million a year of private capital in nature restoration by 2027, rising to £1 billion a year by 2030**, and recently released its *Framework for Nature Markets* with the intention of creating high-integrity nature restoration markets and attracting more private capital.

> The Government has an ambition to attract £500 million a year of private capital in nature restoration by 2027 rising to £1 billion by 2030

However, policy frameworks are still in development, with private investment in nature restoration remaining limited. The policy detail for agri-environment schemes across England, Scotland and Wales remains to be finalised, nature restoration targets only cover a limited number of areas and policies to achieve existing targets are often still in development. The lack of a coordinated, cross-sectoral land-use framework, and the different policy approaches being taken across devolved nations, also create a confusing picture for investors in nature restoration projects. Meanwhile, a lack of skills is increasingly acting as a significant barrier to investment in woodland creation and peatland restoration projects.

Figure 12. **Carbon removal potential in regenerative farming across the UK ($MtCO_2e/yr$)**



Source: "Land of Plenty: A nature-positive pathway to decarbonise UK agriculture and land use", WWF (2022), Land of Plenty.[435]

Policy priorities

Overview

This section puts forward a range of policy recommendations for the UK Government – and, in some cases, devolved governments – to drive investment growth in nature restoration projects through sustainable agricultural practices and land use. These include:

- **Global biodiversity policy:** Working with international partners to deliver the international cooperation mechanisms under the GBF, and continuing to implement the GBF's core biodiversity restoration goals and key interim targets in UK legislation.
- **Land use:** Introducing a framework overseen by a coordinated body setting out England's overall strategy to restore nature through more sustainable land use across different economic activities, with tangible nature restoration objectives for each key sector of the economy. Work in parallel with devolved governments to develop a more coordinated UK approach on nature restoration.
- **Agriculture:** Complete the policy detail, option design and payment rates for agri-environment schemes across England, Wales and Scotland, and consider further interventions to increase the take-up of these schemes.
- **Nature restoration:** Continue to develop the policies under the 2023 EIP (Local Nature Recovery Networks etc.) to achieve England's nature restoration targets under the Environment Act 2021, consider broadening the range of nature restoration targets under the Environment Act and complete the Nature Markets Framework to create world-leading and high-integrity nature markets in the UK.
- **Woodland and peatland:** Develop a targeted strategy to address the workforce skills gaps that are hampering investment in major woodland creation and peatland restoration projects.

Introduce a coordinated land use framework with tangible nature restoration objectives for each key sector of the economy

Nature restoration: key policy recommendations

Type of intervention	Detail of intervention	Expected benefit and context
Supporting the implementation of the GBF	• **Complete the implementation of the GBF's long-term goals and 2030 targets into the UK's domestic policy and legislation** and through the preparation of the updated National Biodiversity Strategy and Action Plan.[436] *See recommendations below.* • Proactively **engage with international partners to deliver the cooperation mechanisms** set out in the GBF. Priorities include the provision of financial resources, capacity building and technical and scientific resources to support biodiversity restoration projects and market creation in developing nations.	• The **Kunming-Montreal GBF,** agreed in December 2022, pledged to **halt and reverse biodiversity loss by 2030.**[437] • The GBF consists of **four core goals by 2050**. These centre around (i) the restoration of resilient and well-connected ecosystems, (ii) the sustainable use and measurement of biodiversity, (iii) the equitable sharing of genetic resources, and (iv) the mobilisation of adequate financial, technical and scientific resources to meet the GBF's goals, with a focus on providing financial support to developing nations. • These goals are underpinned by **23 interim targets and actions for 2030**, including a target for 30 per cent of all terrestrial areas, inland waters and coastal/marine areas to be under effective conservation and management by 2030. A similar target has been set to place 30 per cent of *degraded* terrestrial areas, inland waters and coastal/marine areas under effective restoration by 2030. • If fully implemented, the goals and interim targets set out in the GBF provide an important stepping stone towards the creation of global markets for biodiversity and nature restoration. • Through domestic policy implementation and proactive diplomatic interventions, UK Government actions can strengthen the integrity and effectiveness of the GBF and its potential for creating long-term global markets for nature and biodiversity restoration.
Developing a coordinated UK approach to nature recovery	• Publish a **coordinated Land Use Framework**, overseen by a coordinating body, setting out England's overall strategy to restore nature through more sustainable land use across different economic activities (e.g., food production, biomass production, afforestation etc.), **with tangible nature restoration commitments set for – and tailored to – different economic sectors.**[438, 439] The Framework should clearly identify how land will be prioritised for nature and biodiversity restoration, carbon storage, farming energy production and other key uses. • Maximise **coordination between UK nations** on nature restoration approaches in agriculture and other land-use sectors. • Continue to **integrate** the UK's approach to **nature restoration in future updates to the Net Zero Strategy and future National Adaptation Plans.**	• There are **a range of policy frameworks and commitments in place to restore the natural environment** in areas such as agriculture, peatland, woodland and broader land-use management. However, England **does not have an integrated land-use strategy and policy frameworks often differ across devolved nations.** This results in an overall policy framework for nature restoration **that is hard to navigate for investors**. • An overarching Land Use Framework will provide investors with clarity on the investment needs, specific project opportunities and available market mechanisms to invest in nature restoration at scale. • A coordinated approach with devolved nations will help create a coherent investment framework for nature restoration across the UK. • Given the potential of nature restoration to act as a carbon sink and improve infrastructure resilience to extreme-weather events, fully integrating nature restoration into the UK's net-zero and climate-adaptation strategies will optimise the environmental and economic benefits of these investments.

Nature restoration: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Incorporating nature-related metrics into economic measurement tools	• Begin to implement the recommendations from *The Economics of Biodiversity: The Dasgupta Review*, led by Sir Partha Dasgupta and commissioned by HM Treasury, and in particular, the recommendation to **integrate the ONS Natural Capital Accounts** and other nature metrics into economic statistics and measures of economic success.[440]	• HM Treasury commissioned the Dasgupta Review. The Final Report recommended the inclusion of nature-related metrics into the Government's economic measurement tools to ensure policy decisions take better account of the health and state of natural assets that underpin economic and social activity.[441] These recommendations are yet to be acted on. • Integrating nature-related metrics into national economic measurement tools will help inform economic and fiscal policymaking in Treasury and across Whitehall, ensuring greater coherence with the UK's nature restoration targets and supporting the growth of nature restoration markets.
Implementing agri-environment support schemes	• All recommendations below concern both the UK Government and the governments of devolved nations: • Build on policy progress to date and continue to **develop the policy detail, option design, and payment rates for agri-environment schemes.** • Consider whether further interventions are required to **increase farmer take-up of high ambition agri-environment schemes**. • Work together to introduce a user-friendly but robust approach to **monitor, report and verify carbon emissions reductions on farms.**	• **Important progress has been made in developing** and rolling out **agri-environment schemes in England** (Environmental Land Management Schemes – ELMs), **Scotland** (Agri-Environment and Climate Scheme) **and Wales** (Sustainable Farming Scheme – from 2025). Replacing subsidies under the EU's Common Agricultural Policy, **these schemes reward farmers for efforts to restore nature alongside food production**. • **Environmental Land Management Schemes** in England include the *Sustainable Farming Incentive* (over 3,000 schemes as of June 2023) the *Landscape Recovery Schemes* (projects as of November 2023) and the *Woodland Creation Scheme* (from 2025).[442,443] • However, **much work remains to be done on the policy detail, option design and payment details for agri-environment schemes** across the UK and in particular Scotland and Wales.[444] • **Providing full clarity on the policy design and payment rates for agri-environment schemes** across all UK nations **is essential to attract investment at scale in nature restoration** projects in the agricultural sector. • Monitoring the take-up of agri-environment schemes and making further interventions if necessary to support take-up will help scale up investment opportunities. • **A robust and transparent approach to carbon-emissions monitoring** on farms will strengthen the integrity of nature restoration investments on farm and **guard against greenwashing**.
Implementing and broadening England's Environment Act targets and EIP	• Implement at pace the **key commitments set out under the Environment Act targets and the January 2023 EIP**, including measures relating to rolling out the Nature Recovery Network and Local Nature Recovery Strategies.[445] • Consider **broadening the set of nature restoration targets to cover other important areas** such as soil restoration and peatland restoration.[446]	• Pursuant to the ***Environment Act 2021*** and as part of its commitment under the *Global Biodiversity Framework*, the Government introduced in December 2022 a range of legally binding environmental improvement targets for England.[447, 448] These include **targets over the next 15 to 20 years on air quality**, halting the decline of and restoring **biodiversity**, **marine protected areas**, **woodland creation**, **water quality**, **water demand reduction** and **waste reduction**.

Nature restoration: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Implementing and broadening England's Environment Act targets and EIP *(continued)*	• Oversee the successful operation of the newly introduced, mandatory **biodiversity net gain** requirement for developers and learn lessons for the broader scaling up of nature restoration markets.[449] Provide **adequate resourcing to local authorities and forestry commissions** to ensure successful implementation of the new requirements.	• These targets are underpinned, to a degree, by **policies**, commitments, **and interim targets** – mostly set for 2028 – set out in the **EIP**.[450] This includes a target to **protect 30 per cent of land and seas** for nature **by 2030** through the **Nature Recovery Network**, the creation and restoration of 70 areas for wildlife through the next round of **Landscape Recovery Projects**, the development of **Local Nature Recovery Strategies** and measures to promote **biodiversity net gain** for new developments in the built environment. • **Implementing the targets and underpinning policy commitments set out in the Environment Act and EIP will be essential to** drive growing investment in nature restoration and **achieve the Government's ambition to mobilise at least £500 million of annual private capital by 2027 and over £1 billion by 2030.**[451] • Broadening the scope of targets under the Environment Act can help attract private investment across a broader range of nature restoration projects and markets. • The **biodiversity net gain requirement** introduced in February 2024 pursuant to the Environment Act and EIP **requires developers to deliver ten per cent improvements for nature on all new housing, commercial and industrial infrastructure projects** in England. • Effective implementation of new nature restoration requirements, such as biodiversity net gain, is essential to meet the Environment Act targets. However, research funded by the Department for Environment, Food & Rural Affairs (Defra) in 2022 found that fewer than ten per cent of local planning authority respondents felt they had adequate expertise and resources to deliver the biodiversity net gain requirement.[452] Sufficient resources and training in local planning authorities will allow timely and effective delivery of biodiversity net gain assessments and encourage investment in nature restoration projects.
Overcoming barriers to peatland restoration	• Use the upcoming **Peatland Restoration Roadmap** to put in place incentives to **address current barriers to peatland restoration projects,** with a particular focus on skills provision, workforce availability and infrastructure provision. • Put forward a timeframe for the **end of domestic and industrial peat extraction.**	• Despite some ambitions and funding in place, **efforts to restore degraded peatland are progressing slowly**: 12,700 hectares of peatland were restored in 2022/2023, compared to a Government target of 29,000 hectares per year by 2025 and Climate Change Committee recommendations of 67,000 hectares a year by 2025.[453] • **Skills gaps**, **workforce availability** and lack of infrastructure have all been cited **as current barriers to delivery for peatland restoration.**[454] Tackling these barriers is essential to open up a greater range of peatland restoration projects to private investment. • Putting in place clear timeframes to end peat extraction will strengthen the market signal for peatland restoration projects as well as create a market signal for alternatives to peat.

Nature restoration: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Overcoming barriers to woodland creation and restoration	• Review financial incentives to **make woodland creation schemes more appealing to landowners and managers**. • Put in place skills provision and financial incentives to **tackle the ongoing gap in skills and workforce availability** in woodland creation and management.	• The carbon sink provided by UK forestry has constantly reduced since 2017.[455] • **Various targets, ambitions and supportive funding are in place across the UK to create and restore woodlands**. In England, the ***Environment Act 2021*** sets a **target for 16.5 per cent of total land area to be covered by tree canopy and woodland by 2050**, compared to 14.5 per cent today (equivalent to planting 10,000 hectares of trees a year between 2025 and 2050). Scotland and Wales have annual tree planting targets of 18,000 and 2,000 hectares respectively.[456] • There remains a **delivery gap to achieve the UK's woodland creation and restoration ambitions**. Afforestation in 2022 amounted to 13,900 hectares versus a target of 30,000 hectares a year by 2025, with most new woodland created in Scotland.[457] Barriers to delivery and investment include **skills gaps, lack of workforce availability** and reluctance of landowners and managers to host woodland creation and restoration schemes.[458] • Ensuring that incentives are in place to encourage landowners and managers to host tree-planting projects and tackling the ongoing skills and workforce availability gap is critical to create a pipeline of investable woodland creation and restoration projects at the necessary scale.
Creating high-integrity UK nature markets	• Building on the recommendations above and the publication of the *Framework for Nature Markets* and the subsequent update,[459] **create world-leading, high-integrity nature markets in the UK by continuing to develop at pace the**: (i) **market guidelines**; (ii) market **access rules**; (iii) **investment standards** (through the British Standards Institute [BSI]); (iv) **governance arrangements** for these markets.[460] • Continue to **grow seed funding in the *Big Nature Impact Fund* and similar schemes** to crowd in further private investment in nature restoration projects and de-risk future private investment in these projects.[461]	• The ***UK Peatland Code*** and ***UK Woodland Carbon Code*** provide independent certification for carbon savings from peatland restoration projects and woodland creation and restoration projects.[462,463] • Building on these initiatives, the UK Government published in March 2023 a ***Framework for Nature Markets.***[464] This framework sets out high-level principles as well as the Government's initial plans to support the creation of high-integrity nature restoration markets. • The **proposals in the Framework** will continue to be developed over the coming years and include putting in place: (i) **detailed guidelines for voluntary nature markets** (building on international best practice from voluntary carbon markets and the Taskforce on Nature-related Financial Disclosures recommendations); (ii) **rules on how farmers and other land and coastal managers can access nature markets** and combine public/private revenue streams; (iii) **a pipeline of investment standards**, of which the first iteration will be released for public consultation later in 2024, for nature markets to be developed by the BSI; (iv) a **review of regulatory and institutional arrangements** to support the good governance of these markets, including a review of the tax regime by a joint HM Treasury and HM Revenue and Customs working group with industry representatives.[465,466]

Nature restoration: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Creating high-integrity UK nature markets *(continued)*		• Rapidly **putting this framework in place will** help the UK create world-leading nature markets to **attract global private investment** and provide the UK with a competitive edge in the creation of **nature markets** globally. • The Government has committed **£30 million in seed funding to the *Big Nature Impact Fund*** to crowd in private investment in a range of nature restoration projects in England and has **recently closed the third round of the Natural Environment Investment Readiness Fund,** offering individual grants up to £100,000, totalling £5 million, to help farmers develop nature restoration projects to the point that they are ready to attract private investment.[467, 468] • Continued, targeted public funding will help improve investor knowledge and confidence in nature restoration projects, thereby lowering the perception of risk among private investors and growing long-term private investment flows.

Key takeaways

1. **A coordinated UK approach to land use:** Develop a co-ordinated Land Use Framework for England, setting out tangible nature restoration objectives for each key sector of the economy and growing coordination with devolved governments.
2. **Completing and scaling up agri-environment schemes:** Complete the policy detail, option design and payment rates for agri-environment schemes in England, Scotland and Wales, and consider further interventions to increase the take-up of these schemes.
3. **Creating a pipeline of investable nature restoration projects through regulatory targets:** Accelerate policy development under the Environmental Improvement Plan (EIP) that will attract private investment to achieve the Environment Act's nature restoration targets, broaden the scope of these targets and tackle the skills gaps standing in the way of investment in peatland restoration and woodland creation projects.
4. **Creating a pipeline of investable nature restoration projects through voluntary markets:** Finalise the rules and investment standards under the Nature Markets Framework to create high-integrity, voluntary nature markets, and continue to use targeted public funding such as through the Big Nature Impact Fund to crowd in private investment in complex projects.

9. Driving investment in greenhouse gas removal technologies

The availability of carbon storage in offshore sites is likely to start in **2027** at the earliest, despite the 2025 target to begin storing emissions.[469]

The National Infrastructure Commission estimates that residual emissions will be between **40 million tonnes and 100 million tonnes** of CO_2 per year by 2050.[470]

The Government's Carbon Capture, Utilisation and Storage (CCUS) Vision estimates that the growing deployment of CCS could boost the economy by **£5 billion** per year by 2050.[471]

The Climate Change Committee (CCC) estimates that, annually, **6.4 million tonnes** of carbon dioxide emissions equivalent ($MTCO_2e$) will need to be removed during the Fifth Carbon Budget (2027–2032) and **23.4 $MtCO_2e$** during the Sixth Carbon Budget (2032–2037).[472]

The UK Continental Shelf potentially has enough capacity to safely store up to **78 billion tonnes** of carbon – one of the largest potential CO_2 storage capacities in Europe.[473]

The National Infrastructure Commission estimates that the engineered Greenhouse Gas Removal (GGR) sector could generate revenues worth around **£2 billion** a year by 2030, rising to the **tens of billions** by 2050.[474]

CCUS technologies could support **50,000** jobs by 2030.[475]

CCUS could store **20Mt–30Mt** of carbon per year by 2030 (equivalent to taking **six million** cars off the road).[476]

Investment insights

Ben Luckett
Managing Director, Venture Capital

Scenarios from governments and public bodies forecast that CCUS will play a key part in reaching net zero. Investment in technologies to support this ambition is needed now; the development of new and nascent technologies such as direct air carbon capture (DAC) or bioenergy with carbon capture and storage (BECCS) should be explored further. The key challenge for DAC is the very low concentration of CO_2 in the atmosphere – it either requires exposure to significant volumes of air or a process to concentrate it; with BECCS, the time and expense of the production of biomass is a key drawback. More positively, the venture capital ecosystem is well placed to play its part in the investment needed to promote wider early-stage risk taking in cleantech.

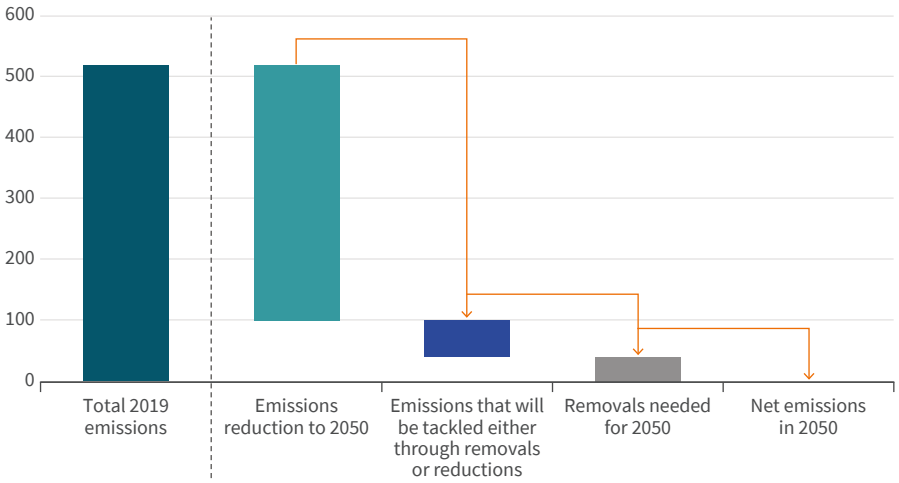
The government should use all levers at its disposal – subsidies, grants, tax, equity, policy, regulatory and convening power – to stimulate investment, encourage innovation and create a supportive environment. Specifically, consideration should be given to a programme of subsided loans (much like the US Title 17 programme), or a first loss venture capital programme for growth investments. Beyond the fluctuating price of carbon under the UK Emissions Trading Scheme (UK ETS), there is currently a lack of additional regulation that provides a sufficiently high and predictable carbon price, without which there is no financial incentive for companies to install CCUS technology to generate negative emissions; this should be addressed to improve market conditions.

The UK's 2021 *Net Zero Strategy* set an ambition to capture at least five million tonnes of CO_2 a year through engineered removal technologies by 2030 as part of meeting its Nationally Determined Contribution (NDC) emissions reduction target under the United Nations' Paris Agreement. Some hard-to-abate sectors, such as aviation, shipping and parts of heavy industry, are unlikely to be able to fully reduce emissions at source by 2050, with **the National Infrastructure Commission estimating that residual emissions from these sectors will range between 40 and 100 million tonnes of CO_2 emissions a year by 2050 in the UK** (Figure 12).[477]

The National Infrastructure Commission estimates that residual emissions from hard-to-abate sectors will range between 40 and 100 $MtCO_2e$ a year by 2050

While removal potential of nature-based solutions should be maximised first, it is widely accepted that nature-based removals alone will not be sufficient to deliver the UK's climate targets.[478, 479, 480] The extent of emissions removals from nature-based solutions is still uncertain, however the CCC estimates that the capacity may be between 35 and 60 million tonnes of CO_2 emissions a year by 2050 – below the residual emissions estimated from hard-to-abate sectors. Engineered GGR technologies – such as BECCS and direct air carbon capture and storage (DACCS) – permanently or near-permanently offset a significant proportion of residual carbon emissions from these sectors.[481]

Figure 13. **Projected UK residual emissions that GGRs may need to remove to reach net zero in 2050 ($MtCO_2e$)**



Source: "Engineered greenhouse gas removals, National Infrastructure Commission, July 2021.[482]

The investment opportunity in GGRs is potentially significant. The CCC estimates that to remain on a cost-effective pathway to meet the 2050 net-zero target, **an annual average of 6.4 million tonnes of CO_2 emissions equivalent will need to be removed through GGR technologies during the fifth carbon budget period** (2027–2032), **rising to an annual average of 23.4 million tonnes of CO_2 emissions in the sixth carbon budget period** (2033–2037).[483]

The investment opportunity in Greenhouse Gas Removals is potentially significant

However, the development of technologies such as DACCS and BECCS and that of the corresponding policy framework are both at an early stage, their successful deployment is closely tied to the availability and affordability of CCS technology, and the capital and operational costs are significant, with the National Infrastructure Commission estimating that **the cost of removing emissions through GGRs will be between £100 to £400 per tonne of CO_2**. In addition, further work is required to fully assess the environmental integrity of the negative emissions and biomass sourcing involved in GGR projects.

There are currently no engineered removal projects operating within the UK, and there is a risk that no BECCS or DACCS projects will be operational by 2030 given the current pace of policy and project development. The UK Government recently published a *CCUS Vision,* which sets out how the UK plans to transition from early CCS projects backed by public funding to a competitive CCS market by 2035, which includes plans for GGR projects.

There are currently no engineered removal projects operating within the UK

The Government has also published a draft business model to provide revenue predictability for GGR project developers achieving negative emissions. However, the state of the UK policy framework is somewhat behind that of jurisdictions such as the United States, where the Inflation Reduction Act has significantly increased carbon removal tax credits available for DAC ($130/tonne of CO_2), DACCS ($180/tonne of CO_2) and BECCS projects ($85/tonne of CO_2).[484]

The UK Government's CCUS Vision sets out how the UK plans to transition to a competitive CCS market by 2035

Policy priorities

Overview

This section sets out a range of policy recommendations to attract early investment in the first GGR projects and safeguards to ensure these comply with high degrees of environmental integrity. Key recommendations include increasing the pace of policy development, by **finalising the business model to provide revenue predictability for negative emissions achieved through GGR projects** (such as through a Contract for Difference [CfD] for carbon), **clarifying how GGR technologies will be included in the first projects to proceed under the CCUS Cluster Sequencing Programme**, the extent to which GGR projects will benefit from the £20 billion of funding earmarked for CCUS at the 2023 Spring Budget, and how these projects will be **connected to CCS transport and storage infrastructure**.

Provide revenue predictability for negative emissions achieved through GGR projects

This section also sets out recommendations to develop **robust sustainability criteria on the monitoring, reporting and verification of negative emissions**, as well as strengthening the UK's sustainability criteria and compliance arrangements when it comes to the **prioritisation, sourcing and use of biomass**.

Develop robust sustainability criteria on the monitoring, reporting, and verification of negative emissions

GGR technologies: key policy recommendations

Type of intervention	Detail of intervention	Expected benefit and context
Accelerating timelines	• Accelerate **the development of a policy framework** for engineered GGRs. • This should **include clear timelines for** the different deployment stages of **the first BECCS and DACCS projects.**	• Despite some important groundwork, many aspects of the policy framework for engineered GGR projects are not yet finalised, **with the risk that no BECCS or DACCS project will be operational by 2030.** The **slow pace of policy development** for engineered GGR projects **in the UK** contrasts with **accelerated policy development in other jurisdictions**, especially the US. • Urgent development of the policy framework for GGRs is essential if the UK is to attract early investment in these technologies and if it is to meet its emissions-removal targets for 2030.
Clarifying early funding support and revenue streams	• Finalise a Business Model **for engineered GGR technologies such as DACCS and BECCS** to provide greater clarity on revenue streams for negative emissions, building on the December 2023 *GGR Business Model Update*.[485]	• **The Government published in December 2023 a non-binding update on its proposals for a Business Model for GGR projects** and Business Model for power projects using BECCS technology.[486]

GGR technologies: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Clarifying early funding support and revenue streams *(continued)*	• Provide clarity **on the initial funding support** that will be provided for early stage BECCS and DACCS projects and on the **timing** of that funding. • Provide clarity on the timing and allocation of the £20 billion CCS funding earmarked at the 2023 Spring Budget (see policy recommendations in Sections 1 and 3). • Consider increasing that budget to accelerate the CCUS market creation phase, conditional upon specific milestones being met.	• Proposals are based on developing **a CfD for carbon (CfDc)** framework to provide developers with predictable revenues for delivering negative emissions **over a 15-year time horizon**. Strike prices would be calculated by taking into account a combination of: (i) the capital and operational expenditure of constructing and operating a GGR plant; (ii) an "allowed return on investment". Reference prices would initially be calculated through a combination of a developer's "Achieved Sale Price" on the negative emissions market, combined with a Price Discovery Incentive. • **Clarifying the allocation of Government funding for early GGR projects and finalising the GGR Business Model** proposals in a way that provides viable and predictable revenues for project developers **will be essential in attracting private sector investment in early stage BECCS and DACCS projects** and kickstarting the market for engineered removals.
Providing access to CCS networks	• Building on the Government's December 2023 *CCUS Vision* document, set out a clear **strategy as to how engineered GGR projects are to connect to the CCS transport and storage network.**[487] • Include early stage GGR projects in upcoming projects to be shortlisted under the CCUS Cluster Sequencing Programme.	• **Providing near-term clarity as to how engineered GGR projects are to connect to the CCS network** and be included in the CCUS Sequencing Programme **is essential to support the technical and commercial viability of early stage BECCS and DACCS plants**, and for these projects to be considered by private investors. • No engineered removal projects have currently been included as part of the Track 1 and Track 2 projects shortlisted under the CCUS Sequencing Programme.
Putting in place robust sustainability criteria and public engagement	• **Publish robust guidelines for the monitoring, reporting and verification of emissions removals from GGR projects.** This should be based on international best practice and working closely with international partners. It should include an independent review of the lifecycle carbon footprint and biodiversity impacts of BECCS projects, building on the recent *BECCS Task and Finish Group Report*.[488] • Build on the 2023 *Biomass Strategy* and the recent recommendations from the National Audit Office (NAO) on biomass sustainability, by: (i) continuing to **refine the UK's strategy on the priority uses of biomass**; (ii) developing **a common sustainability framework for the use of biomass across different economic sectors**; (iii) **strengthening criteria on** the **sustainable sourcing** of domestically produced and imported biomass; (iv) **strengthening the assurance arrangements** for businesses to demonstrate compliance with these sustainability criteria; and (v) developing plans for sustainable domestic biomass production.[489, 490] • Put in place **a coordinated public engagement campaign** to improve public understanding of – and support for – the targeted use of engineered GGR technologies.[491]	• **Robust guidelines on monitoring, reporting and verification (MRV) are essential to provide investors**, business, and the public **with confidence** regarding the permanent carbon emissions removals being delivered by GGR projects. • **Robust sustainability criteria** on the use and sourcing of biomass **are essential to prevent unintended negative environmental impacts from the use of biomass** in engineered GGR technologies and other sectors. • The Government published a Biomass Strategy in August 2023, outlining initial perspectives for the priority uses of biomass, with an important long-term role identified for BECCS projects.[492] The strategy commits to producing a common sustainability framework for the use of biomass across different economic sectors, subject to consultation. • In January 2024, **the NAO highlighted the need for Government to strengthen current sustainability criteria for the use of biomass** in the power and heat sectors, and for future applications such as BECCS plants. **The NAO also highlighted the need to review and strengthen current assurance arrangements** to provide greater certainty and transparency on companies' compliance with biomass sustainability criteria.[493] • Robust sustainability and MRV criteria and guidelines, together with a public engagement campaign, are essential to deliver long-term investor confidence and public consensus behind the role and viability of GGR projects, thereby enabling the development of a long-term market for GGR projects which financial institutions can invest in.

GGR technologies: key policy recommendations *(continued)*

Type of intervention	Detail of intervention	Expected benefit and context
Coordination between all devolved administrations	• The Westminster Government and Devolved Administrations should work closely together on a strategy for the location and deployment of GGR projects.	• GGR projects involve significant capital costs as well as important technological and construction risks. There is not yet a coordinated UK-wide approach as to the identification, location and development of GGR projects. • A coordinated UK-wide approach will ensure the best location for GGR projects, support their efficient deployment, and provide investors with a simpler market landscape.
Impact on the power grid	• The Government should **incorporate the electricity demand implications of DACCS and other GGR projects in its power-sector planning** and modelling.	• Anticipating the future electricity demand from GGR projects will ensure these projects are **supported by adequate grid infrastructure and are technically viable**. • **This modelling will also help clarify:** (i) **the realistic scale of potential GGR project deployment** from a power-grid perspective given growing electricity demand from priority sectors such as heating, transport and heavy industry; (ii) **the investment requirements in zero-carbon power generation** and grid infrastructure that will need to be met in the coming decade.

Key takeaways

1. **Completing business models:** Complete the business model for Greenhouse Gas Removal (GGR) projects, such as direct air with carbon capture and storage (DACCS) and bio energy with carbon capture and storage (BECCS) projects, by providing revenue predictability over a 15-year period for negative emissions.
2. **Improved co-ordination with the CCUS framework:** Clarify how GGR projects will be included as part of the CCUS Cluster Sequencing Programme, the extent to which they will benefit from the £20 billion of public funding allocated to CCUS, and how GGR projects will be connected to CCS transport and storage infrastructure.
3. **Sustainability criteria to deliver high-integrity offsets:** Develop robust sustainability criteria for (i) the monitoring, reporting and verification of negative emissions and (ii) strengthen sustainability criteria and compliance arrangements for the production, import and use of biomass in GGR projects.

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Contact us

Aviva Investors
80 Fenchurch Street
London EC3M 4AE
+44 (0)20 7809 6000

www.avivainvestors.com