MISSION ZERO

Independent Review of Net Zero

Rt Hon Chris Skidmore MP

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Foreword from the Net Zero Review Chair

Forty-two months ago, the UK became the first G7 country to sign our commitment to net zero greenhouse gas emissions by 2050 into law. This landmark commitment built on the UK's international climate leadership in passing the pioneering Climate Change Act in 2008 — becoming the first major country to establish a clear governance framework on how to achieve emissions reductions.

The UK's leadership on tackling climate change has not only delivered real change at home — reducing our carbon dioxide emissions over the past twenty years by nearly 50% compared to 1990 levels — it has led to a global transformation in how countries and companies now view the importance of taking action on net zero. Thanks to the UK's Presidency of COP26, the Glasgow Climate Pact in November 2021 witnessed over 90% of the world's GDP commit to a net zero target.

Indeed, the rest of the world, along with international investment communities, has woken up to the fact that the energy transition is a new economic reality. 2022 marked a watershed moment for global investment in net zero — not least from the US' Inflation Reduction Act, with its commitment of placing clean technologies at the heart of future economic strategy.

The global reality of the energy security crisis and rising gas and fossil fuel prices in 2022 has also demonstrated the importance of delivering future energy security through the greater use of domestically generated renewable and clean sources of power, while seeking to better reduce energy demand.

Forty-two months on, then, much has changed. For this reason, this Independent Review of Net Zero was commissioned in September 2022, to ask how the UK could better meet its net zero commitments, taking account of these global changes. It was commissioned also to ask how the UK might deliver its own net zero targets in a manner that was both more affordable, more efficient, and in a pro-business and pro-enterprise way. Indeed, net zero, decarbonisation and clean energy growth will only happen if it delivers the economic benefits that can demonstrate to the whole of society the true value of the energy transition.

It is for the whole of society that net zero needs to work, and for this reason the Review has taken a whole of society approach to our evidence gathering. The Review has sought to engage, listen, and learn from businesses, organisations, industries, and communities from across the UK. We received over 1800 written submissions as part of our official Call for Evidence — testament to the strong interest in delivering on net zero — as well as holding over 50 evidence roundtables, visiting every devolved nation in the UK and each region in England, and speaking personally to a thousand participants in our engagement sessions. It is their voices and views that this Review has sought to represent, as one of the largest national engagement exercises on the future of net zero and its role in the UK economy.

The recommendations that have been made in this Review have come from this extensive engagement. We have sought to understand not only the barriers that are preventing businesses, regions, communities, and households from taking further action to decarbonise, but also to explore the opportunities that can catalyse further economic growth.

Above all, this Review has sought to ask how the UK can deliver on its net zero commitments by demonstrating how to deliver and implement most effectively and efficiently a plan for our future energy transition. Climate commitments and net zero targets remain just words on a page without a clear, consistent, and stable transition plan. I hope that this Independent Review can provide additional clarity and certainty on how the UK can not only meet its net zero commitments but can once again demonstrate international leadership in setting out a comprehensive roadmap towards a net zero future. While forty-two months may have passed since the UK signed net zero into law, there remain just three hundred and twenty-four months until 2050. Planning effectively for that net zero future must be our priority.

The Review's recommendations require not merely action, but careful decisions to be taken. Central to delivering net zero will be making the right decisions at the right time to ensure that we achieve net zero in the most efficient manner possible. Crucial to taking decisions, however, is recognising that to delay making them creates new consequences, the costs of which can be greater than previously anticipated. Equally, rushed and poorly executed decision making can produce adverse consequences with similar costs.

This Review has sought to establish how best to create a delivery ecosystem to achieve the best possible decisions for the future. This requires not merely government to play its role, but importantly to empower the agency of regions, local communities, and individuals to play a greater role in their own net zero journey. How we create a 'big bang' moment for net zero, enabling and unleashing the potential of the whole of the UK to seize the opportunities that net zero presents has been a key focus of this Review.

Across the Review, we have sought to make recommendations both for government, for each sector and industry, for local regions and authorities, indeed for individual households. Net zero decision making requires action not merely from government, but from all stakeholders involved. Not all these recommendations will be able to be implemented immediately: indeed, the overriding message of the Review is that we must deliver greater certainty, consistency, and clarity across net zero policy making, with a stability of approach that requires long term planning. There will be recommendations that have been made which can be taken forward now; there will be others that the government will be unable to take forward without further engagement and consultation with industry and communities. It is also understood that government will not be able to accept every recommendation, however where it can act now, we argue that the costs of doing so will be less if action is taken sooner. We have suggested therefore an approach that recognises what recommendations should be taken forward now, with a '25 by 2025' framework — twenty-five policies that could be realistically delivered by 2025 — alongside other wider recommendations.

As the former Energy Minister who was responsible for signing the UK's net zero commitment into law forty-two months ago, it has been an honour to chair this Independent Review on Net Zero. Not only have I witnessed first-hand what a catalysing effect the net zero commitment is having on business and industry across the UK, I have also been able to better understand the challenges and opportunities that net zero presents to UK businesses, communities, and households. Delivering on those challenges and meeting those opportunities is what I hope this Review has been able to achieve.

Rt Hon Chris Skidmore OBE

Acknowledgements

For any independent review to reflect the breadth and depth of opinion and evidence needed, public participation in its engagement exercise is essential. The Net Zero Review is indebted to the hundreds of participants who took part in the fifty-two evidence roundtable sessions, as well as the 1800+ organisations and individuals who submitted to the official Call for Evidence.

The Chair is also extremely grateful to the work of the Net Zero Review team, who have worked to produce the report, compile evidence and statistical analyses, organise visits and roundtables at a rapid pace. The Chair would like to thank the Director of the Net Zero Review Ryan McLaughlin and Net Zero Strategy Director General Lee McDonough in addition to: Adam Kerson, Amber Woodward, Barnaby Powell, Cllr Max Austin, Colm Williams, Harry Robinson, Henna Deol, Henry Green, Jack Taylor, Joanna Carew, Julie Damborg, Lois Raines, Louis Maskery, Lydia McKee, Magdalena Lomacka, Massimiliano Verri, Nick Velani, Olivia Johnson, Sally Heard, Swapna Uddin, Theresa Löber, Verena Leckebusch.

In addition, the Net Zero Review has benefitted from the repeated engagement of a number of individuals through the process of the Review, whom the Chair would like to thank including: Josh Buckland, Tim Lord, Chris Stark, Lord Deben, Guy Newey, Charlie Ogilvie, Sir Patrick Vallance, Lord Nicholas Stern, Michael Liebreich, Amber Rudd, Claire O'Neill.

The Chair would also like to put on record his thanks to Harvard Kennedy School Mossavar-Rahmani Center for Business and Government where he is a Senior Fellow for helping to contribute to the wider systems thinking processes, in particular to Professor Richard Zeckhauser and John Haigh.

Finally, the Chair would like to personally thank his wife Lydia for all her commitment, help and support in making the Net Zero Review and the available time needed for its engagement process possible.

Executive Summary

The Net Zero Review was perhaps the largest national engagement on net zero

1. The Net Zero Review travelled to all four nations of the UK, received over 1800 responses to the Call for Evidence, and held more than 50 roundtables, making it one of the largest engagement exercises on net zero in the UK. We heard a clear message from businesses, organisations, individuals, and local government across the country: **net zero is creating a new era of opportunity, but government, industry, and individuals need to act to make the most of the opportunities, reduce costs, and ensure we deliver successfully.**

2. The Review is split into two parts:

   - Part 1 explains the opportunity and benefits to individuals and the economy. It places domestic action in an international context and emphasises that the UK must go further and faster to realise the economic benefits of net zero.
   - Part 2 sets out how to achieve this opportunity, across six pillars. It makes recommendations to catalyse action in individual sectors of the economy, and to enhance the role of local authorities, communities, and individuals to deliver net zero.

3. The recommendations in this Review show how action can be taken in the short, medium, and long term to turbocharge our delivery, set clear roadmaps that provide the certainty needed for investment and R&D, and deliver net zero in a pro-growth, pro-business, low-cost way.

Net zero is the growth opportunity of the 21st century

4. **The UK should be proud of the steps it has taken to achieve net zero.** Progress since 2019 has exceeded expectations. In setting the net zero target, the United Kingdom was building on the progress of many years – not least a quiet transformation of our power system, from one dominated by coal, to one increasingly driven by a clean and endless supply of wind blowing across the North Sea.

5. **The economy and climate change are intertwined.** While this Review has a clear focus on ways to achieve growth and reduce the costs of net zero, it is impossible to consider this in isolation from the physical risks that climate change presents. In a high emission future, the level of global disruption will be so severe that 'normal' economic activity will become very challenging.

6. The Review has heard loud and clear that **net zero is the economic opportunity of the 21st century.** The evidence presented to the Review has shown that the pace of recent change has created a rush of economic opportunity at a massive, global scale. With more than 90% of global GDP covered by a net zero target[1] there is now huge global momentum to reach net zero and capture the economic opportunities. This is driven by businesses of all sizes who have recognised that net zero can help them grow.

7. **The UK is well-placed to take advantage**. McKinsey estimates a global market opportunity of £1 trillion for British businesses by 2030[2] and the Government estimates that the transition can support 480,000 jobs in 2030.[3] The UK enjoys a comparative advantage over other advanced economies in several key areas – notably offshore wind, carbon capture and storage, and green finance – and so can capitalise on export opportunities from the global transition.

8. **We must act decisively to seize the opportunities in a global race.** We are not alone in seeing the opportunity around the world. Countries and businesses have woken up. From the USA's $369 billion investment in clean technology through the Inflation Reduction Act[4] and the 'France 2030' investment plan in France[5] to the EU's 'Fit for 55' programme[6] it is clear we are in an international race for capital, skills, and the industries of the future. We must act quickly, and in collaboration with our international partners, to cement the UK as a prime destination for international capital and unlock export opportunities for British businesses around the globe. Failing to do so will mean missed opportunities.

9. **We must move quickly.** We have heard from businesses that economic opportunities are being missed today because of weaknesses in the UK's investment environment – whether that be skills shortages or inconsistent policy commitment. Moving quickly must include spending money. We know that investing in net zero today will be cheaper than delaying, as well as increasing the economic and climate benefits. Analysis suggests that delaying action by ten years could mean UK debt could be 23% of GDP higher in 2050, doubling the fiscal cost of achieving net zero and not capitalising on economies of scale.[7] Oxford research has shown that a fast transition to net zero based on scaling up key green technologies will continue to drive their costs down, and transitioning to a decarbonised energy system based on green technologies by 2050 can save the world at least $12 trillion, compared to continuing our current levels of fossil fuel use.[8]

10. Ultimately, the benefits of net zero will outweigh the costs. In some estimates, the UK would see approximately 2% additional growth in GDP, through the benefits from new jobs, increased economic activity, reduced fossil fuel imports and cost savings (for example cheaper household bills).[9] These estimates do not reflect the risk and disruption of not acting, which would run so clearly counter to the prevailing expectations of business and global trends. For all that there are some risks to the public from the transition, considered in detail in this Review, for the individual the benefits of net zero will – particularly with the right interventions by government – outweigh the costs. This Review sets out recommendations to provide clarity and certainty to businesses and investors and offers a view on how to back up the UK's ambitious net zero vision with clear delivery pathways.

The challenge of translating bold ambition into action

11. The Government's *Net Zero Strategy* sets out the UK's decarbonisation pathway out to 2037, based on modelling on the most cost-effective net zero energy system in 2050. **New analysis conducted over the course of the Review shows that this is still the right pathway and the policies outlined in the Strategy should go ahead**. Delay is a significant risk. Our engagement and own analysis have shown that the benefits of decarbonisation are larger if it is done sooner.

12. We have made great progress decarbonising already with success stories in offshore wind and electric vehicles and it is essential we continue these. **However, too often, we heard of problems hampering business and local areas from going as far and as fast as they**

want to. Whether it is lack of policy clarity, capital waiting for investible propositions, infrastructure bottlenecks, or delays in the planning system, it is clear that we need action to catalyse the deployment of clean solutions, particularly if we want British companies to capture the economic benefits.

13. **This is too important to get wrong.** Delivering net zero is the industrial revolution of our time – and climate change the greatest threat. Not only can the transition deliver a thriving, modern, green economy but it can materially improve people's lives. Supporting nature must be an essential part of the UK's response. A thriving natural environment is inextricably linked with protecting our climate and growing our economy.

14. **Work is needed to secure the benefits and minimise costs.** We are at a crossroads. We can either go further and faster in the transition, capitalising on our comparative advantages on clean technologies, our world class science base, our global leadership on financial services and the natural power reserves of the North Sea – or we can hold up our hands and say it is too difficult and watch our world-leading sectors, such as the City of London or our advanced car manufacturing, pack up and move on, taking high-skilled, high-paying jobs with them.

15. The Review's findings are unequivocal: **we must grab this opportunity, there is no future economy but a green economy**. And with the recommendations set out to turbocharge our approach across key industries, catalyse action in homes, community halls, and local and national government across the country, **we can**.

A mission approach for a pro-growth, pro-business transition

16. The Review has listened and engaged with almost every sector to identify the barriers to future delivery, as well as the opportunities that could be seized in the future. Overwhelmingly, the common message has been the need for clarity, certainty, consistency, and continuity from government. Sectors have indicated that a long-term, stable investment plan is required. We have identified ten priority missions to harness public and private action out to 2035:

- A strategic framework and delivery plan for the critical networks of the future to turbocharge onshore and offshore development

1. Grid and Infrastructure

- Full-scale deployment of solar including a rooftop revolution to harness one of the cheapest forms of energy, increase our energy independence and deliver up to 70GW of British solar generation by 2035

2. Solar

- Pave the way for onshore deployment, working closely with communities to deliver local benefits

3. Onshore Wind

- A programmatic approach for a next generation fleet of nuclear, supporting a high-tech British industry covering the whole supply chain

4. Nuclear

- Setting a clear plan for industry decarbonisation built around long term investment in CCUS and hydrogen networks and technologies

5. Energy Intensives and Industry

- Stimulate the efficient and circular use of resources across the economy, galvanising action on recycling and the reuse of critical materials

6. Circular Economy and Waste

- Unblocking the planning system and reforming the relationship between central and local government to give local authorities and communities the power they need to act on net zero

7. Net Zero Local Big Bang

- Working towards gas free homes by 2035 and giving consumers greater understanding of their household through a new Net Zero Performance Certificate

8. Energy Efficiency For Households

- Embed nature and habitat restoration throughout transition plans, maximising co-benefits for climate and nature wherever possible

9. Net Zero Nature

- Catalyse decisions and action with an R&D and technology roadmap to 2050, pushing for more agile regulation, and supporting up to three 10-year demonstrators

10. R&D And Innovation

17. This Review sets out to assess how we deliver a more affordable and efficient transition. It is clear that we bring down costs by creating **certainty and stability** and that by **early action** we can build industries and supply chains in the UK, producing growth. The Review's recommendations unblock barriers across the policy landscape, from how to decarbonise oil and gas extraction to providing clarity for industry through a long-term vision for the UK Emissions Trading Scheme (ETS). It makes the case for more long-term delivery frameworks to tackle the challenges we face and unlock the benefits there for the taking.

18. The Review's evidence points towards some basic principles of effective net zero decision-making that should underpin this action. We must:

- Quickly take the **decisions we know we have to.** This is how we will achieve net zero in a more affordable and efficient way, at the same time as providing certainty for inward investment in the UK;
- **Invest in research and development** so we are ready to take decisions that we know we are going to have to make, such as rolling out demonstrator projects; and
- Prepare the ground with **agile and flexible policy frameworks** so we are ready for the future, resilient in the face of uncertainty, and equipped to act at speed when opportunities arise.

Infrastructure is the key that will unlock net zero

19. The net zero clock is ticking. To achieve net zero by 2050 and our international and domestic commitments on the way, we need to act quickly and decisively. Infrastructure will be key. The Review heard from hundreds of innovative companies eager to bring new technologies to market but being hampered by slow, ponderous bureaucracy and an antiquated approach to grid connections not suitable for a modern 21st century electrified economy. The Review recommends:

- **Accelerating the implementation of the *British Energy Security Strategy*** to finally update the mandate of Ofgem, create the Future System Operator which is essential to a holistic approach to solve the challenges of our future, multi-fuel energy system and accelerate the connection of our cheap renewable generation
- **A cross-sectoral infrastructure strategy by 2025.** We need to rapidly build and adapt the infrastructure for electricity, hydrogen, other liquid and gaseous fuels and CO_2 networks that support our green economy. The scale of this challenge, and the breadth, is too much to be left to the whims of individual projects
- **Reforming our approach to planning**, streamlining processes and, where locally supported, **unleashing solar and developing onshore wind**, the cheapest forms of generation, to be rapidly deployed in communities across the country and enable local people to reap the benefits of local, low carbon generation

Creating sustainable governance structures

20. None of this will happen without a **step change in the government's approach to delivering net zero**. For all the UK's past success and future ambition, the Review has heard from many respondents frustrated by a lack of long-term thinking, siloed behaviour from government departments, and uncertainty over the length of funding commitments. Evidence suggests this

is holding back deployment of green technologies, hampering investment across all sectors, and inhibiting the ability to create British jobs. To unlock this, and bring the clarity, certainty, and consistency desperately needed, the Review recommends:

- An over-arching **government financing strategy** by the end of 2023, giving long-term clarity to business and investors and ensuring we capitalise on our industrial strengths
- A **long-term programmatic** approach to net zero projects **and considering longer-term funding certainty** for major priorities for net zero – where we know that long-term policy commitment will be essential for success
- An **Office for Net Zero Delivery**, responsible for placing net zero delivery at the heart of government thinking, ensuring best practice for key delivery projects, and taking ownership of net zero priorities where they span multiple departments

Backing businesses

21. The private sector is critical to the net zero transition. Their investment and innovation will bring low carbon technology to the mass market. They will drive many of the benefits we will all experience from net zero, not least economic growth.

22. The UK economy is transitioning towards net zero – with businesses decarbonising and capturing new opportunities. But the Review has heard from the hundreds of businesses consulted that more is needed. In many cases, cross-cutting actions is required – on skills, support for small and medium businesses, and providing the right investment environment. The Review recommends:

- **Reviewing incentives for investment**: Review how HMT incentivises investment in decarbonisation, including via the tax system and capital allowances
- **Protecting industries from environmental undercutting**: Progress with the consultation on carbon leakage measures and speed up decision-making to enable Government to implement effective future carbon leakage mitigations from 2026
- **Providing a forward look on the ETS**: To provide businesses with certainty and increase the incentives to invest in new, green technologies, the government should work within the UK ETS Authority to develop a pathway for the UK ETS until 2040
- **Building the skills needed for the transition**: Drive forward delivery of the Green Jobs Taskforce recommendations and the commitments from the *Net Zero Strategy*, reporting regularly on progress starting by mid-2023
- **Helping SMEs upskill:** Launch a ‘Help to Grow Green’ campaign, offering information resources and vouchers for SMEs to plan and invest in the transition

23. A more resource efficient economy can drive down costs for businesses and individuals, create new jobs, and reduce exposure to rising commodity prices. The Review recommends **a mission to kickstart transition to a circular economy** through a joint taskforce on circular business models, working to end the export of plastic waste, and delivery of planned waste reforms.

Catalysing local action

24. The Review is also clear that there must be more place-based, locally led action on net zero. Our local areas and communities want to act on net zero, but too often government gets in the way. The Government must provide central leadership on net zero, but it must also **empower people and places to deliver.** Place-based action on net zero will not only lead to more local support but will deliver better economic outcomes as well. The Review recommends:

- Reforming the **planning system** at local and national level to ensure it properly supports net zero. One of the starkest messages from hundreds of organisations and individuals is that the planning system is undermining net zero and the economic opportunities that come with it. The Review recommends wide-ranging local planning reform – from the introduction of a net zero test to a rapid review of bottlenecks in the system – to ensure that it is fully aligned with our net zero future
- Simplifying the local net zero **funding landscape** to make it more efficient and productive for both central and local government. Local authorities are a key partner in delivering net zero, but current central government funding arrangements are standing in the way of effective local action. Stakeholders told us that the funding landscape is disjointed, unfair, and expensive for local authorities to navigate. The Review recommends wholescale simplification of local net zero funding, including consolidation of different pots and a reduction in competitive bidding. These changes will save both central and local government time and money, as well as do more to encourage a systems-wide approach to delivering net zero
- Providing full backing to a set of **'trailblazer' places** that want to go further and faster on net zero, with the aim of reaching net zero by 2030

Increasing transparency and engaging people

25. **The government must talk to the public about net zero.** Net zero will affect everyone in the UK and nearly half the policies in the government's *Net Zero Strategy* rely on individual action. There is widespread support for net zero, but often this is undermined by a lack of information, cost, and opportunities we cannot access. The Review sets out how the government can change that by putting public engagement at the heart of its work on net zero. We recommend:

- A **major expansion of the government's public reporting on net zero.** What gets measured gets done – and people deserve to understand the changes that are happening and being planned. We recommend improving and increasing the information available to the public about net zero and doing more to track public attitudes and experiences
- Government ramps up engagement with the public on net zero, publishing a **public engagement strategy**
- To put power in people's hands, go further on information provision through the creation of a **Carbon Calculator**, providing consumers with the information they need to make the choices they want
- Government continues to work with industry towards introducing a **standardised approach to ecolabelling** for as many products as possible by 2025. To support transparency, government should review options for a **Net Zero Charter** mark as a gold standard for sustainability

Delivering cleaner, cheaper, greener homes

26. The cheapest energy is the energy we do not use and by improving the insulation and heating sources of our homes we will have warmer, cleaner places to live. New analysis for the Review shows that the transition can save an average household a cumulative £400-£6,000 by 2050.[10] Government should be commended for its recent actions on energy efficiency, such as targeting demand reduction, but we must go further and faster. The Review calls for:

- Government **to bring forward all consultations and work to mandate the Future Homes Standard by 2025** and for **all homes sold to be EPC C by 2033**. A Net Zero Homes Standard should be considered for the future, as homes that have taken the appropriate steps to be as efficient as possible through a mixture of fabric and low carbon heating measures will be more financially desirable to live in, buy, and sell
- Alongside this government must urgently adopt a 10-year mission to make heat pumps a widespread technology in the UK and **regulate now for the end of new and replacement gas boilers by 2033** at the latest. Ensuring we turbocharge our adoption of heat pumps and low carbon heating sources, ending our reliance on fossil fuels in our homes once and for all
- To provide clarity for consumers, government must urgently reform EPC ratings to create a clearer, more accessible **Net Zero Performance Certificate** (NZPC) for households

Capitalising on our international leadership

27. The UK has had a leading role in global climate action in the last decade. Our roles as COP26 president and recent G7 Presidency put us in a strong position to lead the way for increased ambitions globally, showing leadership and setting the direction for decarbonisation. We now need to retain this position without these platforms, remaining a key player in the global debate. This would enable us to promote UK solutions globally – creating economic growth and investment in the UK economy. The Review recommends that government should:

- Conduct a **strategic review on the UK's international climate leadership** by 2023
- Establish a **baseline for environmental and climate protections in future free trade agreements** and for removal of trade barriers to environmental goods and services

Setting ourselves up for 2050 and beyond

28. Decisions taken today will be critical for the UK's ability to decarbonise in a pro-growth and low-cost way in the years leading up to 2050. They will also set the stage for the kind of economy and society we want after 2050. The UK must apply this long-term view to all of the issues raised in this Review. In particular, there are three areas that require action today, with a view to the 2040s, 2050s and beyond:

- The government, working with sectoral leads by Autumn 2023, must **apply whole systems thinking to create an R&D and technology roadmap outlining the key decision points** that must be made to ensure priority technologies deliver on the UK's net zero and growth ambitions
- BEIS and HMT should **review how to incentivise greater R&D for net zero**, including considering the role of clarity on research priorities and government support, tax credits, greater ring-fencing of R&D spend, and enabling regulations

- **Government must make regulatory processes agile** enough to match that of innovation by a) establishing up to three new R&D demonstrator projects, out to 2035, aligning with the ten-year missions set out by this review, and b) including in forthcoming work from the Office for Science and Technology Strategy (OSTS) how regulators can provide more opportunity for demonstrations for net zero technologies

25 key actions for 2025

29. Tackling the biggest challenges will require government and industry work in partnership, over the long term, bringing about a new economy. This will bring green British jobs, and an economy that is solving global challenges and capturing opportunities to export our technologies and expertise. To go further, faster, the Review calls for action on our key 25 for 2025 recommendations:

#	Objective	Recommendation
1	**Cleaner, greener homes**	Provide **certainty by 2024 on the new and replacement gas boiler phase out date** to drive industry and investor confidence. The Review recommends bringing the proposed date of 2035 forward and legislating for 2033. Set a **legislative target for gas free homes and appliances by the same date**, to contribute to a gas free grid in future. **Legislate for all homes sold by 2033 to also have an EPC rating of C or above**, with exclusions around certain properties (e.g. listed properties, on grounds of affordability). Government should mandate landlords to include 'average bill cost' alongside EPC (and possible NZPC) rating, when letting out a property. This will help renters understand what costs to expect, while also helping to put a premium on energy efficient homes.
2	**Cleaner, greener homes**	Bring forward all consultations and work to **mandate the Future Homes Standard by 2025** to prevent further delays by ensuring standard applies to all developments. This should include a consultation on mandating new homes to be built with solar and deliver the Net Zero Homes Standard, ensuring that the planning system is flexible enough to enable this.
3	**Non-domestic energy efficiency**	Legislate by 2025 the **minimum energy efficiency rating to EPC B for all non-domestic buildings, both rented and owned, by 2030**. Legislate for **EPC B rating for all new non-domestic buildings from 2025**.
4	**Stable environment for business to plan and invest**	Conduct and publish, before Autumn 2023, **a review of how we should change regulation for emerging net zero technologies** to enable their rapid and safe introduction, to support the net zero transition and boost growth.
5	**Stable environment for business to plan and invest**	By the end of 2023 HMT should **review how policy incentivises investment in decarbonisation, including via the tax system and capital allowances**.

#	Objective	Recommendation
6	**Stable environment for business to plan and invest**	Through their update to the Green Finance Strategy, BEIS and HMT should set out **a clear, robust and ambitious approach to disclosure, standard setting, and scaling up green finance** – including how it will meet existing commitments to implement Sustainable Disclosure Requirements across the economy; how it will provide a clear, long-term plan for attracting capital to meet net zero ambitions, and how to maintain the UK's position as the leading green finance hub internationally and metrics for success.
7	**Stable environment for business to plan and invest**	A **new forum to coordinate across all regulators** on the signals they are sending to businesses and investors across sectors about the net zero transition – including Ofwat, Ofgem, Environment Agency, Competition and Markets Authority, FCA, and the North Sea Transition Authority.
8	**Long term funding certainty**	At the next Spending Review, review options for **providing longer-term certainty to a small number of major priorities** for net zero – where we know that long-term policy commitment will be essential for success and provide long-term opportunities to save money.
9	**Stable environment for business to plan and invest**	Publish an **overarching financing strategy** covering how existing and future government spending, policies, and regulation will scale up private finance to deliver the UK's net zero enabled growth and energy security ambitions. This should include setting out the role of UKIB, BBB, BII, and IPA and UKEF in the transition.
10	**CCUS**	In 2023, government must act quickly to re-envisage and **implement a clear CCUS roadmap**, showing the plan beyond 2030. As part of the roadmap, government should take a pragmatic approach to cluster selection. This means allowing the most advanced clusters to progress more quickly.
11	**Accelerating renewables**	Set up taskforce and deployment roadmaps in 2023 for **solar to reach up to 70GW by 2035** and **onshore wind** to reach required deployment levels for 2035 net zero grid.
12	**Hydrogen**	By the end of 2023, develop and implement an ambitious and pragmatic **'10 year' delivery roadmap for the scaling up of hydrogen production**. Government should deliver hydrogen business models as soon as legislation allows and confirm the long-term funding envelope available for hydrogen revenue support, to incentivise timely investment.
13	**Nuclear**	**Implement reforms set out in the British Energy Security Strategy to double down on achieving UK's nuclear baseload requirement**: a. Expedite the set-up of Great British Nuclear in early 2023, ensuring required funding and skills are in place; b. Government and GBN to set out clear roadmap in 2023 for reaching final investment decision in the next Parliament. Government to ensure funding is in place. As part of the roadmap, government should assess the possibility to increase the current ambitions supporting the development of supply chain to service a fleet of projects; c. Roadmap to set out clear pathways for different nuclear technologies (including small modular reactors) and the selection process. This should consider how to use programmatic approach to deliver further cost reductions in a competitive environment; d. Government to deliver on siting strategy by 2024.

#	Objective	Recommendation
14	**Empowering consumers**	Ofgem should **maintain focus on a timely implementation** of its market-wide half-hourly settlement.
15	**Transport**	Swift delivery of **ZEV mandate to apply from 2024** while maintaining regulations and funding to support EV/ZEV uptake and continuing to drive emission reductions from internal combustion engines.
16	**Food, agriculture and nature**	Publish a **Land Use framework** as soon as possible, and by mid-2023.
17	**Circular Economy**	Launch **a task force to work jointly with industry to identify barriers and enablers and develop sector-specific circular economy business models** for priority sectors. This should have representation from BEIS, Defra, DLUHC, HMT and DIT, and include the role of Extended Producer Responsibility in promoting reuse, repair, remanufacturing, and rental alongside recycling, in line with the powers under the Environment Act 2021.
18	**Oil and Gas**	Publish an **offshore industries integrated strategy** by the end of 2024 which should include roles and responsibilities for electrification of oil and gas infrastructure, how the planning and consenting regime will operate, a plan for how the system will be regulated, timetables and sequencing for the growth and construction of infrastructure, and a skills and supply chain plan for growth of the integrated industries.
19	**Oil and Gas**	**Accelerate the end to routine flaring** from 2030 to 2025.
20	**Local and regional**	Fully back at least **one Trailblazer Net Zero City, Local Authority and Community**, with the aim for these places to reach net zero by 2030.
21	**Local and regional**	**Reform the local planning system and the National Planning Policy Framework now.** Have a clearer vision on net zero with the intention to introduce a net zero test, give clarity on when local areas can exceed national standards, give guidance on LAEP, encourage greater use of spatial planning and the creation of Net Zero Neighbourhood plans, and set out a framework for community benefits.
22	**Individuals**	Publish a public engagement plan for England by 2023, to **ramp up public engagement on net zero.**
23	**International**	**Conduct a strategic review of the UK's international climate leadership** and ensure the 2030 Strategic Framework on Climate and Nature provides practical direction for the UK's international climate and nature leadership.
24	**Carbon Markets**	By 2024, work within the UK ETS Authority to **develop a pathway for the UK ETS until 2040**. This pathway should address: a. Set out a vision on the future design and operation of the ETS; b. Set out a timeline for expanding the coverage to the rest of the UK economy, as well as sectors consulted on including maritime and waste; c. Address inclusion of GGRs to incentivise early investment in new technologies and potentially nature-based solutions; d. Provide reassurance to businesses around how the Government will mitigate the risk of carbon leakage as a result of expanding the ETS.

#	Objective	Recommendation
25	**R&D**	By Autumn 2023, **create a roadmap which details decision points for developing and deploying R&D and technologies that are critical for enabling the net zero pathway to 2050**.

Net Zero Review: Part 1

Part 1: Net zero is the growth opportunity of the 21st century

The Net Zero Review has travelled to all four nations of the UK, received 1800+ responses to our call for evidence, and held more than 50 roundtables. From this extensive national conversation, seven clear conclusions have emerged.

1. **Net zero is creating a new era of change and opportunity**
2. **The UK must act decisively to seize the economic opportunities and smooth the transition**
3. **The benefits of investing in net zero today outweigh the costs**
4. **Unlocking the ambition of places and communities will deliver the most successful version of net zero**
5. **Net zero can materially improve people's lives – now and in 2050 – but work is needed to secure the benefits and minimise costs**
6. **Net zero by 2050 remains the right target for the UK: it is backed by the science, widely followed, and is creating real opportunity**
7. **Significant additional government action is required to ensure that the UK achieves net zero in the best way possible for the economy and the public**

Conclusion 1: Net zero is creating a new era of change and opportunity

1. **In 2019, the United Kingdom led the world's major economies in setting a target of net zero emissions by 2050.** This single goal contained ambitious transformations for how we generate power, use our land, manufacture our goods, travel, and heat our homes. Net zero also implied a commitment to embracing the opportunities of a new technological era. It did all this, while doing our duty in the face of the great global challenge of our age: the extreme threats to the planet and humanity from greenhouse gas emissions (see 'The direct risks of climate change to the UK').

2. **Progress since 2019 has exceeded expectations.** In setting the net zero target, the UK was building on the progress of many years – not least a quiet transformation of our power system, from one dominated by coal to one increasingly driven by a clean and endless supply of wind blowing across the North Sea. Even still, the changes we have seen since setting net zero, both in the United Kingdom and globally, go far beyond what might have been expected in 2019. Today 91% of the global economy is committed to net zero.[11] Renewable energy costs are dropping sharply (see Figure 1). UK offshore wind prices fell by 70% since 2014,[i] [12] with offshore,

[i] With the offshore wind Contracts for Difference 4 2022 strike price of 37.35 £/MWh and 2014 CfD 1 strike price of £115-120/MWh.

onshore, and solar dropping below the cost of fossil fuels, promising a society in the very near future where the sun and wind meet most of our energy needs.[ii] [13] Society is responding too. When asked about a range of issues, climate change was the second biggest concern facing adults in Great Britain (74%), with the rising cost of living being the main concern (79%).[14]

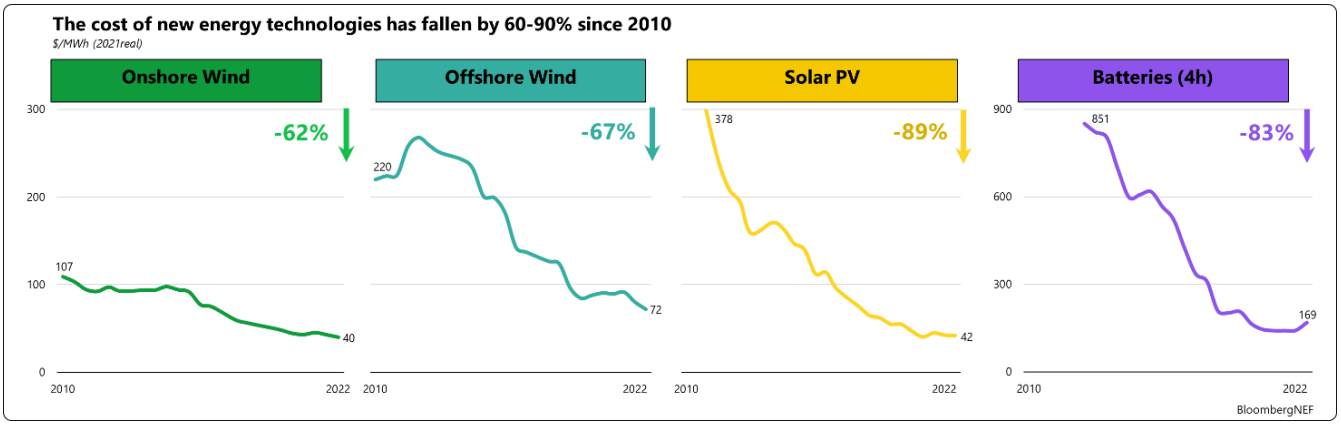


Figure 1 – *The global cost of onshore wind, offshore wind, solar, and batteries 2010-2022 (Source: BNEF)*

3. **Net zero is the economic opportunity of the 21st century.** The evidence presented to the review has shown that the pace of recent change has created a global rush of economic opportunity perhaps never seen before. From the $370 billion support for clean energy agreed by the United States Senate, to the European Green Deal's €600 billion green investment – the world is responding to this opportunity. A central question for this Review is how the UK can best position itself in this global marketplace. The opportunity on offer is huge. The global market opportunity for UK businesses from net zero could be worth more than £1 trillion in the period 2021 to 2030.[15] If we seize it, we can usher in a new generation of UK businesses, providing high-skilled jobs for our generation and our children. Failure to compete globally risks missing this opportunity, seeing UK industries move away and other countries capturing the economic gains.

4. **The UK is in a race to capture the economic benefits of net zero.** Other major economies are acting to encourage investment and develop new technology and industries. Most notably, through the 2022 Inflation Reduction Act the USA has committed more than $370 billion to clean energy. Without fast and decisive action, this will see the UK losing opportunities to other countries and failing to position itself as a global partner for trade and collaboration around net zero. The costs of failing to act now are high.

5. **Net zero can make household energy bills less exposed to volatile and high fossil fuel prices.** The high cost of energy must be at the forefront of decision-making on net zero. The illegal invasion of Ukraine has dramatically changed the short-term landscape, creating new pressure on household bills, and increasing many countries' ambitions to secure their own national energy supply, including the UK's. There have been some suggestions that the path to net zero increased household energy costs or the UK's vulnerability to the kind of dramatic shock seen in Ukraine. The evidence does not support either assertion.

6. **Energy costs in a decarbonised UK power system are expected to be lower. Recent analysis shows this is already happening in the EU.** In 2022, with wind and solar reducing wholesale prices substantially and increased the share of renewables to consistently around 40% of total generation,[16] the average wholesale electricity price was about 15% below the

[ii] On Wednesday 2nd November 2022, over 70% of the GB electricity grid was powered by low carbon sources, with wind alone providing more than half of Britain's power.

average of the first half of the year.[17] New analysis from the Review also shows clearly that household-level decarbonisation measures in the UK can reduce average bills further. In some instances, policy decisions to slow down some green technologies (e.g. solar or energy efficiency) or delivery failures may have meant opportunities to make bills cheaper have been missed.[18] Crucially, decreasing the energy system's dependence on fossil fuels will also free the UK from feeling the effects of their price volatility. This should help households as well as economic growth by bringing more certainty to individual and business financial planning and investment decisions.

7. **Despite the opportunities, real challenges remain.** Some of these challenges lie in delivering on UK ambition. The Review has seen persuasive evidence of the UK not matching world-leading ambition with world-leading delivery, with economic opportunities being lost due to a lack of consistent long-term policy or investment. The UK must also be alive to the risks of net zero reducing some sectors' global competitiveness in the short-term, even as it seizes the many opportunities for global leadership in others. Finally, for all the persuasive evidence that net zero will be a net benefit to UK households, bring cheaper bills, new jobs and cleaner air, there are genuine issues around affordability, accessibility and fairness that require a strong response.

8. **The danger that climate change poses cannot be ignored.** The Review was tasked with assessing how to deliver net zero in a pro-growth manner. The evidence of the scale of the opportunity is striking. However, this assessment must be made in the context of the global response to climate change – probably the largest single threat to humanity. We know that the world is still not moving fast enough to decarbonise. Accounting for the implementation of Nationally Determined Contributions (NDCs) up until 2030, the best estimate of peak temperature by the end of the century is in the range of 2.1°C to 2.9°C[19] – bringing with it terrible threats to our species. For the UK the challenge lies in delivering on the ambitious targets it has set, and in continuing to show leadership on the world stage.

9. **Decarbonising can be good for households and the economy.** This Review brought together perhaps the largest collection of evidence and perspectives on net zero ever presented to the Government. We received over 1800 submissions to the Review's call for evidence from the public, business, charities, and academics. The Chair, Chris Skidmore MP, has led more than 50 roundtables, talking to over one thousand people. This included travelling to all four nations of the UK to hear how the challenges and opportunities of the transition differ across the country. This report draws extensively on this evidence, seeking to provide an accurate and balanced summary of the views expressed. Its conclusions are strengthened by new analysis completed for the Review, including new modelling of the impact of today's higher fossil fuel prices on how the UK reaches net zero and distributional analysis modelling of the impact of net zero policies on UK households. The evidence has led the Review to make recommendations, covering the economy, the power system, research, and the needs of individuals and communities. But most importantly, the evidence has pointed to one overwhelming conclusion:

10. **An unstoppable and essential drive to decarbonise is re-shaping the global economy, bringing a new era of opportunity. The UK has a golden chance to grasp this opportunity – but it requires serious and renewed commitment, more than justified by the prize on offer and the cost of missing out.**

Conclusion 2: The UK must act decisively to seize the economic opportunities and smooth the transition

11. **Net zero will drive widespread changes to the global economy.** Almost every sector will be affected, whether directly or because of wider changes around them. In many cases this will create new economic activity – in some it will lead to sectors declining or stopping altogether. We can expect changes to:

    - How we **heat our homes and buildings** – and the attention paid to making them more energy efficient, e.g. through better insulation. This will involve retrofitting the current stock and changing how we construct new buildings.
    - How we **generate electricity**, with a massive increase in the use of renewable energy technologies like wind and solar – as well as upgrades to our grid and a much greater emphasis on storing energy using batteries and other technology.
    - How we **travel** – with the growing popularity of clean versions of the vehicles we currently use (e.g. electric vehicles, electric trains), alongside new lower carbon fuels for planes. In many countries, we can expect people to be encouraged to cycle and walk more.
    - How we **produce food** – improving the sustainability of farming practices and helping to sequester carbon by improving the soil management and biodiversity of farmland. In some countries, including the UK, we are seeing a decline in demand for some of the foods that need the most carbon to produce – such as red meat[20] – and there is potential for lab-grown alternatives.
    - How we **use land** – with many countries, including the UK, setting huge targets for tree planting, halting and reversing deforestation, and other ways to use the natural environment to absorb carbon dioxide. This will include key commodities moving towards sustainable and deforestation-free supply chains.
    - **Consumer behaviours** – growing public desire to help reduce emissions, including in the UK, means new demand for products that are seen as green. At the same time, we can expect businesses to feel more pressure from their customers, boards, and shareholders to reduce their own emissions.
    - New **manufacturing and materials** – the new technologies (e.g. wind turbines or batteries) will need to be built, often requiring highly-technical skilled workforces. The raw materials for these are often different to those needed for current mainstream technologies – creating new demand for mining and processing. We can also expect greater interest in reusing and recycling as part of a drive towards an economy that wastes less.
    - New **services** – we can expect new demand for expertise in using and manufacturing these technologies, in environmental law, in green financial reporting, in sustainable investment, and elsewhere.
    - New **skills and education** – these new activities will require workers to learn new skills, changing the focus of both technical and academic education.
    - **And many changes we cannot predict today**. Any predictions for 2050 will inevitably miss the emergence of major new technologies, economic activity, and social changes. Either as the primary driver or as a secondary influence, we can be certain that growing activity to decarbonise and the impacts of climate change will lead to widespread and unexpected changes to the economy.

12. **The opportunities these changes will bring are global and vast.** The global market opportunity for UK businesses from net zero could be worth more than £1 trillion (in total cumulative revenue) in the period 2021 to 2030.[21] By 2030 global exports for low-carbon goods and services could be worth £1.0 trillion–£1.8 trillion a year, seven to twelve times more than today.[22] Global spending on electric vehicles (EVs) and charging infrastructure surged by 77% to $273 billion in 2021.[23] Some estimates suggest net zero could generate an additional £330 billion in extra economic activity every year by 2030.[24] For the UK, government estimates that the net zero transition could generate up to £100 billion of private investment and support up to 480,000 jobs by 2030.[25] Ecuity analysis estimates that renewable and low-carbon technologies could support 1.38 million jobs by 2050, with around 600,000 of these materialising in this decade thanks to home retrofits and energy efficiency installations in buildings.[26]

13. **In the UK this could include new export opportunities.** Updated analysis[27] by the Department for Business, Energy & Industrial Strategy (BEIS) estimates that just over half of the £60 billion gross value added (GVA) potential from sectoral decarbonisation in 2050 comes from export related opportunities.[28] Realising the economic potential of net zero rests on capturing export opportunities as well as export demand ensuing from the net zero transition. Energy Innovation Needs Assessments research (2019) identified that, for example, growth in the UK road transport sector is expected to be supported mainly by export opportunities, whereas growth in the construction sector is primarily driven by domestic demand.[29]

14. **There is also evidence that net zero can make the UK economy more productive.** The UK has a structural issue of low productivity. ONS analysis suggests that Germany is around 10% more productive than the UK, with France and the US 18% and 23% more productive respectively.[30] Two thirds of UK workers are employed in businesses with below-average productivity, suggesting that economy-wide policies are needed to tackle the UK's productivity challenge. Research from the Green Alliance and Nesta suggests that the majority of changes the UK is expected to see as a result of moving towards net zero have the potential to be positive for productivity.[31]

15. **Business recognises these opportunities – and the UK economy is already taking advantage.** There are already an estimated 430,000 jobs in low carbon businesses and their supply chains across the country with turnover estimated at £41.2 billion in 2020.[32] [33] UK companies exported £12.7 billion of environmental goods and services in 2019.[34] This is the tip of the iceberg, compared to the size of the global market opportunity for UK businesses described above. The Government's planned pathway to net zero carbon emissions by 2050 could support nearly 700,000 direct jobs in 2030,[35] approximately 780,000 direct jobs (and an additional 905,000 in the supply chain) in 2035,[36] and 1.18 million direct jobs in 2050.[37] This compares to 208,000 direct jobs (and an additional 222,000 in the supply chain) in low carbon businesses currently (2020 data).[38] It is worth noting that jobs estimates from different studies vary because of different definitions of the green economy and different analytical assumptions.

16. The Review has heard from hundreds of businesses that see these opportunities and what they can mean for the people living in the UK:

> "*The interests of the business community will be best served by a managed transition marked by effective government leadership on, and commitment to, net zero. Business is on board with the necessity of the transition and is looking for guidance and leadership from government as to how to achieve it efficiently and effectively*" – Institute of Directors (IoD)[39]

"This is not just a moral consideration from investors who see value in positive ESG [environmental, social, and governance] ratings, but there is a recognition of the financial risks of investments that are not climate or transition resilient. The return on investment in the green economy is also markedly strong – recent research by Imperial College London and the IEA found that investments in green energy generated returns of 75.4% compared to just 8.8% for fossil fuels"[40] – Confederation of British Industry (CBI)[41]

17. **There is now huge global momentum – driven by industry as well as coordinated global action– to reach net zero and capture the economic opportunities. The UK and international business see these opportunities and are responding.** Half of the world's leading institutions and 40% of companies have made net zero pledges.[42] Over 4,400 UK companies and financial organisations have signed the *Race to Zero* pledge – a 'UN-backed global campaign rallying companies, cities, regions, financial and educational institutions to take rigorous and immediate action to halve global emissions by 2030 and deliver a healthier, fairer zero carbon world'.[43] In many cases companies are outstripping the ambition being shown by the Government, pushing for decarbonisation targets well before 2050.

18. **Their money is following these commitments**. In 2021, global investment in the low-carbon energy transition totalled $755 billion, up from $595 billion in 2020 (a 27% increase) and just $264 billion in 2011.[44] Global climate-tech equity investment in 2021 equalled $165 billion.[45] In the same year, an estimated £24 billion of new investment was committed to UK low carbon sectors.[46] The UK's Global Investment Summit (2021) secured £9.7 billion foreign investment for UK offshore wind, hydrogen, and electric vehicles.[47] Since then, Australian businesses alone have committed to investing £28.5 billion into clean energy, technology, and infrastructure projects in the UK. Global employment in renewable energy reached 12.7 million jobs in 2021 (more than in fossil fuels).[48] This was a rise of 700,000 new jobs in one year, demonstrating resiliency despite multiple challenges.

19. In 2021 alone, an estimated £24 billion of new investment was committed in the UK across low carbon sectors.[49] This includes:

- **Octopus Renewables** and Renewable Energy Systems (RES) have announced £3 billion in investment into green hydrogen plants by 2030;[50]
- **Bentley** committed to producing its first electric car at its UK plant in Crewe and will invest up to £2.5 billion in electrification and sustainability over the next decade;[51]
- **Kingfisher** (owner of Screwfix and B&Q) has invested £19.6 million in energy efficiency projects including LED lighting installations, building energy management systems and insulation and heating improvements. Solar PV has also been installed at 29 stores, offices, and distribution centres, while biomass boilers are supplying two distribution centres and one head office building. Total investments into renewables have helped generate 9.5 million kWh per year and delivered more than £1.3 million in financial benefit per year;[52]
- **Aviva**, who were the first major insurer in the world to aim to achieve net zero carbon by 2040, committed to invest £2.5 billion in low carbon and renewable energy infrastructure. Aviva also plan to power all their offices with 100% renewable electricity.[53]

20. **Other countries have made bold and ambitious interventions in response to these opportunities – the UK must respond.** The USA's Inflation Reduction Act (IRA) committed around $370 billion in incentives and programmes to accelerate action on climate and energy.[54] Germany have proposed a €177 billion Climate and Transformation Fund from the 2023-2026 federal budget to retrofit buildings and support programmes for industry.[55] France has

committed €30 billion committed, as part of the 'France 2030' investment plan, to speed up the ecological transition.[56] Other parts of the world are recognising that the market has shifted and are explicitly acting in response. Launching new tax credits for hydrogen, the Canadian government specifically justified the move by saying: "Without new measures to keep pace with the Inflation Reduction Act, Canada risks being left behind."[57]

21. The UK's offer needs to respond to global change – otherwise we risk losing out on new opportunities and seeing current economic activity move away. The UK has invested too – for example the 2020 *Ten Point Plan* mobilised £26 billion of government capital investment for the green industrial revolution.[58] But two clear conclusions emerge from the Review's evidence:

- First, that the recent investment by other countries has massively stimulated the global market. The Boston Consulting Group describe the Inflation Reduction Act as follows:

  "Legislation of this magnitude and duration lasting through the 2030s and beyond is likely to have profound and lasting impacts across US and global climate and energy systems, supply chains, industries, and trade. US legislation on climate and energy also has the potential to trigger policy actions from other nations, both large energy producers that compete across these value chains, and large energy consumers."[59]

- Second, that early signs suggest that it is shifting investment towards the USA and away from other countries, including the UK[60] – albeit the legality of the measures may now be subject to challenge.[61]

22. **The UK has strengths to respond to these opportunities**. The Economy 2030 inquiry, jointly led by LSE and the Resolution Foundation, assessed the UK's pre-existing relative strengths against the changes to the economy we can expect net zero to drive.[62] It found a range of UK strengths including: tidal, offshore wind and nuclear energy and carbon capture technologies, and a strong science base and universities.

23. **However, these are not universal – and they require specialisation.** The Economy 2030 inquiry found: '[The] UK is not the world leader overall in clean technologies or traded goods. It certainly does worse than Germany, which has stronger advantages in many areas of manufacturing, has more existing green strengths, and more proximate future opportunities, particularly in more complex goods. But the UK is among the top countries in terms of its specialisation in clean technologies and products, and there are specific areas of strength that can be built upon as part of a new economic strategy for the UK'.[63]

24. **Industry has told the Review very clearly what is required to grasp the economic opportunities ahead.** The Review describes in detail the major issues raised by industry and a wide range of other stakeholders, which overwhelmingly focused on greater policy certainty and interventions on skills and the wider labour market. The evidence is clear that industry wants to act to deliver net zero – the Review's recommendations set out how government can best support this.

Conclusion 3: The benefits of investing in net zero today outweigh the costs

25. **Net zero needs significant investment.** The Climate Change Committee (CCC) estimated that an additional £13.5 billion of investment will be needed in 2022, rising to £50-60 billion per year by the early 2030s to meet the UK's net zero goals.[64] Around 85% of decarbonisation between 2020 and 2035 will involve low carbon technologies or fuels alone or in combination with behaviour change.[65] This investment will primarily come from the private sector – and it is clear that significant capital is available globally. The private sector is ready to pay for net zero and expects high and secure returns on investment. Government investment has a crucial role to play in funding R&D, major infrastructure, and incentivising investment in early-stage technologies that will be critical for the transition.

26. **Evidence suggests the benefits of net zero outweigh the costs.** The CCC's comprehensive Carbon Budget 6 analysis has found that the direct costs of decarbonisation throughout the next 30 years will be less than 1% of UK GDP – and could potentially be lower than persisting with the status quo technologies, in the case that high global gas prices persist. In other analysis, work by Cambridge Econometrics for the CCC estimates that the UK would see approximately 2% additional growth in GDP when also considering the indirect economic effects of the transition, through the benefits from new jobs, increased economic activity, reduced fossil fuel imports and cost savings (e.g. cheaper household bills).[66] These estimates do not reflect the potential increased risk and disruption of a course of inaction, which would be counter to the prevailing expectations of business and global trends described above.

27. **The wider societal benefits will be higher still.** The full story implies a much greater benefit. The CCC analysis does not quantify a number of critical factors which are difficult to model effectively or depend on how net zero is delivered rather than whether it happens at all. These include: minimising the costs of not acting on climate change (e.g. flood damage) and the benefits of cleaner air to people's health and productivity. Analysis from the Swiss Re Institute estimates that significant economic damage will occur, even with the fulfilment of pledges and targets on climate change. Relative to a world without climate change they estimate global GDP damages of 11% GDP if emissions rise in line with current policies.[67]

28. The rest of this chapter set out the broader economic opportunities, including from the growing global market for low-carbon goods and services and potential productivity gains.

29. The short-term benefits of government investing in net zero will primarily sit in making homes warmer, with people suffering less from the cold and benefitting from reduced energy bills as a result. New analysis from the Review also shows clearly that household-level decarbonisation measures in the UK can reduce average bills. With the Government liable to support energy companies' revenues as part of the Energy Price Guarantee, the savings to the exchequer from greater energy efficiency investment have never been higher.

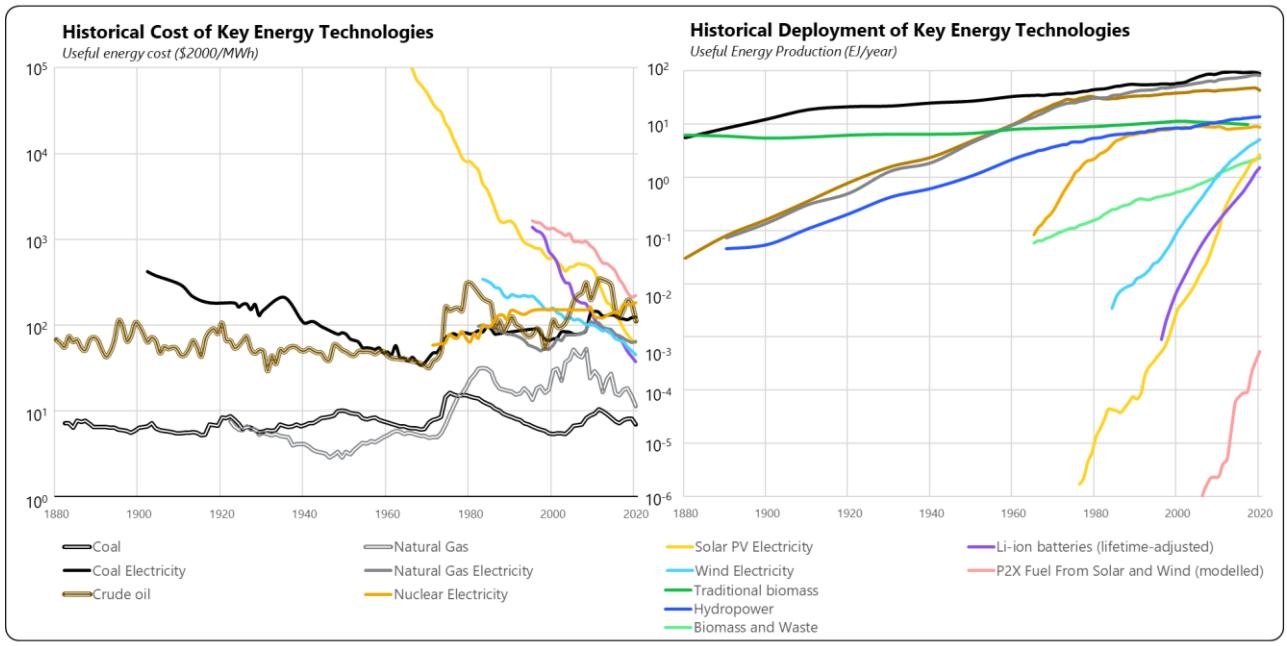


Figure 2 – ***Historical cost (left) and deployment (right) of key energy technologies (Source: Way et al., 2022, 'Empirically grounded technology forecasts and the energy transition')***

30. **Investing now is cheaper than delaying.** Office for Budget Responsibility (OBR) analysis suggests in their delayed action scenario that public sector debt could be 23% higher than in their early action scenario by 2050, thus doubling the fiscal impact of achieving net zero.[68] Oxford research has shown that a 'fast transition' to net zero based on scaling up key green technologies will continue to drive their costs down, **and transitioning to a decarbonised energy system based on green technologies by 2050 can save the world at least $12 trillion, compared to continuing our current levels of fossil fuel use**.[69] Recent evidence shows how technology costs can decrease as a result of significant investment. These trends have been observed most sharply for solar, biopower, wind, and batteries – which is good news for the net zero transition – see Figure 2.

Conclusion 4: Unlocking the ambition of places and communities will deliver the most successful version of net zero

31. **Local action is key to delivering net zero in the cheapest and most effective way possible.** Taking a more locally led, place-based approach can deliver a net zero transition with more local support, better tailoring to local needs, and bring economic and social benefits. Research coordinated by UKRI suggested that adopting a place-specific approach could save £137 billion of investment and return an additional £431 billion of financial and social benefits.[70] This is because each community will have a different path to net zero, which local leaders are best placed to understand and shape. But there are also many commonalities on these paths that places can take advantage of to increase economies of scale, build regional supply chains and skills expertise, and attract green investment.

32. **There is huge ambition in local government and in all four nations of the UK.** For example, more than 300 local authorities have set their own net zero target and/or declared a climate emergency. Many of these targets are ahead of the UK's 2050 date, such as Greater

Manchester by 2038, West Midlands by 2041, and Scotland by 2045. Crucially, places are not just setting ambition, but acting as well, demonstrating in practice how growth and net zero can go hand-in-hand for communities across the country. The Review heard first hand from the leaders of local and devolved governments about their net zero ambitions and what drives them.

> *"For both Manchester and Greater Manchester, reaching a net zero target (we both have set a science-based net zero target of 2038) is essential for both protecting the existing local economy and transitioning to a new, dynamic green economy driving local economic growth."* – Manchester City Council and the Manchester Climate Change Agency[71]

33. **The economic opportunities of net zero across the country are clear.** In the past year, we have also seen major (multi-annual) investment commitments announced:

- **Zero emission vehicles (ZEVs):** Drawing billions of pounds of investment, and will support thousands of high-quality jobs across the UK, e.g. in North East England (Nissan, £1 billion investment and 6,000 jobs[72]);
- **Offshore wind:** Pipeline of fixed-bottom wind farm projects mainly off the East coasts of England and Scotland, with scope for development of floating windfarms in the Celtic Sea and Scotland;
- **CCUS & Hydrogen:** Proposals from industry cover the length and breadth of the Union, including in the Humber, Teesside, the North West, the South East, Wales, Northern Ireland and Scotland;
- **Clean heat:** Benefits from investment and deployment of clean heat technologies – such as manufacturing and installer jobs or product cost reductions – will be UK-wide. Current and potential UK heat pump manufacturing facilities are predominantly outside the South East.

34. **Every part of the country has different decarbonisation needs and opportunities.** The Review has considered what can be done at a national level to help local areas respond to their particular requirements. This also includes supporting places that currently rely on high-carbon industries to adapt or decarbonise – and maximising the work of countless community and neighbourhood schemes all over the country in support of reaching net zero.

Conclusion 5: Net zero can materially improve people's lives – now and in 2050 – but work is needed to secure the benefits and minimise costs

35. **We all have an important role to play in the transition to net zero.** Almost half of the policies in the Government's *Net Zero Strategy* rely on personal action. In many cases, people are already making these decisions. Survey data suggests that 45% of the UK population are already taking personal action to reduce their carbon emissions. 11% plan to within the next six months, and a further 11% plan to in more than six months' time.[73]

36. **Net zero can materially improve people's lives.** The evidence submitted to the Review has shown clear opportunities in:

- **Cheaper bills and warmer homes.** The UK's ambitious drive to create clean energy, for example through offshore wind, will mean that the average consumer bill in 2024 will be cheaper than it would have been otherwise.[74] In any pathway to net zero, our homes will also need to become more energy efficient. British homes are currently the least well-insulated in

Western Europe losing three degrees on average every five hours.[75] A successful programme to improve the energy efficiency of new and existing homes will mean they retain heat more effectively, stay warmer for longer, and therefore reduce the need to have the heating on.

- **Jobs.** As described above, net zero provides a significant opportunity in terms of new and well-paid jobs. These will be available in many different parts of the country, offering long-term opportunity for many in some of the places that most need it. For example, the North East will likely benefit from the transition to net zero through 27,000 additional jobs by 2050.[76]
- **Access to nature.** Planting trees is projected to contribute around 20%[77] to reducing UK emissions – with the Government's current target to plant an area larger than Birmingham each year.[78] This ambition is dovetailing with growing ambition from local areas and land managers to improve biodiversity on their land and restore depleted habitats. If we can also make more new green spaces accessible to the public and tourists, it could have a material impact on people's lives. We know, for example, that immersion in nature benefits people's health.[79]
- **Cleaner air.** Air pollution contributes to the deaths of between 28,000 and 36,000 people in the UK every year. The costs to health and social care from poor air quality could reach £5.3 billion by 2035.[80] In 2020 cars and taxis contributed 58% of domestic transport carbon monoxide emissions and 32% of nitrogen oxide emissions worsening UK air quality.[81] Overall life-cycle emissions from EV with a decarbonised power system could be 70-90% lower than those of Internal Combustion Engine (ICE) cars.[82] By 2035, Society of Motor Manufacturers and Traders (SMMT) analysis suggests that the BEV share of the total fleet will be 47% in their central scenario and 57% in their high scenario.[83] This will make a material difference to keeping people healthier for longer.
- **Sustainable and cleaner travel.** Electric vehicles, alongside increasing use of public transport, cycling, and walking also have benefits beyond air quality. They can reduce noise and congestion and provide more reliable and affordable services. Cycling and walking can deliver significant improvements in public health and wellbeing. Physical inactivity costs the NHS up to £1 billion a year, with further indirect costs of £8.2 billion per year, which active travel can reduce.[84]

37. **The benefits to net zero are not all guaranteed – and depend on decisions taken by the Government today.** This Review has directly considered the risks that UK households might face from the transition to net zero. These include:

- **Cost.** 17% of adults have no savings at all and one in ten have £100 or less in the UK.[85] For many, there are real challenges to affording an electric vehicle or insulation for their homes – regardless of their personal support for net zero or the fact that it may save them money in the long-term. The Government has recognised this risk, but more action is needed to help people afford the changes they will need to make.
- **Access to new jobs.** How many and what kind of jobs are created from the transition to net zero will depend on decisions taken by the Government and industry. Without an attractive investment environment, coupled with support for people to train and re-train, some of the opportunities will be lost.
- **Access to information.** The public overwhelmingly support net zero[86] – but the evidence shows people do not always know the right ways to reduce their emissions and capture the other benefits, such as warmer homes. More can be done to provide people with key information, so that those who want to act can do so in the best way for them.

38. **The Government must not shy away from the barriers to net zero – but instead engage the public in an open discussion that explains the benefits, trade-offs, and challenges.** ***Pillar 5*** considers these issues in detail.

Conclusion 6: Net zero by 2050 remains the right target for the UK – it is backed by the science, widely followed, and is creating real opportunity

39. **Net zero by 2050 is not an arbitrary target**. It was put forward through the 2015 Paris Agreement, which 193 parties including the UK, endorsed. The Government's independent climate advisors, in recommending net zero by 2050, described the target as:

> *"achievable with known technologies, alongside improvements in people's lives, and within the expected economic cost that Parliament accepted when it legislated the existing 2050 target for an 80% reduction from 1990."*[87]

40. **The target of limiting global warming to 1.5℃ is not arbitrary.** It was determined by a combined assessment of the physical climate impacts of different levels of warming, the economic and technical feasibility of different rates of emission reduction, and political choices on the balance between benefits and costs. Higher levels of global warming will lead to progressively greater risks of adverse impacts across multiple sectors. With increasing global warming, losses and damages will increase and additional human and natural systems will likely reach adaptation limits. While the Earth's climate will still experience year-to-year variability, limiting warming to 1.5°C will reduce the frequency and intensity of weather events such as heatwaves, heavy rainfall and droughts compared to higher levels of global warming. While there are some economic and technically feasible pathways that can still limit warming to below 1.5°C, limiting warming to much lower levels is likely to exceed the current bounds of economic and technical feasibility.

41. **The Government's *Net Zero Strategy* sought to establish what was needed to decarbonise our economy over the next 30 years and keep us on the path to net zero.** The Review has had access to the underlying modelling that informs the Government's approach to net zero.[iii] The *Net Zero Strategy* technological mix was based on cost-minimisation, going with the grain of consumer choice, and avoiding wasteful scrappage. In particular, it focuses on the intensive activity needed in the next decade – this ranges from early-stage research to deployment of mature technologies to better understanding of different clean power sources. However, it did not account for changes in circumstances, namely the Russian invasion of Ukraine, leading to high energy bills, contributing to inflation and the cost-of-living crisis.

42. **The Strategy's approach remains broadly the best way to maximise delivery confidence and minimise cost – even as the context has changed.** Updated modelling, using UK TIMES, commissioned by the Review team based on higher fossil fuel prices shows that while gains from decarbonisation are even higher now, the cost-optimising pathway does not see

[iii] The overall 2050 energy mix and emissions from different areas of economic and social life were determined with the use of a cost-minimising model, UK TIMES. This model, used also by UCL, solves for the least-cost way to provide the needed energy requirements to processes in all sectors of the economy, subject to pre-determined emissions targets. Bottom-up modelling supplemented this analysis, focusing on the intensive activity needed between now and 2037.

significant acceleration of change.[iv] This is because the speed of how quickly we can roll out the main decarbonisation technologies is constrained by the current realities of supply chains and production, rather than costs.[v] This, together with uncertainty over future fossil fuel prices, means that it would not be credible to re-set the pathway to a substantially faster one – but where government can help to speed up the roll out of low-carbon solutions, this will likely lead to increased benefits to people and businesses. This analysis is also in line with recent CCC modelling using a more bottom-up approach.

43. **Recent changes have not significantly affected the mixture of technologies required for reaching net zero.** The updated analysis conducted for the Review shows that the cost-minimising technological mix for net zero in 2050 scenarios is similar to what the Government expected in late 2021 (see Figure 4 below, visually very close to the equivalent scenario shown in the *Net Zero Strategy*). In the extreme scenario modelled, the new results see more energy being delivered through power and less by hydrogen[vi] and an increase in the proportion of green hydrogen vs. blue.[vii] Given long-term uncertainty and the use of an extreme scenario in this modelling, these variations do not suggest a need to alter current targets or policy – but remind us that modelling should be done at regular intervals to check the optimal system design at more recent fossil fuel prices.

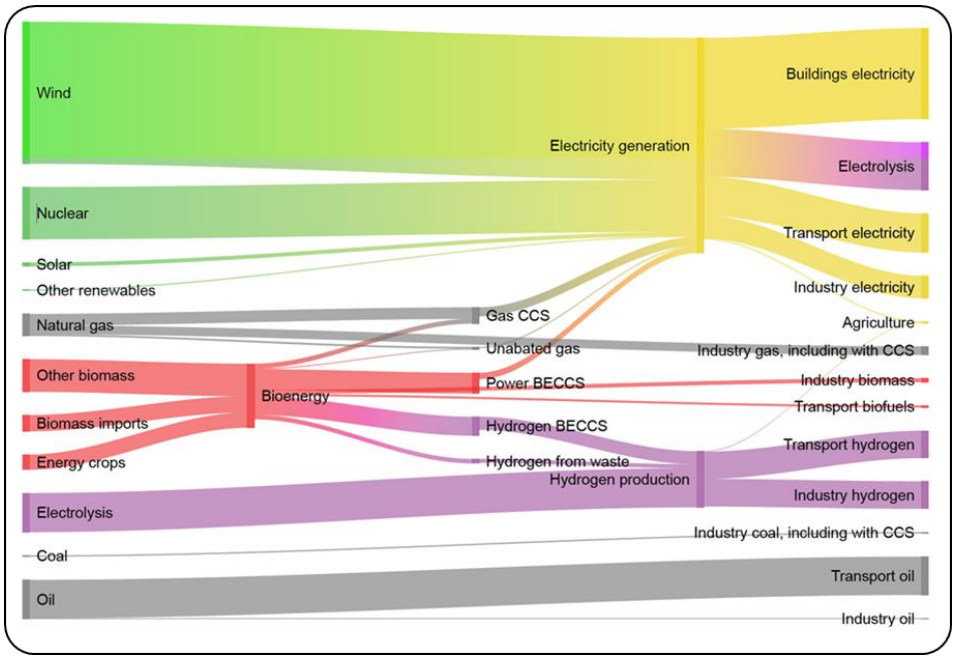


Figure 4 – *Net Zero Strategy 2050 High Electrification Technology Mix (2022 Fossil Fuel Price Projections) (Source: UK Times Analysis by BEIS)*

[iv] When modelling a very high stress-case scenario for future fossil fuel prices, the model deploys EVs and heat pumps ~10% faster by 2030, and accelerates the deployment of electricity, while slightly holding off on hydrogen. The higher ambition on electrification is in line with already-existing policy direction given that the 2022 British Energy Security Strategy accelerated offshore wind and nuclear deployment.

[v] Bottom-up modelling at the time of the NZS publication was roughly in line with UK TIMES deployment rates, so even though it was not possible to re-run sector-level analysis within the timescales of the Review, we can use UK TIMES modelling as the basis for the above conclusion on the validity of the pathway.

[vi] Though no change in predicted hydrogen use is observed in 2030, meaning that the government's current target remains valid even if fossil fuel prices persist to be as high as projected by a 'stress' case scenario.

[vii] Since UK's hydrogen policy mechanism is technology agnostic, the result on green hydrogen does not point to a need to change policy direction, though it should send an important signal to industry and investors regarding the importance of electrolysers and related technology.

44. **However, we predict that the costs of the transition will be comparatively lower if fossil fuel prices remain high.** Even though the technology mix required for net zero by 2050 does not change, the costs do, showing lower costs of decarbonisation in the case that high fossil fuel prices persist. This makes the case for net zero even stronger and means that, while it would not be credible to re-set the pathway to a substantially faster one, government helping to speed up the roll out of low-carbon solutions will likely lead to increased benefits to people and businesses.

45. **There is some scope to go further and faster in specific areas**. The pathway to net zero has already been made more ambitious. The 2022 *British Energy Security Strategy* accelerated the deployment of some of UK's leading clean electricity supply technologies. UK's investment in offshore wind provides an example of an intervention which resulted in progress beyond the boldest projections. Well-targeted interventions have the potential of accelerating some parts of the transition, while decreasing the delivery uncertainty of the whole project. They can also reduce costs. The Review does not recommend reopening the planned pathway to net zero, however its recommendations are intended to clear the way and turbocharge the UK's progress in key areas, particularly those with a major opportunity to drive growth or bring down costs.

Conclusion 7: Significant additional government action is required to ensure that the UK achieves net zero in the best way possible for the economy and the public

46. **The UK should be proud of the steps it has taken to achieve net zero.** Setting the target in 2019 was a genuine moment of global leadership, continued by our COP presidency. The *Net Zero Strategy* was recognised by the UK's climate advisors as "an ambitious and comprehensive strategy that marks a significant step forward for UK climate policy".[88] These statements of ambition have helped to deliver the continuing reduction in UK carbon emissions coupled with significant inward investment and new jobs.

47. **However, the need for further action is clear.** For all the UK's successes and clear ambition shown by government, it is not on track to deliver on all of its commitments according to the latest progress report by the CCC, which shows risks across most sectors – but particularly agriculture, aviation, waste, and buildings decarbonisation.

48. **Climate and economic risks cannot be separated.** While this Review has a clear focus on ways to achieve growth and reduce the costs of net zero, it is impossible to consider this in isolation from the physical risks that climate change presents. In a high emission future, the level of global disruption will be so severe that 'normal' economic activity seems very challenging, e.g. agricultural yield growth could fall by 30% (at a time when almost 50% more food production will be needed to meet global demand) and the number of people lacking sufficient water could increase to five billion.[89] At the same time, the physical changes that we already know are certain mean that the UK will need to adapt in any scenario to some form of change. This will materially affect some of the activities that this review considers in detail, for example how and where homes and energy infrastructure are built.

49. **Similarly, we must invest in nature restoration and protection as part of our plans for climate recovery and economic growth.** Our economies are embedded within nature,[90] and sustained economic growth requires the recovery of nature. A report by the World Economic Forum and PwC found that "$44 trillion of economic value generation – over half the world's

total GDP – is moderately or highly dependent on nature."[91] In particular, the Review sets out a clear call to action to drive progress on nature restoration and nature-based solutions to deliver net zero. When well-implemented in the right places, investment in nature can help us mitigate and adapt to climate change, support the recovery of the natural environment, and provide multiple other benefits to people. These include:

- Mitigating the impacts of extreme weather events and reducing future risks to our food security by minimising crop yield losses;
- Urban green spaces cooling our cities, reducing our energy demand, and preventing productivity losses in summer; and
- Coastal wetlands and saltmarshes protecting communities from storms and flooding.

50. **In the context of great economic opportunity and growing risks from climate change, the review makes 129 recommendations to Government.** These cover the full range of government levers, including regulation, tax and spend. Some are for immediate action, and others should form part of a longer-term strategy. All would, according to the evidence we have seen, materially improve the UK's approach to net zero – by reducing delivery risks, making things cheaper, or helping to drive growth. The recommendations fall into six pillars:

    1. **Securing net zero**: A framework for a sustainable industrial strategy to deliver growth and jobs during the transition.
    2. **Powering net zero**: The gear shift we need in delivery to achieve our targets and recommends specific actions to unblock the pipeline, including a re-think of our energy infrastructure. It proposes a solar revolution and onshore wind revolution.
    3. **Net zero and the economy**: Going further to capture the economic opportunities across sectors, for businesses of all sizes.
    4. **Net zero and the community**: How we unlock local action by reforming the relationship between local and central government, making sure the planning system supports net zero and turbocharging community energy and action.
    5. **Net zero and the individual**: The role of individuals in the transition, how they can be supported to make green choices, and how government can ensure that net zero works for everyone.
    6. **The future of net zero**: Seizing the global opportunities from new technology and R&D innovation now and out to 2050. It also looks at the UK's carbon pricing regime and how the UK can maintain its international leadership on climate.

The direct risks of climate change to the UK

Developed under advice from the Met Office

- **The UK will be affected by climate change.** All areas of the UK are already warmer as a result of climate change, with particular increases in the summer, and further warming projected in the decades to come. This is consistent with warming that other countries will experience.
- **In particular, we will see changes to temperature, rainfall, and sea-level rise:**
    - **Temperature.** Climate change has already increased the chance of seeing a summer as hot as 2018 to between 12-25%. In a 2°C warmer world the chance of such a hot summer is doubled. Days where extra energy is needed for cooling, such as air conditioning, fans, and more refrigeration will more than double and wildfire danger can increase by 40%–70%.
    - **Rainfall.** An increase in both the intensity of winter rainfall and the number of wet days is expected.[92] In a high emission scenario, we are likely to see less rain in summer and more rain in winter – suggesting the need to manage water resources in the UK very differently compared to today. Despite overall summer drying trends in the future, new data suggests future increases in the intensity of heavy summer rainfall events. For urban areas particularly, this will impact on the frequency and severity[93] of surface water flooding. In a 2°C warmer world, flood frequency in Wales increases by 50%.
    - **Sea-level rise.** Sea level around the UK will continue to rise under all emission pathways. The pattern of sea level rise is not uniform across the UK. For London, sea level rise by the end of the century (when compared to 1981-2000) in a low emission scenario is very likely to be in the range 0.29 m to 0.70 m. In a high emission scenario, the range is very likely to be 0.53 m to 1.15 m. Sea-level will continue to rise into the next century. We can continue to expect increases to extreme coastal water levels as a result, and we cannot rule out additional changes in storm surges.
- **The heatwave of 2022 demonstrates the change we are seeing.** The summer of 2022 was the first time that the UK hit an air temperature above 40°C and was without question among the UK's hottest and driest summers on record. Evidence suggests that climate change has already made these summer extremes in temperature more likely. Continued global warming will see the likelihood of 40°C or above increase markedly – potentially to 1 in 15 years by the end of the century under a medium-emissions scenario and to one in every three to four years if emissions are high.
- **These changes bring new risks.** These include increased risk to homes and infrastructure from flooding, life lost from extreme heat (there were 2,500+ heat-related deaths in summer 2020),[94] and many wider impacts on nature, public services, and business from the disruption. There are unlikely scenarios where these risks are much worse. For instance, future maximum daily temperatures above 45°C are experienced in some future climate scenarios. Similarly, we cannot rule out sea-level rise exceeding 1.5m by 2100, although this is considered unlikely.

Net Zero Review: Part 2

Introduction to Part 2:

51. **Part 1** of the Review set the scene. Net zero is creating a new era of opportunity for the UK to capitalise on. It explains the opportunity and benefits to individuals and the economy. It places domestic action in an international context and emphasises that the UK must progress faster to realise economic benefits and minimise costs.

52. **In Part 2** we set out how government and industry should achieve this opportunity, stepping from the cross-cutting macro framework for a green industrial revolution and the specific actions needed to catalyse action in individual sectors of the economy through to how we enhance the role of local authorities, communities, and the individual to deliver a just transition. This part covers six key pillars:

53. **Pillar one** sets out the framework for a sustainable industrial strategy to deliver growth and jobs in the net zero transition. It covers the four guardrails for government to drive forwards net zero – certainty, continuity, clarity, and consistency. In this pillar we discuss the enabling infrastructure to deliver net zero including the investment environment, government structures, delivery mechanisms, and the UK's role internationally.

54. **Pillar two** notes the great progress to date on clean power, highlights the gear shift we need in delivery to achieve our targets, and recommends specific actions to unblock the pipeline, including a re-think of our energy infrastructure. It proposes both a solar and onshore wind revolution. The Pillar also sets out the need to go further and faster on:

    - New technologies, such as CCUS, Hydrogen and Greenhouse Gas Removals. We emphasise feedback on the need for policy and regulatory certainty for the long-term including interim milestones.
    - Nuclear and energy markets reform. We bring out industry feedback on the need for certainty as soon as possible via Great British Nuclear and the Review of Electricity Market Arrangements.
    - Fuels infrastructure. We propose a coordinated government strategy to provide certainty for different low carbon fuels and CO_2 networks.

55. **Pillar three** builds on pillar one by introducing the economic opportunities across each sector, the challenges to realising these and recommending specific actions to give greater business and investor certainty to decarbonise faster.

56. **Pillar four** outlines how we unlock local action by reforming the relationship between local and central government, making sure the planning system supports net zero, and turbocharging community energy and action. This pillar focuses on the benefits of a place-based, place-sensitive, locally led approach to net zero that can be delivered through greater local empowerment and devolution.

57. **Pillar five** discusses the role of individuals in the transition, how they can be supported to make green choices, and how government can ensure that net zero works for everyone. Three key areas require particular action:

- Agency (empowering people and arming them with the information they need to make the decisions they want to);
- Affordability (lowering upfront costs of new technologies);
- Accessibility (ensuring the benefits are accessible to everyone, and not focused on certain groups or parts of the country).

58. **Pillar six** looks ahead and outlines how we ensure that relevant R&D and technologies are in place at the right time, implement a long-term plan for effectively pricing carbon, and maintain our position as an international leader and collaborator in the net zero transition.

Pillar 1: Securing Net Zero

The transition to net zero requires **transformational change in how we live our lives** – from how we consume electricity, to the work we do and objects we use. To ensure this change is successful and maximises economic growth for the UK, **we need to get the basics right and move at pace to keep up with the rest of the world.**

This Review has heard that there are **foundational barriers to building the infrastructure, unlocking the private investment, and forging the global partnerships required to unlock net zero.** Addressing these requires key cross-cutting measures, built on four principles: **certainty, continuity, clarity, and consistency**.

Key recommendations:

1. Conduct and publish, before Autumn 2023, a review of how we should change regulation for emerging net zero technologies to enable their rapid and safe introduction, to support the net zero transition and boost growth
2. Review how policy incentivises investment in decarbonisation, including via the tax system and capital allowances.
3. At the next Spending Review, review options for providing longer-term certainty to a small number of major priorities for net zero – where we know that long-term policy commitment will be essential for success and provide long-term opportunities to save money.
4. Through their update to the *Green Finance Strategy*, BEIS and HMT should set out a clear, robust and ambitious approach to disclosure, standard setting, and scaling up green finance – including how it will meet existing commitments to implement Sustainable Disclosure Requirements across the economy, how it will provide a clear, long-term plan for attracting capital to meet net zero ambitions, and how to maintain the UK's position as the leading green finance hub internationally and metrics for success.
5. Publish an overarching financing strategy covering how existing and future government spending, policies, and regulation will scale up private finance to deliver the UK’s net zero enabled growth and energy security ambitions. This should include setting out the role of UKIB, BBB, BII, and IPA and UKEF in the transition.

1.1 The guard-rails for net zero

59. **The transition to net zero will see a fundamental shift from the systems of today, from a changing how we generate and consume energy, to how we travel and the objects we use.** This new system requires new, long-term ways of thinking and new, more agile structures for delivery. Securing net zero means laying the foundations of the net zero economy, without which the entire energy transition would be impossible. The underpinning architecture of net zero may seem prosaic, but without the enabling power of a stable regulatory environment, one which provides long-term investment opportunities in business models that send strong price signals to investors and encourages investment in UK businesses, the net zero transition will not be financed. As the UK Corporate Leaders Group told the Review:

> *"there is a need for clarity and stability in the policy environment, with long term strategies in place that support businesses to make the decisions needed to achieve net zero"*
> – UK Corporate Leaders Group[95]

60. **Infrastructure is the key that will unlock net zero**; to achieve net zero by 2050 and the decarbonisation of power supply by 2035, along with the 68% emissions reductions required across the whole economy in the UK's Nationally Determined Contributions (NDCs) for 2030, it must be done not merely at scale, but at speed. The net zero clock is ticking. Amid the Government's targets to deliver on its net zero ambitions, the concept of how to monitor time is lacking: whether through delivery at the centre, planning delays, lack of capacity, or capability in the supply chain, delays to progress need to be measured and monitored. Alongside emissions targets we should develop monitoring mechanisms to track progress, similar to delivery targets enshrined in other organisations such as the NHS.

61. **The Review has heard calls from all quarters for a step change in how we plan, build, and operate key infrastructure that will underpin the transition.** We will discuss the specific challenges of accelerating energy network infrastructure in ***Pillar 2***. Stakeholders told us that we will only get to net zero if we **utilise private investment and unlock the 'wall of capital' waiting to invest in green, sustainable projects.** But to turn on the taps, investors and businesses told us of the need for government to put 'guard-rails' on the transition. These will unlock investment, drive down the cost of capital, and ensure the transition results in economic growth.

62. Individual activity alone will not get us to net zero, we need to take a systems approach. Government has a role in setting the bold, ambitious missions to get there – challenges that can only be tackled through the combined effort of industry, government and the public breaking down traditional barriers and taking new approaches. Time and time again, stakeholders identified common barriers to progress, articulated clearly by the Confederation of British Industry (CBI) as:

> *"Inconsistency in policy […] lag time to get projects up and running due to slow and inconsistent approaches to planning and consenting across technologies and regions [and] lack of clarity over clear delivery pathways and interim targets with key milestones for adoption."* – Confederation of British Industry (CBI)[96]

63. In this Review we find that an approach, driven by **missions** (see below and the ***Executive Summary***) to provide certainty, clarity, continuity, and consistency, will galvanise momentum and deliver tremendous green growth in the UK. Well-defined missions that aim to resolve complex cross-cutting technological, social, behavioural, and economic challenges, can create

momentum, and build confidence. The archetype of a successful mission consists of these four interlinked components, addressing common challenges identified in our evidence base (see Figure 1.1).

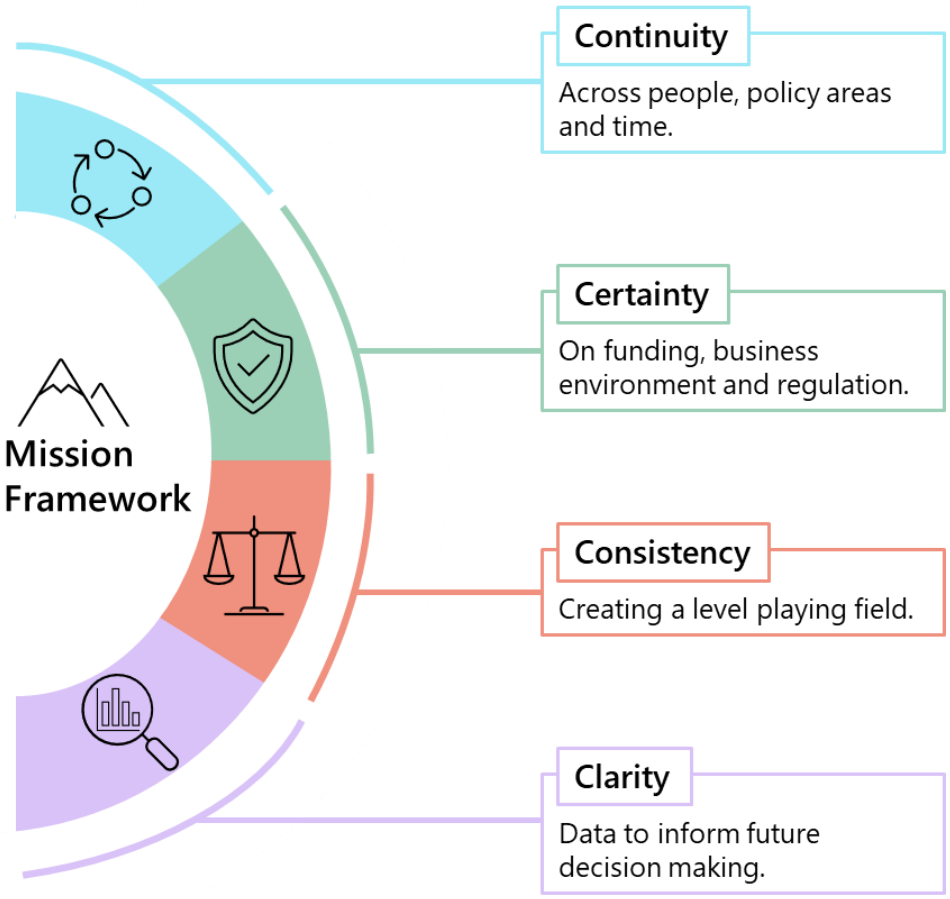


Figure 1.1 – *This Review takes a mission-led approach*

1.2 Certainty

64. Government must provide the long-term **certainty** that allows businesses and individuals to make plans, confident in the knowledge that UK policy or funding will not rapidly change without very good reason. The absence of this certainty has been one of the most striking themes of the evidence provided to the Review. It is a clear barrier to action for businesses and individuals.[15] This matters on the international stage too. The UK must demonstrate that its ambitions are being matched by credible delivery plans if it is to show the international community that we are serious about our leadership role in the net zero transition. As COP26 President, the UK worked with international partners to mobilise the transition from coal and pledged support to protecting vulnerable countries like Pakistan. Certainty about the UK's commitment to international climate initiatives is critical for the UK to continue to provide leadership.

65. On a local level, differing approaches between boroughs or local authorities create barriers for businesses to invest and predict demand. On an individual level, the Government has an important role in helping people understand what is being asked of them, and to shape major life decisions such as what skills they could develop, or what they buy. Changing positions creates confusion and disengagement.

66. Based on the evidence presented to the Review, the actions the UK must take to deliver certainty are:

- Create a stable environment for businesses to plan and invest
- Provide long-term funding certainty
- Well-designed funding schemes
- Well-designed, smart regulation
- Provide support via government-owned investment banks

Government should publish an **overarching financing strategy** covering **how existing and future government spending, policies, and regulation will scale up private finance** to deliver the UK's net zero enabled growth and energy security ambitions. This should include setting out the role of UKIB, BBB, BII, and IPA and UKEF in the transition.

1.2.1 Create a stable environment for businesses to plan and invest

67. Increasingly, firms are recognising that a low carbon future will be a profitable one. Business affiliation to *Race to Zero* nearly doubling since September 2021[97] and at least two thirds of the UK's FTSE100 companies signed up to it.[98] But markets are built on expectations, which is particularly important for the net zero transition given it involves structural transformation. **It is therefore government's role to reduce policy-induced risk and provide a stable environment for businesses to plan and invest.[99]**

68. Whilst the UK has several advantages to attract investment – it remained second in the European league table for foreign direct investment projects in 2021 – **we are part of a global race.** The rest of the world is also looking to reduce carbon emissions, transition to net zero, and grow low-carbon economies.

69. **A lack of timely investment is diminishing UK comparative advantage.** This Review heard that:

> *"The UK has been investing far less as a fraction of GDP than its competitors over the last decade, a critical reason for its comparatively weak growth performance. The first challenge is therefore to create stronger conditions for private investment".* – LSE[100]

70. **To effectively compete the UK must invest more now and provide policy and public funding certainty. This will crowd-in the levels of estimated investment needed from private firms and individuals.** The Climate Change Committee (CCC) estimates that additional net zero capital investment needs to grow five-fold from approximately £10 billion/year in 2020 to approximately £50 billion/year in 2030.[101] This additional investment will not only produce emissions reductions, but also major financial savings in operating costs.

71. **Evidence provided to the review has shown that the *Net Zero Strategy* and other recent government publications have not provided adequate certainty to business and investors.** Clearer plans, focused on individual sectors, set out over the long-term, and communicated clearly to the public, are important to ensure buy-in and providing a stable investment environment. Stakeholders were clear that this is not happening:

> *"Certainty for business and consumers is critical but as highlighted repeatedly in this Committee's recent reports…, government has too often pursued stop-start strategies which undermine confidence for business, investors and consumers in committing to measures which would reduce carbon emissions, especially when some green alternatives are still significantly more expensive than current options."* – Public Accounts Committee, 2nd March 2022*[102]*

72. We heard several examples of where a lack of clear long-term planning is undermining business confidence and willingness to invest. For example, at roundtables held by the Review we were told that "[the] risk of start-stop policy also damages investor confidence. Those considering investment in green infrastructure in the UK were held up when the Energy Bill was rumoured to pause."

73. The Review also heard a **call for a "UK Net Zero (government) Investment Plan" from thirty UK companies and financial institutions managing approximately £3 trillion in assets.[103]** They called for a plan that:

- Assessed the total investment needed in natural capital and nature-based solutions
- Set out a proposal for independent tracking of public and private financial flows
- Outlined a strategic financing plan to close the gap between required and actual financial flows and alignment of governance structures with this whole of economy approach.

74. This Review agrees that a current lack of a stable environment to invest in is a barrier which, if addressed, will facilitate further investor confidence**. The Review recommends that the Government publish an overarching financing strategy covering how existing and future government spending, policies, and regulation will scale up private finance to deliver the UK's net zero enabled growth and energy security ambitions.** This should include setting out the role of UKIB, BBB, BII, and IPA and UKEF in the transition (see below).

Provide funding support via government-owned investment banks

75. The Government needs to utilise public financial institutions to provide long term certainty to businesses for the net zero transition, and de-risk projects to attract private finance. Government should use the above public financing strategy to **clarify how it will use the various public finance institutions** (UK Investment Bank, British Business Bank, British International Investment, Infrastructure and Projects Authority and UK Export Finance as well as those in the devolved nations Scottish National Investment Bank and Development Bank of Wales) to **crowd in the private finance required** for the transition over the next ten years.

76. Many of the investment opportunities that the transition offers, whether in new technologies or supporting firms in decarbonising their operations, are fairly new and therefore considered riskier by financial market participants. This means that private finance on its own is not always willing or able to provide the finance for those projects without some involvement of the public sector. In particular, government has an important role to play in de-risking investment projects, for example by providing guarantees or types of investment that help crowd in private finance. Stakeholders have highlighted guarantees in particular as more effective and easier to scale than government grants.

77. The government-owned financial institutions and advisory organisations, including the **UK Investment Bank (UKIB), British Business Bank (BBB), British International Investment (BII), Infrastructure and Projects Authority (IPA) and UK Export Finance (UKEF), as well as those in the devolved nations such as the Scottish National Investment Bank and Development Bank of Wales,** are well placed to operate in this space, and government should work closely with them to provide long-term certainty to business.

78. We have heard that there is a greater role for these institutions in the transition:

> *"UKIB, IPA and BBB could provide guarantees for green projects if they expanded their risk mandate to cover securitisations via blended finance. This is where guarantees are made for projects that would not be funded due to a lack of credit appetite within the market"* - Barclays[104]

> *"Most new projects are sub-investment grade in nature and are often very large. The UK government should mobilise entities such as the UK Infrastructure Bank (UKIB), British Business Bank (BBB), and UK Export Finance (UKEF) to provide the necessary enhancements to deliver investment-grade credit profiles that can unlock vast amounts of capital in the private and public markets."* – Societe Generale[105]

79. While some government-owned investment banks have made sustainability a core part of their purpose, they should institutionalise their coordination to ensure a joined-up strategy and approach for enabling the transition. In addition, these institutions and government should clarify how they will work together in supporting finance and exports for the transition for businesses big and small. And UK Government Investments (UKGI), the entity that oversees HM Treasury (HMT)'s holdings in firms such as NatWest, should use its role as shareholder to actively steer firms that it partly owns to transition towards net zero.

1.2.2 Provide long-term funding certainty

At the next Spending Review, government should **review options for providing longer-term certainty to a small number of major priorities for net zero** – where we know that long-term policy commitment will be essential for success and provide long-term opportunities to save money.

80. This Review has consistently heard a call for the Government to provide longer-term certainty – including in long-term funding – for specific net zero policies. We heard from several local authorities, including Lewisham Council, who told us that one of the biggest barriers they are facing with regards to implementing net zero policies is "Funding certainty and scale. Particularly a lack of funding that allows Councils to plan and work with contractors over a long period of time to retrofit housing stock. Without consistent long-term funding it is difficult to attract contractors in this space to train workers and grow their business".[106]

81. **This is particularly an issue for emerging technologies which require consistent support to develop from early-stage research into commercial products** – and where long-term certainty is likely to attract higher levels of investment and ultimately reduce costs.

> *"Contracts for difference (CfD) support for wind power has helped realise significant cost reductions with the price of offshore almost halving between 2010-2020 (Carbon Brief). Similar time and support will be required to realise an equivalent cost reduction for hydrogen, recognising long project lead times, high upfront costs and varying investment cycles across the production, transportation, storage, and end use sectors."* – Hydrogen UK[107]

82. **A reluctance to provide long-term funding beyond spending review cycles – while understandable – exacerbates this risk.** While changing policy commitment or new delivery risks have often been the cause of this inconsistency – it is right to look at all the ways in which the Government can signal its long-term commitment. The Government follows a principle of generally not committing spending outside of a spending review period. This is designed to ensure that spending decisions do not bind future governments to previous commitments and that money is spent in a way that considers the fiscal environment and best value for money at the time. This is a sensible default position to follow. However, it limits funding certainty for almost all spending to a five-year window at best – requiring new rounds of bidding and negotiations between government departments at the end of that period.

83. **There are examples where the Government has taken a different approach.** For example, in 2020 the Government announced a six-year, £5.2 billion investment in flood protection. This went beyond usual spending review cycles, demonstrating that the Government can – in extraordinary circumstances – set out long-term commitments for urgent national priorities. The *Levy Control Framework* for renewable electricity is another example where Government decided funding – in this case for schemes to support low carbon electricity – over a longer period of time.[108]

84. **For businesses, the certainty that funding is allocated for the medium-term is a crucial signal of UK commitment**. Of the emerging technologies that the Government's *Net Zero Strategy* most relies upon, it is hydrogen and CCUS where stakeholders have flagged that the investment landscape currently appears to be most uncertain and therefore needing clear signalling of support from the Government. Long-term funding certainty is not currently in place for either. For example, the Government has committed to annual allocation rounds for electrolytic hydrogen production throughout the 2020s but made no commitments on the overall budget envelope for these rounds. Similarly, while the Government has committed to a 'Track 2'

bidding process for CCUS projects, there will need to be further allocation rounds for CCUS projects and this will need to be underpinned by a long-term funding commitment. The CCC has made clear that CCUS is a necessity for net zero, and the London School of Economics has found that 'the potential contribution of CCUS to sustainable growth is high, especially considering the long-term preservation of jobs – potentially up to 53,000 by 2030 – in energy-intensive industries'[109]. Other countries, for example the USA through the *Inflation Reduction Act*, have taken major recent steps to provide longer-term certainty to grow their capacity in these technologies. In this context, the absence of long-term funding commitments to some of the major technologies we know will be required by the UK appears to be creating unnecessary uncertainty and risk.

85. Given the long-term nature of some of the investments required, we recommend that HMT at the next Spending Review, **review options for providing longer-term certainty to a small number of major priorities for net zero** – where we know that long-term policy commitment will be essential for success and provide long-term opportunities to save money. CCUS, hydrogen, and nuclear should all be under consideration.

1.2.3 Well-designed funding schemes

Government to **lead a bespoke consultation on funding scheme design** – with a ministerial champion – to report on the issues and recommend reforms to government.

86. **Stakeholders have told us that the design of schemes can also be a blocker to their successful delivery.** Well-intentioned schemes established by different government departments can, according to stakeholders, overlap and undermine each other, sending conflicting and confusing messages to those applying for funding.

> *"To help tackle fuel poverty and improve social housing, Cornwall currently draws funding from multiple Government funding sources, matched with our own and private funds. Each grant-funded activity needs to be managed separately and delivered to prescriptive funding criteria. Although improving, Government funding is still often characterised by ambitious delivery timescales and short lead-in times. The complex interplay between different funds and the need to manage multiple grants and parallel reporting procedures creates delivery challenges. This model increases costs and complexity and delays delivery, as each funding programme requires a discrete approval and contracting processes. The highly prescriptive nature of grant criteria is a barrier to our ability to blend funding, making area-based interventions unduly complex and inefficient to manage – undermining our ability to deliver outcomes efficiently"* – Cornwall Council[110]

> *"The lack of a certain policy environment has proved challenging. For example, the renewable energy feed in tariff scheme was stopped suddenly, which created problems for many businesses. Creating policy in a way that gives some certainty in the direction of travel will be hugely helpful. The Landfill Tax Directive is a good example of policy that enabled businesses to plan for future changes in advance"* – Business in the Community[111]

87. Government's task is not easy, and it is unlikely that this issue applies to net zero alone. However, it is clear that the current approach undermines the effectiveness of the money spent. We recommend that government leads a bespoke consultation on funding scheme design – with a ministerial champion – to report on the issues and recommend reforms to government.

1.2.4 Well-designed, smart regulation

88. Well-designed, smart regulation acts as a guide and enabler of growth. To be environmentally and economically effective, regulations must be pitched at the right geographic scale, be coherent with other existing policies, set a clear direction that increases in stringency over time, and implemented in such a way that works with business timescales.[112] Well-designed environmental regulations and standards are also crucial for delivering the Government's industrial and environmental policy objectives.

89. Given the recent and current global pressures, many businesses are operating under significant uncertainty. UK business requires the stability that a long-term, well-designed, and well-implemented policy framework can provide.

90. A recent paper by Dr Jeff Hardy and Laura Sandys makes the case for a more anticipatory approach to energy regulation.[113] Anticipatory regulation provides a set of behaviours and tools to help policymakers identify, build and test solutions to emerging challenges. The anticipatory approach is outcome-focused and encourages collaboration between diverse stakeholders, including regulators. Under this approach, the regulator allows businesses more freedom to innovate, in return for being part of the process and having access to data to understand emerging consumer issues.

91. Strong regulatory signals have been given by Government in the past to drive economic growth and decarbonisation – for example through the 2030 ban on the sale of new petrol and diesel cars and vans. Business has responded and sought to capitalise on the opportunities generated from these interventions:

- **Signals to new market**. We have seen from the regulatory ban on new petrol and diesel car and van sales that strong regulatory signals lead to strong market reaction.
- **Revenue stability**. Contracts for difference have given greater certainty and stability of revenues to electricity generators by reducing their exposure to volatile wholesale prices, whilst protecting consumers from paying for higher support costs when electricity prices are high.
- **Support for enterprise and innovation**. The UK enjoys a strong performance for attracting Venture Capital investment and has provided highly competitive regulatory environment to support the sector. Venture capital can provide an outsized role in economic growth, through backing early-stage transformative ideas.
- **Price reviews.** Ofwat holds a price review every five years to set up-to-date limits on what water suppliers can charge their customers. Ofgem has recently brought forward their price cap reviews to every three months, given the current crisis, but previously updated every six months.

92. These interventions clearly demonstrate the powerful role that the right regulation – green tape rather than red tape – can play in driving growth and delivering net zero. We recommend:

Government to establish a **new forum to coordinate across all regulators on the signals they are sending to businesses and investors** across sectors about the net zero transition – including Ofwat, Ofgem, HSE, Environment Agency, Competition and Markets Authority, FCA, and the North Sea Transition Authority

Government should conduct and publish, before Autumn 2023, **a review of how we should change regulation for emerging net zero technologies** to enable their rapid and safe introduction, to support the net zero transition and boost growth

93. These actions should also consider the regulatory recommendations made in ***Pillar 6*** and will require collaborating on work being progressed from the recent announcement in the Budget that Sir Patrick Vallance (as Government Chief Scientific Advisor) will "lead new work on how we should change regulation to better support safe and fast introduction of new emerging technologies."

1.3 Continuity

94. Net zero is a thirty-year challenge, relying on many different people to act across different policy areas. **Continuity**, with input from all the different people responsible for delivery and reaching across the political spectrum, is therefore critical. We have seen very recent examples where changes in political direction have created significant uncertainty – for example the decision to pause the Energy Security Bill which, although now reversed, created major uncertainty for vital industries. The Review also heard from local government on this issue:

> *"The timeliness of developing policy following consultation is a huge concern, the waits for consultation responses and the subsequent policy are far too long.…Funding schemes and programmes need to be based on realistic timescales and longer investment periods. This also provides longer term certainty for the market. It will, in turn, enable ambitions to be realised and a continuity of approach to bring forth far greater impacts and legacy offshoot opportunities going forwards."* – Kent County Council[114]

95. The Review's mission-led approach urges government to take a programmatic multi-year approach to the delivery of major priorities. It also urges government to identify opportunities to ensure political consensus over the long term – providing industry certainty beyond the lifecycle of a single political term.

96. Based on the evidence presented to the Review, the key steps the UK must take to deliver this are:

- Strengthen parliamentary scrutiny
- Establish a new Office for Net Zero to drive overall delivery and ensure a joined-up approach across Government
- Bring major net zero delivery programmes out of departments and into dedicated delivery agencies

1.3.1 Strengthen parliamentary scrutiny

New **'Net Zero select committees'** should be created in **both Houses of Parliament.**

97. **In the Climate Change Committee, the UK has a sophisticated and robust scrutiny mechanism** – providing annual public reports to Parliament on UK progress towards net zero for which the Government has a statutory responsibility to respond to.

98. **At the same time, there is significant parliamentary scrutiny of the Government's work to deliver net zero.** In the last year, many committees, including the BEIS Select Committee, the Environmental Audit Committee, and the Public Accounts Committee have run enquiries into elements of the Government's net zero policy. This is a welcome and necessary role for Parliament and the select committee structure to play. These cross-party forums matter. Without long-term commitment and stable frameworks, net zero will be harder to achieve, with costs higher and benefits lower. Cross-party consensus on key climate policies and investments is therefore crucial.

99. **However it is not clear that the current select committee structure is sufficient.** There is no single select committee with overarching responsibility for scrutinising net zero. This creates two risks:

- A lack of a single parliamentary scrutiny function with oversight for the whole net zero mission – encapsulating the breadth of environmental, social, and economic issues it covers.
- A missed opportunity in developing widespread expertise of the Government's decarbonisation activity, and its successes and challenges.

100. **We recommend new 'Net Zero select committees' in both Houses of Parliament.** Dedicated net zero select committees could ensure consistent and detailed scrutiny – in partnership with whatever scrutiny other committees may rightfully wish to apply. The scale of net zero justifies this dedicated Parliamentary scrutiny. Among other functions, these committees could act as a dedicated receiver of the Climate Change Committee's annual progress report – scrutinising both the detail of the report and of the Government's response. It could also look closely at the differences in how net zero is being delivered across the UK, working with leaders from the devolved administrations and local and regional government to establish best practice.

1.3.2 Strong delivery governance

101. **The UK is world-leading in its net zero ambition, but delivery needs to be strengthened.** The UK has some of the most ambitious net zero targets in the world. This should be a source of genuine pride. However, ambition alone does not create success, in terms of decarbonisation or the economic benefits that net zero can bring. There are many UK successes, including the increasing number of electric vehicles on the roads. But there are also failures, including peat restoration (exacerbated by an ineffective burning ban) and the *Green Homes Grant*, where the National Audit Office found that: "Despite the Department's considerable efforts, the rushed delivery and implementation of the scheme has significantly reduced the benefits that might have been achieved, caused frustration for homeowners and installers, and had limited impact on job creation for the longer term."[115]

102. **Delivery of net zero requires a whole of Government effort**, not unlike the challenges faced in delivering the COVID-19 vaccines or preparing for Brexit. Effective governance must be long term to provide the clarity, certainty, and direction that the public, businesses and investors need. This also means taking a UK-wide approach – as the CCC has noted, the UK Government and the Devolved Administrations must work together more effectively if they are to deliver net zero effectively.

103. **Net zero programmes are often some of the most difficult to deliver, some failure can be expected.** Decarbonisation often involves emerging technologies and markets, partnership working between Government and industry, and other possible sources of uncertainty and delivery risk. Not all technologies will succeed. Failure, particularly in R&D, should not be stigmatised. It should be embraced as a necessary part of the process and an opportunity to learn lessons that will bring new opportunities in the future. In this context, we must be agile – setting up complex, bureaucratic structures is a sure-fire way to miss our targets and lose out on the benefits.

104. **The delivery risk associated with net zero means it requires special arrangements to ensure delivery.** As well as the complexity described above, the unplanned disruption from net zero programmes can be very high – particularly where other activity is relying upon a single programme's success (e.g. the roll out of electric vehicle, or EV, charging infrastructure, or the modernisation of the grid). The Government also has very limited means by which to compensate for failing to deliver on its current commitments. The CCC has concluded:

"Delivery must be actively managed. In any case, our plans must be based on realistic assessment. While some policies may be more successful than expected, not all policies will deliver. These risks cannot credibly be tackled with an even greater reliance on greenhouse gas removal technologies. The Government should develop contingency plans, such as encouraging reduced consumer demand for high-carbon activities (e.g., through healthier diets, or curbs to growth in demand for flights)" – The Climate Change Committee (CCC)[116]

The UK 100 argued:

"We need a comprehensive, local Net Zero Delivery Framework to include:

A National and Net Zero Delivery Board to deliver the framework and tackle blockages and barriers where the Delivery Unit (see below) notes systemic policy or funding barriers and contradictions. An independent Chair reporting directly to the Cabinet Office with members from across local authorities, devolved administrations and national Government.

A new National and Net Zero Delivery Unit to deliver the support programme, collect and analyse data and act as a channel between individual authorities and the Board and government departments, with wide representation from across the UK Government and informed by local and combined authorities and national Government".[117]

A new Office for Net Zero Delivery

Government to **establish an 'Office for Net Zero Delivery' by Spring 2023,** to ensure that the cross-departmental priorities for net zero are properly managed.

105. **Net zero requires strong leadership and a joined-up approach.** Many stakeholders commented on the need for coordinated action across Government to deliver net zero:

"Net zero requires an all-of-government effort to drive increased and well-targeted investments across innovation, infrastructure and skills. Central coordination and oversight of the transition can ensure that every government department is doing its fair share towards net zero while preventing any policies that would unintentionally undermine the transition from being put forward" – LSE[118]

"A lack of joined-up policy making has often undermined cross-government ambitions. In 2020 we identified policy incoherence as a key barrier to progress on climate change: progress on electric vehicles, for instance, has often been undermined by unsupportive tax policies and stop-start subsidies, progress on decarbonising homes by weak building standards and lack of investment in energy efficiency" – Institute for Government[119]

106. **Some of the largest decarbonisation challenges are shared across different parts of Government**. These include decarbonising housing (DLUHC and BEIS), developing the green economy (BEIS, DIT, HMT, DfE and others), and ensuring land is used in a way that enables decarbonisation (BEIS, Defra, and others). In all cases, the role of HM Treasury is crucial for determining the tax and spend levers used to deliver on these objectives – and in many cases some or all of the policy responsibility is devolved.

107. **The interactions between different policies related to net zero are often highly complicated**. These include trade-offs on land use, for example between tree-planting and biomass production, reforming the planning system, developing the electricity grid, and supporting the public through the net zero transition. The Review has considered elsewhere in this report options for improving cross-Government decision-making on planning and land-use.

108. **A 'systems' approach has been widely recommended to the Review as a tool for managing these interactions.** In 2020, the Prime Minister's Council for Science and Technology wrote to the Government stating:

> *"We believe that a rigorous systems approach will reveal the effects that policy decisions in all areas of government will have on delivery of net zero, enabling recommended that the Government strengthens the central oversight of net zero – which currently rests with BEIS decision-makers to understand how different policies interact and influence the transition of the whole economy towards net zero. It will also enable government to understand the interaction between mitigation, adaptation and resilience, including the need to protect biodiversity and wider sustainability initiatives."* – Council for Science and Technology[120]

109. The complexity of a whole economy transition, underpinned by common energy infrastructure and influenced by cross-cutting enablers like our planning system, requires joined-up thinking across different levels of decision-making. The application of systems thinking, which recognises these interactions and their complexity, must be baked into policy decisions and the design of net zero programmes and funding schemes. This should include forums set up to bring different perspectives together at the early stage of development of new initiatives.

110. **Net zero requires ongoing work to ensure the right investment landscape**, as described throughout this report. As well as the other points raised elsewhere, we have heard from stakeholders of challenges accessing the right people and departments in government to discuss investment and business needs. Schemes are cross-cutting and firms often have cross-cutting interests that do not sit within any single department. It is therefore important that there is a clear point of contact for net zero-related businesses looking to invest in the UK and a clear strategic view across the investment landscape.

111. We recommend the Government establish a new 'Office for Net Zero Delivery' to ensure that the cross-departmental priorities for net zero are properly managed. The Office for Net Zero Delivery should:

- Have joint ministerial oversight from BEIS and Cabinet Office;
- Take overall ownership of the delivery of net zero – including holding individual departments to account for their delivery;
- Work with all government actors to bring further net zero-enabled investment by improving the business environment and addressing barriers to investment for interested foreign and domestic investors, and companies wishing to export internationally;
- Manage cross-cutting risks to delivery and share best-practice and common insights across different government delivery activity;
- Manage the strategic relationship between the UK Government and Devolved Administrations (including ensuring regular net zero ministerial meetings);
- Own the delivery of priorities that sit outside any individual government department's remit – working in partnership with individual departments but ultimately being responsible;
- Advise government internally on best delivery practice for net zero programmes – working in partnership with the Infrastructure and Projects Authority, Climate Change Committee, and National Audit Office; and
- Identify lessons learned from attempts to deliver net zero activity – with a focus on open engagement with industry and devolved and local delivery partners.

112. Good organisation is not a replacement for strong political leadership on net zero – but the evidence presented to the Review suggests that the specific remit outlined above would materially plug an important gap in the UK's existing armoury and unblock the economic opportunity described elsewhere.

Establish delivery agencies for the highest priority and most complex net zero programmes

Government to **consider the case for creating new separate delivery agencies** to deliver long-term decarbonisation programmes.

113. **As discussed, major net zero programmes would benefit from greater long-term consistency.** The net zero challenge relies on delivering major programmes to roll out or develop new technologies, such as electric vehicle charging infrastructure or new nuclear power stations. By focusing on long term plans and 'pathways' for key sectors, we can galvanise deployment, development of supply chains and bolster the focus on skills and training.

114. **The Government has already recognised the value of establishing long-term bodies outside of departments in order to deliver some of these programmes.** The British Energy Security Strategy announced that the Government will scope and set up a body, Great British Nuclear (GBN), to develop a pipeline of new nuclear projects and support the UK's nuclear industry. Based on the evidence presented to the Review, this model appears to be an attractive one to replicate for other major priorities.

115. We recommend that the **Government considers creating new separate delivery agencies to deliver long-term decarbonisation programmes.** These would:

- Own the long-term delivery of policy ambitions set by departments, e.g. targets for rolling out specific new energy infrastructure;
- Be accountable for delivery to their sponsoring departments and to relevant parliamentary select committees;
- Regularly publish data on progress; and
- Work closely with the Devolved Administrations.

1.4 Clarity

116. The right decisions cannot be taken without high quality information and **clarity** about what is happening and what is planned. The Review recommends a significant increase in the use of data to report on what is really happening in net zero. This would drive decisions that are data-based, open up government's work to greater scrutiny, and engage the public in the story of what is happening. At the same time, the UK's strategy needs to be clear about where its efforts will be most rewarded, based on its competitive edge in the global net zero market.

117. Based on the evidence presented to the Review, the key steps the UK must take to deliver this are:

- Using data to help the country see the UK's progress and understand how we are all participating
- Supporting businesses to measure emissions through their supply chains
- Focusing on UK competitive advantage

1.4.1 Use data to help the country see the UK's progress and understand how we are all participating

A new public platform for net zero data

Government to significantly expand its **public reporting on net zero - potentially either through the ONS's climate portal or developed in partnership with the CCC.** This will act as a tool both for **public communication and greater scrutiny of government's progress** towards net zero. It should set out regular and publicly accessible data on key progress indicators.

118. **The public needs more information about net zero – including authoritative official data that is trustworthy and engaging.** As ***Pillar 5*** describes, net zero will have a major impact on many parts of our lives - from how we travel to how we heat our homes. Evidence suggests that there is significant public support for net zero action, with 95% of voters of the 2019 General Election supporting parties that committed to net zero by 2050. Polling suggests that 45% of the population has already taken action to reduce their carbon emissions, with 22% more planning to so in the future.[121] Evidence suggests barriers preventing people from engaging with net zero include cost, difficulty accessing low-carbon alternatives, and a lack of information about what action to take.

119. **Evidence suggests that the public do not have all the information they need to assess how net zero impacts them.** In 2021, while finding general support for net zero policies, research found that public support for them dropped significantly when people were presented with potential implications for them personally.[122] Given the importance of the transition and the scale of potential change, there is a clear and democratic argument for ensuring the implications of net zero are made more transparent. There are practical arguments too. Almost half of the actions in the Government's *Net Zero Strategy* require public action.[123]

120. **There are also strong external calls for the Government to provide more information about its plans for net zero and open itself up to greater scrutiny.** The Public Accounts Committee has on several recent occasions highlighted the need for greater transparency

about the Government's progress towards net zero, including on reducing the Government's own emissions:

> *"The Department and HM Treasury should also set out how it will ensure Parliament can scrutinise the implementation of its net zero policies. We expect this to take the form of annual reports that include the updated costs to 2050 and the amount spent in that year in the public sector to achieve net zero as well as the impact on consumers, households, businesses and local and central government across all sectors and departments and what the expected CO2 reductions will be".* – Public Accounts Committee, 2nd March 2022[124]

121. The CCC has similarly identified the need for a stronger public monitoring framework of the journey to net zero. In their 2022 progress report, they set out detailed new progress indicators to assess the risks of net zero delivery in greater detail than that published so far by the Government.[125]

122. **The Government has recognised the need for greater clarity, but it can go further**. The *Net Zero Strategy* committed to an annual overview of progress towards net zero alongside an update on progress against 24 indicators. However, this does not match the ambition set by the CCC, who have identified 369 indicators that can and should be publicly monitored. Nor does this annual update provide the required level of granularity or public engagement that stakeholders are clearly calling for, or that the evidence suggests is needed.

123. We recommend a major expansion of the Government's public reporting on net zero - potentially through the Office for National Statistics (ONS)'s climate change statistics portal or developed in partnership with the CCC. This would act as a tool both for public communication and for greater scrutiny of government's progress towards net zero. It should set out regular and publicly accessible data on key indicators of progress, including:

- Changes to the economy linked to net zero - e.g. the number of new green jobs
- Information on co-benefits associated with net zero - e.g. air quality
- Information on public attitudes towards net zero – as described in ***Pillar 5***
- Data on progress against key net zero targets and outcomes- e.g. a 30,000 hectare tree-planting target
- Data on key signals and enablers that affect this delivery - e.g. planning application timelines, waiting times for heat pump quotes

Review opportunities to present net zero and GDP together

Government to **review how often it publishes data on UK emissions** – and represent this alongside GDP.

124. Measuring a country's climate emissions is a very complicated undertaking. The UK's approach combines a variety of datasets around energy use to create a single calculation. The difficulty of this undertaking means that the final estimates are not published until nearly a year after the end of the year in question.[126] The Review accepts that this length of time is required to publish the fully robust statistics required for national accounting purposes. However, there are major drawbacks to this, particularly in the context of the clear public and parliamentary desire for information on the UK's net zero progress, because that delay reduces the usefulness or public interest in the data when it becomes available.

125. The obvious comparison is with GDP. The ONS publishes monthly and quarterly estimates of GDP numbers[127] which generally attract media attention and feed into an overall national conversation on the state of the UK economy.[128] The comparison is not a perfect one – GDP is a simpler calculation than emissions – but it points towards where emissions data should aim to be.

126. We therefore propose that the Government and the ONS work together to review options for creating a simplified calculation of UK emissions – published with appropriate caveats – to give a more regular indicative sense of UK progress. There may also be a future role for technology to directly measure emissions to allow for more immediate measurement.

127. The end point of this should be for emission and GDP numbers to be published alongside each other. The evidence seen by the Review clearly shows that growth based on high emissions is not sustainable – industry is working to reduce emissions and long-term growth is reduced in a high emission world. As well as helping to provide a high-profile moment for giving the public an update on decarbonisation, publishing an assessment of GDP against UK emissions will help to ensure that any link between future UK growth and emissions is clearly scrutinised – to ensure a long-term sustainable footing for growth.

Go further to show the impacts of fiscal events on net zero

Government should work with OBR and CCC to set out a process for how it will ensure the climate impacts of fiscal decision making are considered. It should commit to publishing the climate impacts of future spending reviews.

128. **It is important to measure the climate impacts of public spending.** Public spending is just one lever to make progress on net zero, and effective regulation and private finance are also important. Given the significance of public spending, however, it is essential to ensure the climate impacts of all fiscal decisions are assessed and considered.

129. **HMT has taken valuable steps forward in demonstrating the impact of fiscal events on net zero.** In December 2022, the Government published analysis of the environmental impact of the 2021 Spending Review. This showed that 54% of spending they analysed directly or indirectly contributed to decreasing emissions, whereas 16% increased emissions.[129]

130. **This was a really important step, and we encourage them to go further.** Requiring information on emissions during the spending review process will have been an important tool for influencing individual departments to consider these impacts when bidding for money – and will have given ministers valuable data about the impact of spending decisions on the UK's climate goals. Making this public is a welcome and valuable signal that the Government is actively considering the impact its decisions have on emissions and is willing to open their net zero activity to scrutiny.

131. We recommend HMT builds on the recent reporting of Spending Review carbon implications by working with the Office for Budget Responsibility (OBR) and CCC to set out a process for how it will ensure the climate impacts of fiscal decision making are considered. It should commit to publishing the climate impacts of future spending reviews. This is not designed to capture all government policies, as many come forward outside of the spending review cycle and/or do not require public spending.

132. Government departments should prioritise supporting HMT in this process, including ensuring dedicated leads for understanding the environmental impacts of spending within each department.

1.4.2 Support businesses to measure emissions through their supply chains

Government to commission the ONS and/or UKRI to **lead an engagement exercise with business to define their data needs and develop bespoke recommendations** to address these.

133. It is clear that many businesses want to do the right thing in terms of reducing their carbon emissions. Half of the world's leading institutions and 40% of companies have made net zero pledges. But supply chain emissions are a major barrier. For example, the World Economic Forum's Alliance of CEO Climate Leaders, which contains large global businesses like Nestle, Coca Cola, and Bank of America, estimates that 80% of their total emissions footprint comes from their supply chains, also known as Scope 3 emissions.[130]

134. A number of businesses told the Review that a lack of data about emissions in their supply chains creates a challenge for accurately reporting their emissions and taking action to reduce them.

> *"A lack of readily-available GHG emissions data in a standardised format from smaller companies upstream and downstream in value chains makes even the compilation of an accurate carbon inventory challenging, much less taking measures to decarbonise."* – Business in the Community[131]

> *"Visibility on scope 3, data center emissions is low and expect that's a barrier when we want to decarbonise as we scale up"* – RE24 Energy[132]

135. To deliver this, Government should commission the ONS and/or UKRI to lead an engagement exercise with business to define their data needs and develop bespoke recommendations to address these. This should include:

- Consulting businesses on what specific data they would find useful
- Exploring publishing Government-held data
- Exploring opportunities to reduce the costs of measuring data
- Providing Government-backed forums for collaboration and cooperation across value chains to measure emissions

1.4.3 Clarify UK's competitive advantage and green industrial policy

Carry out **competitiveness analysis for clean technologies setting out the UK's export and import strategies** and where it intends to develop leadership - and utilises this to clarify for investors and industry the UK's current green industrial policy.

136. Countries around the world are setting net-zero industrial strategies to create jobs and investment from the drive to net zero. This Review heard that the UK does not have a clearly communicated cross-cutting net zero industrial policy, and now is the moment to set this out.

> *"The drive towards net zero, both for the UK as well as for the development of cleantech exports, could be the ideal moment to write one (green industrial policy), to holistically bring it*

all together under one NetZero Industry policy: electricity, nuclear, hydrogen, infrastructure (electricity grids, energy storage, hydrogen refuelling, sustainable fuels" – Johnson Matthey[133]

137. The UK has several strengths in clean technologies such as tidal, offshore wind, nuclear and CCUS. The UK is also heavily specialised in services including green finance which presents a clear opportunity. However, there is currently no defined comparison of the UK's comparative advantages and where it wishes to develop domestic capabilities for supply of domestic demand, additional capabilities for export, or areas it wishes to import across various net-zero sectors. The UK's previous industrial strategy was welcomed by industry though some have said they are unsure if it is still active industrial policy.

138. A clearly articulated industrial policy will support the UK to position itself as a dominant player in emerging technologies to enable the transition to net zero, expand UK international collaboration and partnerships, and create supply chains and skills pipelines. A green industrial strategy, in parallel with the Government's financing strategy and the Net Zero Delivery Agency has the potential to accelerate progress and unblock barriers to the UK's critical priorities.

139. Therefore, this Review recommends the UK carries out competitiveness analysis for clean technologies. This should set out the UK's export and import strategies and where it intends to develop leadership, and utilise this to clarify for investors and industry the UK's current green industrial policy.

1.5 Consistency

140. First and foremost, the Review has heard of the importance of **consistency** in the UK's approach to net zero. This means creating a level playing field for all businesses to operate in, and avoiding those with greater commitment to net zero from losing a competitive edge as a result.

141. Significant investment is needed for the transition to net zero to happen. The *Net Zero Strategy* estimated that additional capital investment must grow from present levels to an average of £50 - £60 billion per year through the late 2020s and 2030s to reach net zero. The CCC has similar estimates. This is considerably more than seen to date, leaving a significant investment gap. While public finance has an important role to play, government's focus should be on crowding in private finance to close the gap. This could create significant growth opportunities for the UK financial sector (see ***Pillar 3***). But to unlock this finance, consistent and comparable data and information on the risks and opportunities as well as firms' transition plans will be crucial. Clear standards for credible transition plans, reporting requirements, classification systems, and labelling of financial products will provide investors and businesses with the information and tools to act. The Review has heard from key voices in the sector how the lack of consistency on financial reporting leads to lack of adoption and consequential constraints to financial flows.

142. Based on the evidence presented to the Review, the key steps the UK must take to deliver this are:

- Incentivise financial disclosure
- Standard setting - transition plans, taxonomy, greenwashing and stewardship
- International alignment, integration of standards and nature

1.5.1 Incentivise financial disclosures

Government to **endorse and implement the International Sustainability Standards Board (ISSB) standards as soon as possible**. The UK should lead by example, launching a formal adoption mechanism as soon as the ISSB standards are published and moving swiftly to assess and endorse the standards for use in the UK. The UK should aim for 2024/25 as the first sustainability reporting cycle for companies in scope, encouraging companies to apply the ISSB's standards voluntarily in 2023/24.

143. **To unlock finance, and ensure it is directed towards transition activities in the most effective way, financial actors need information.** As well as information on the direction of policy (see "certainty" above), investors need high-quality and consistent information on companies' and other financial institutions' sustainability-related risks and opportunities to help them make informed decisions, a clear policy ask from investors across the Review's engagement.

144. **For the information to be useful for financial decision making, it needs to be comparable across firms (and geographies), economy-wide, and it must be forward-looking.** Doing so will ensure investment decisions take into account not only a firm's current carbon footprint but its plans to reduce that carbon footprint. Several initiatives have led to considerable progress in this area, most notably the framework set out by the Taskforce for Climate-Related Financial Disclosures (TCFD). The UK has taken several steps towards making these requirements mandatory, in 2021 becoming the first G20 country to make TCFD-aligned climate-related

financial disclosures fully mandatory across the economy, a crucial step toward achieving high-quality and comparable disclosure.[134]

145. Building on TCFD and other leading sustainability reporting initiatives, the International Financial Reporting Standards (IFRS) Foundation has established an International Sustainability Standards Board (ISSB) to set a comprehensive global baseline of sustainability-related disclosure standards. The international character of finance means that finance competes for investment opportunities globally. Aligning reporting requirements in the UK with standards established globally and playing an active role in shaping global reporting requirements will put the UK in a strong position to attract international finance into the UK. Clear direction over how international standards apply to UK markets will provide certainty for financial decision makers. In the Green Finance Roadmap[135] government set out the Sustainable Disclosure Requirements (SDRs) - an integrated framework for decision-useful disclosures on sustainability across the economy, building on leading global standards and best practice. In line with these commitments, we therefore recommend that Government endorse and implement the ISSB standards as soon as possible.

> *"It is important that the government proceeds with the Sustainable Disclosure Requirements in a timely manner to provide investors and capital markets with sustainability data that enables the growth of investment and financing of sustainable investments."* – Association for Financial Markets in Europe[136]

146. Ultimately, international sustainability reporting standards need to be on a par with financial reporting requirements and connected to them, without any major deviation from international standards. This will serve to create a level-playing field and a reliable information set for investment decisions. And climate-related disclosure requirements will need to expand beyond corporate reporting to support the information needs of capital providers across asset classes.

1.5.2 Standard setting – transition plans, taxonomy, greenwashing and stewardship

Transition Plans

UK to continue its pioneering work in transition plan disclosures led by the UK Transition Plan Taskforce (TPT), share them internationally, and once more developed, Transition Plan Taskforce **standards to be made mandatory for both listed and private firms to ensure comparable disclosure standards** across the economy, in line with previous government commitment.

147. **The UK has a strong reputation as standard setter for finance, providing credibility and predictability to financial markets.** Building on this tradition, setting clear standards in the green finance space will provide the required certainty and clarity, catalysing further action, both in the UK and globally, and underline the UK's ambition as a leading green financial centre. Underpinned by the Bank of England's work to ensure the resilience of the financial sector to the risks from climate change and ensure the financial system can play its role in supporting the transition, clear standards will allow us to maximise the opportunities of the global and domestic shifts towards clean growth.

148. **One area where the UK has done pioneering work is on transition plans.** Across the economy, numerous firms have set out their ambition to reach net zero. But early plans for how they intend to reach that target have varied in quality and often lack detail on the short-term actions that are being taken to achieve these targets. This makes it difficult to assess the

credibility of individual plans, or to compare approaches to transition planning across multiple entities. Investors are calling for disclosure of these to better understand how to allocate their capital in a way that is aligned with net zero, across the entire economy, and for firms of all sizes. While the Financial Conduct Authority (FCA) has mandated asset managers/owners and listed companies to include comply or explain requirements to publish transition plans since 1 January 2022, there is currently no policy in place to mandate disclosure of transition plans for private companies (e.g. those that would be regulated under the Companies Act). For transition plans to have the intended effect of providing information for investment purposes, they need to become a mandatory requirement for all firms that are in scope for the TCFD requirements, including private companies.

149. **The need for credible and easy-to-understand transition plans goes well beyond the largest financial firms and corporates.** Small and medium-sized enterprises (SMEs) are increasingly experiencing pressure from customers – including mid-size and larger corporates – to demonstrate their green credentials and their plans to transition to net zero. However, in the absence of industry standards they may have to provide different information to each set of stakeholders. A standardised reporting framework could assist SMEs and reduce their administrative burden but, at the moment, there is no coherent framework for SMEs. **Government should look to facilitate and reduce the transaction costs for SMEs providing the relevant information by setting out guidance that considers the appropriate format for SMEs and is proportionate** - requirements should apply more extensively and earlier to large firms before being rolled out to smaller firms. Moreover, consideration should be given to how requirements may need to be tailored for smaller firms to minimise the burden on firms that have less capacity to meet them.

150. **The UK launched the Transition Plan Taskforce (TPT) in 2022, which is a world leading attempt to set the gold standard for firm-level transition plan disclosure across firms of all sizes.** The TPT recently published its draft Framework and Implementation Guidance for consultation, taking the approach of looking beyond entity level decarbonisation and focus on action in the real economy. In addition to providing information to investors, transition plans can highlight any misalignment between commitments and actions, allowing regulators and consumers to call this out and create market integrity and consumer protection. The UK should continue its pioneering work in transition plan disclosures led by the UK Transition Plan Taskforce (TPT), share them internationally, and once more developed, the TPT's standards need to become mandatory for both listed and private firms to ensure comparable disclosure standards across the economy, in line with previous government commitment.

Taxonomy

To ensure government facilitates sufficient investment in transition economic activity, investors need information on transition pathways to put transition plans into context, as well as common categories and definitions on what economic activities are aligned with the transition to net zero. **Government to consider the appropriateness of a transition taxonomy (alongside a green taxonomy) that is simple and proportionate**; and work with international partners to ensure the UK approach is interoperable and harmonised with others' approaches.

151. **Investors and firms that are seeking to invest in and drive the transition need to understand which activities in the economy are aligned with the transition, and which ones are not, to be able to allocate their capital accordingly**. While a growing number of products, both financial and non-financial, are marketed as "green", there is no accepted

definition of which economic activities count as supporting climate objectives. For that they require common definitions, for example in the form of a taxonomy.

152. In 2021, the UK announced work to develop a UK Green Taxonomy, which focuses on those activities and investment options that are already sustainable. It is important for the UK government to provide clarity and implement a coherent green taxonomy at the earliest possibility, delivering on its previous commitment. While investment in green assets is important, the transition, and finance to support that transition, needs to happen across the entire economy, including the decarbonisation of economic activities that have a high-carbon footprint to start with. To ensure government facilitates sufficient investment in transition economic activity, investors need information on transition pathways to put transition plans into context, as well as common categories and definitions on what economic activities are aligned with the transition to net zero. **Government should consider the appropriateness of a transition taxonomy (alongside a green taxonomy) that is simple and proportionate; and work with international partners to ensure the UK approach is interoperable and harmonised with others' approaches.**

Greenwashing

153. **Financial services are innovating to support the transition, and new financial products that are targeted at green or transition activities continue to emerge.** But it can be hard to understand which financial products support the transition and which ones are just labelled as such. This lack of clarity can undermine the integrity of capital markets and consumer confidence. Seeking to address this issue, the FCA is consulting on aspects of the proposed Sustainability Disclosure Requirement (SDR) and investment labels to counter greenwashing. This will ensure that capital flows from institutional and retail investors are reoriented to business activities that contribute to net zero.

154. The Government and the FCA should build on this across a wider scope of sustainability-labelled financial products and instruments, extending beyond UK fund products to overseas funds and pension products, supported as necessary by legislation. The Government and the FCA should also consider how the conceptual and practical foundations for the regime can be applied to support the trusted development of wholesale markets for sustainable finance instruments, including sustainability-linked bonds and loans, and other transition-focussed instruments.

155. The risk of greenwashing goes beyond financial instruments. For example, offsets to greenhouse gas emissions are another area linked to the net zero transition where lack of clarity and reliability around terms and labelling undermine the development of a credible market for offsets. Voluntary Carbon Markets are focused on developing credible standards and accreditation methods to address these issues. It is important they do so with rigour to build trust in the offset market and deliver products that do what they say (see ***Pillar 6***).

Stewardship

156. Investors can shape the transition not only by where they invest, but how they engage with the firms that they are invested in, or considering investing in – known as stewardship. Using their influence, for example through shareholder voting, investors can ensure their money supports activities aimed at reducing the carbon footprint of firms and their supply chains. The stewardship code, which sets stewardship standards for those investing money on behalf of UK savers and pensioners and promotes the responsible allocation, management, and oversight of capital to create long-term value for clients and beneficiaries, should be updated as part of its review at the end of 2023 to explicitly reflect the need to take sustainability and the transition into account.

1.5.3 International alignment, integration of standards and nature

157. Across these areas of development for standards – transition plans, taxonomy, rules to avoid greenwashing, and stewardship – authorities should consider proactively how to align them internationally. Ideally this would be in the form of consistent standards as far as possible, or where needed a mechanism to recognise compliance with overseas standards that are delivering the same outcomes. The international character of finance means that the UK is competing with other countries for finance to support the transition. We've heard from the financial services sector that:

> *"We cannot overstate the importance of a clear taxonomy that is harmonised, where appropriate, with other jurisdictions. As this will facilitate cross-border sustainable finance and lower compliance costs for firms operating in the UK but headquartered overseas."*
> – Societe Generale[137]

158. **The UK should draw on its leadership in this field to shape standards internationally and adopt agreed ones as appropriate**.

159. The greater clarity and certainty for the financial sector over standards needs to be complemented by greater clarity and certainty over the interoperability between different regimes. The Sustainability Disclosure Requirements (SDRs) is a first step in linking up disclosure requirements for climate-related financial risks and transition plans. As both those areas evolve, and disclosure requirements on nature-related risks develop, it is important for government and regulators to clarify how different requirements relate to one another, ensuring that they align in terms of key parameters, such as the scope of the companies captured. This will require cooperation across a number of government departments (HMT, BEIS, DWP) and financial regulators (FCA and FRC).

160. While the focus of green finance to date has been primarily on climate change, that has started to shift, with consideration given to nature-related financial risks and opportunities. For example, nature-based solutions are developing as an asset class in their own right, and the Taskforce for Nature-Related Financial Disclosures (TNFD) has been developing a disclosure framework to complement TCFD on the nature side. As the framework and ecosystem for green finance evolves, government should review how that framework needs to develop to encompass nature as well as climate.

1.5.4 Net Zero Charter Mark

Government to consider the adoption of a **Net Zero Charter Mark** – a mark to acknowledge "best in class" among firms in terms of their role in the transition to net zero.

161. As firms are stepping up to the mark and decarbonising their own operations, their supply chains and proactively pushing forward the transition, it is important to recognise those efforts and allow firms to benefit from their green credentials. At the same time, investors and businesses need to be able to be confident that those green credentials are based hard metrics.

162. Firms that represent "best in class" in terms of their role in the transition should be recognised and rewarded for that. To be granted the Net Zero Charter Mark, they have to be compliant with or ahead of key standards – such as publishing their climate-related financial disclosures, publishing a transition plan with key milestones and progressing against those, and using reliable metrics and data – such as science-based targets – to ensure any disclosure is of high quality.

And they have to be recognised as stewards of the transition within their sector, pushing others along on their journey towards net zero, for example through stewardship along the supply chain. The requirements will tighten over time, as regulation becomes mandatory and firms become more sophisticated in their approach.

Pillar 2: Powering Net Zero

Over the last 15 years, the UK has successfully started replacing fossil fuels with greener and cleaner alternatives, creating new industries, services, jobs and export opportunities. However, to reach net zero we need to go even faster on making changes to the power and fuels we use – and make sure the UK benefits from growth in these new technologies. Rolling out these technologies will require a step change in how we approach energy security, infrastructure, and supply.

Key recommendations

1. Government should set up a taskforce and deployment roadmaps in 2023 for solar to reach up to 70GW by 2035 and onshore wind to reach required deployment levels for 2035 net zero grid.
2. Government should expedite the set-up of Great British Nuclear in early 2023 and set out a clear roadmap in 2023 on how to meet interim and 2050 requirements.
3. Industry should accelerate the end to routine flaring from 2030 to 2025.
4. In 2023, government should act quickly to re-envisage and implement a clear CCUS roadmap, showing the plan beyond 2030. As part of the roadmap, government should take a pragmatic approach to cluster selection. This means allowing the most advanced clusters to progress more quickly.
5. By the end of 2023, government should develop and implement an ambitious and pragmatic ‘ten year’ delivery roadmap for the scaling up of hydrogen production.
6. Government should publish an offshore industries integrated strategy by the end of 2024 which should include roles and responsibilities for electrification of oil and gas infrastructure, how the planning and consenting regime will operate, a plan for how the system will be regulated, timetables and sequencing for the growth and construction of infrastructure, and a skills and supply chain plan for growth of the integrated industries.

2.1 Net zero drives UK energy security

163. Energy security is foundational for achieving net zero, and increasingly the two go hand-in-hand. Wind and solar are now the cheapest forms of energy, and measures to reduce demand and flexibility upgrades are increasingly at the centre of the challenge to guarantee energy security and reach net zero.

164. This Review shows how **energy security is essential to a growing economy** and how we can deliver security and net zero in a way that benefits consumers.

165. **Since government published its *Net Zero Strategy* in 2021, the UK and global context have changed significantly,** fundamentally altering the economic landscape in the UK. Supply chain disruptions during the COVID-19 pandemic, a spike in demand for oil and gas as the global economy reopened, and a restricted supply of gas following Russia's illegal invasion of Ukraine have caused global fossil fuel prices to soar and prompted the high rates of inflation we currently see.[138] Rising prices have, in turn, created considerable cost of living pressures across the UK.

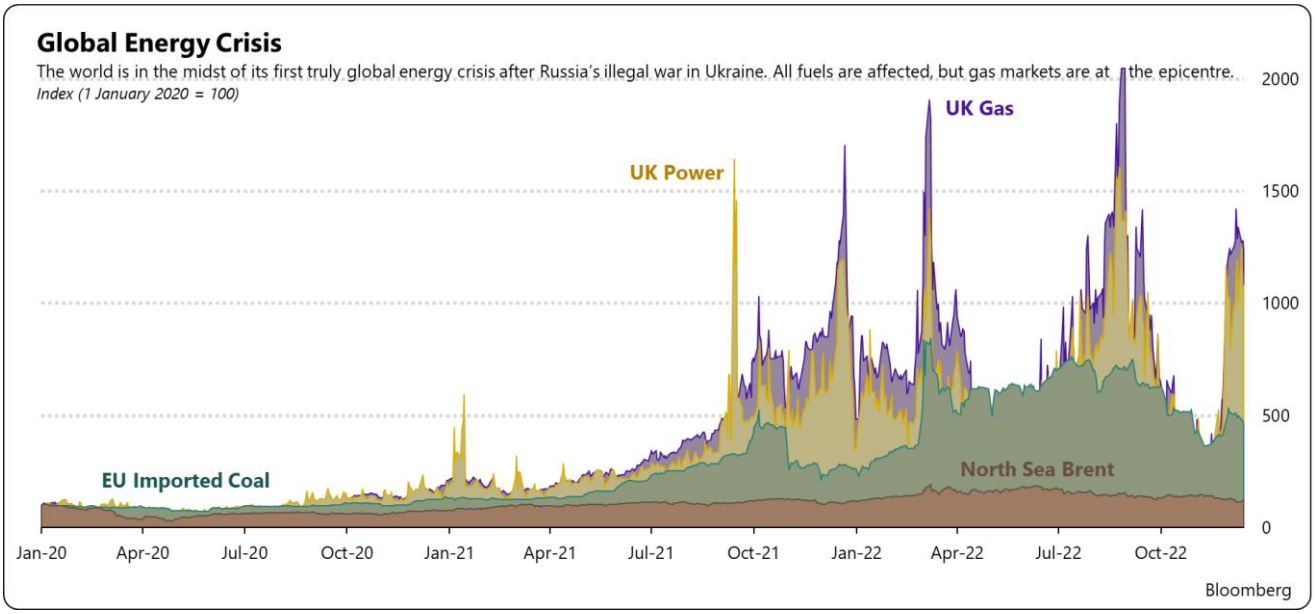


Figure 2.1 – ***The rise in energy prices over the past two years***

166. **This has had a significant impact on the global energy system.** Internationally, it has led to many governments seeking to rapidly diversify away from oil and gas, providing significant incentives to accelerate the transition towards renewables and low carbon fuels. This year's expected jump in wind and solar generation is greater than any one year of growth in gas-fired power generation.[139] This represents a seismic shift in the energy system.

167. **According to the International Energy Agency's 2022 *World Energy Outlook*, for the first-time global demand for all fossil fuels appears to be peaking or plateauing across all scenarios.** Coal demand peaks this decade, natural gas by 2030, and oil by the mid-2030s.[140] This isn't enough to avoid severe climate impacts, but it is progress from where we were a few years ago. Stronger policies can steepen the decline.

2.1.1 Shifting sands: new policy paradigms

168. **These events have created two paradigm shifts in energy policy.** Firstly, it has become clear once again that energy security underpins economic growth and stability, and we must therefore address this as an immediate priority. Without a stable, nationally controlled energy mix, we won't have the foundation to shift energy policy towards net zero. Some countries have taken rushed and expensive measures in reaction to the recent crisis to enhance security and affordability, often at the cost of sustainability and progress towards net zero – whether that be fracking or increasing natural gas production.

169. Secondly, and equally importantly, the crisis and wider shifts in the cost of renewables have shown that green policies can be secure and affordable. Until recently, green energy policies often conflicted with objectives of security and affordability, involving difficult trade-offs in the short term. Whilst some of these trade-offs still hold, the objectives are now converging. With fossil fuels no longer providing the cheapest and securest form of energy, the previous blockers to sustainable energy policy are falling away. In August 2022 it cost over four times more to produce electricity from a combined cycle gas plant in the UK (£420/MWh) compared to the same period last year (£100/MWh).[141] The cost of renewable power has tumbled recently. In 2023, estimates suggest it will be at least six times more expensive to generate electricity from gas in the UK than from onshore wind (though renewables require additional investment in peaking, storage, and flexibility technologies). Ember Climate research shows that decarbonising the power system by 2030 would save the UK £93 billion in gas costs. Moving away from hydrocarbons that are exposed to volatile wholesale pricing and towards a system based primarily on domestic renewables is now the optimal approach.[142]

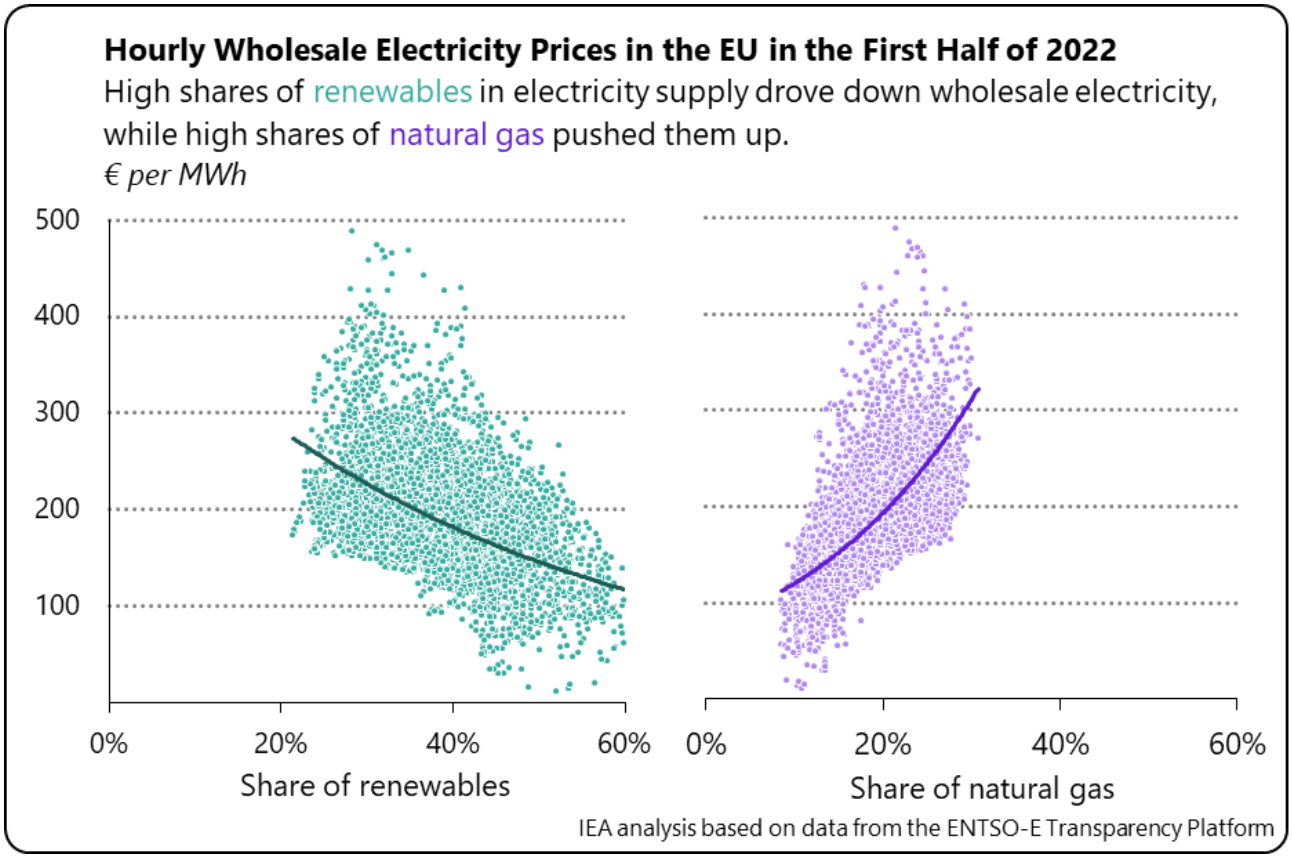


Figure 2.2 – ***Hourly wholesale electricity prices in the EU in the first half of 2022***

170. **From these new paradigms comes a clear focus for government. Policy must help to guarantee a domestic supply of energy which is reliable and free from disruption caused by geopolitical conflicts.** The British Energy Security Strategy (BESS) went some way to recognising this, increasing ambitions for offshore wind, nuclear and hydrogen production and signalling reform of the planning system to catalyse deployment of renewables. As we set out below, government must set out clear policies, lay regulatory foundations and unblock processes to ensure we not only deploy the technologies but build the skills, jobs, and supply chains within the UK. With inflation soaring globally because of high energy prices, this action will also help guarantee an affordable supply of energy for consumers and businesses for the long term.

2.1.2 How energy security can lay the platform for the net zero transition – addressing supply

171. **We must double down on production of renewables, nuclear and hydrogen and other low carbon fuels to give our future energy system a homegrown, secure platform.** In the long run, production of hydrocarbons will be replaced with these cleaner alternatives. Future Energy Scenario modelling by National Grid Electricity System Operator (ESO) highlights that without aggressively tackling demand through electrification of transport and heating, coupled with greater energy efficiency, we will face an expensive and potentially destabilising dependence on oil and gas imports.[143]

172. **However, in the short term we still need oil and gas to secure our energy independence and as transition fuels towards 2050.** We will continue to be dependent on gas and its wholesale price for multiple years, including for heating buildings and marginal production within the power sector.[144] Also, while demand will fall in some parts of the economy such as surface transport, all major forecasters expect resilient or even growing demand for other parts such as petrochemicals.[145] Petrochemical products are ubiquitous and integral to modern societies. They include plastics, fertilisers, and medical equipment, and are also found in many parts of the modern energy system, including solar panels, batteries, and electric vehicle parts.[146] Alternative technologies have not been fully scaled up yet, and therefore demand for oil and gas will remain.

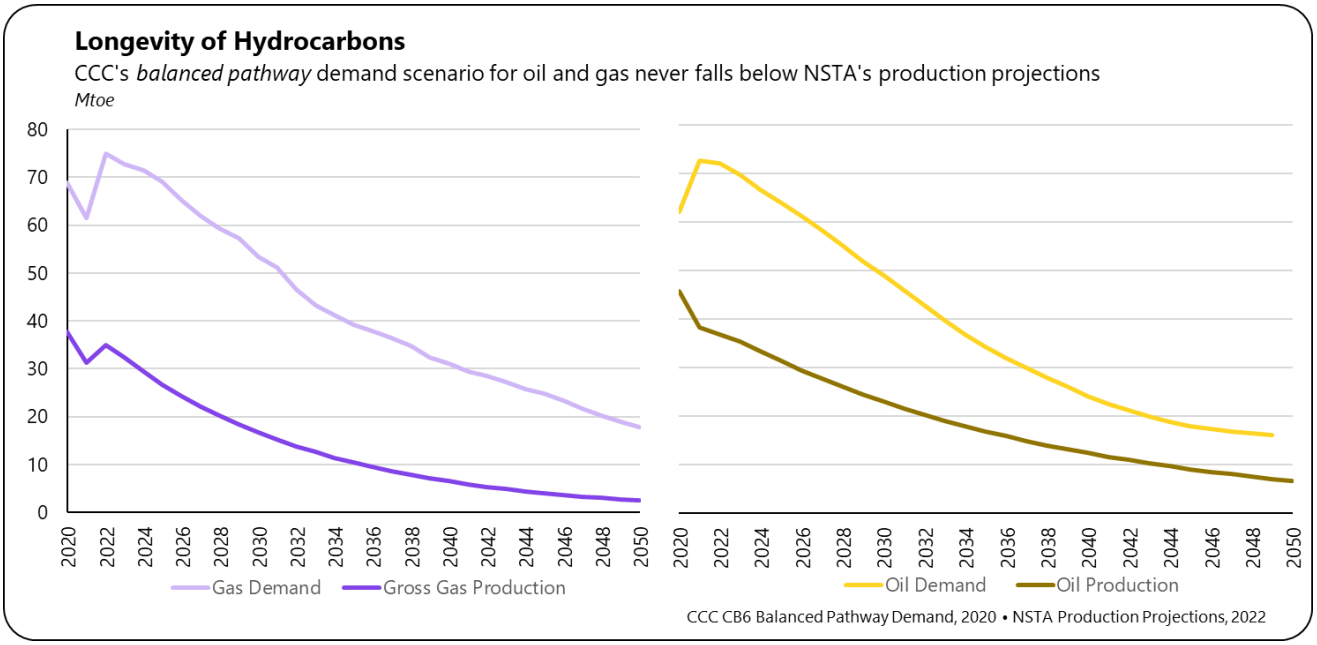


Figure 2.3 – *Comparison of North Sea Transition Authority's production projections against the Climate Change Committee's*

173. That is why, only when absolutely necessary for security, we need **domestic** production and storage of fossil fuels to reduce our vulnerability to international oil and gas imports.

174. The North Sea Transition Authority has been clear in written evidence provided to the Review that "the [UK Continental Shelf (UKCS)] can demonstrate emissions reduction from oil and gas production whilst meeting our security of supply needs".[147] The BESS affirmed this, setting out a strategy to reduce dependence on imports of oil and gas by increasing dependence on the UKCS and setting an ambition to reduce gas demand by 40% by 2030 through increased efficiency and faster uptake of renewables. This has also been reflected in industry action. Centrica recently reopened its Rough gas storage site at around 20% of capacity, enough to heat 1 million homes for 100 days this winter.[148] This will help balance the grid by storing gas when there is a surplus and withdrawing when demand peaks during cold weather. Increasing flexibility like this is a crucial means by which we can deal with the crisis without having to significantly increase production of natural gas.

175. **Replacing imports of liquefied natural gas (LNG) with domestically sourced natural gas does not have to come at the cost of meeting our carbon budget targets.** The production of natural gas from the UKCS can create less than half as much greenhouse gas as imported LNG.[149] At the same time, we must do more to make the extraction of oil and gas cleaner. Importing gas via pipeline from Norway produces a lower average emissions intensity than UK domestic production.[150] We must therefore find ways to make extraction as clean as possible and avoid stranded assets.

2.2 Future energy security - supply chains

The net zero transition will only succeed if it is **underpinned by secure and resilient supply chains**. This security is threatened when **only a small number of nations dominate the sourcing, production, and processing of minerals and materials**.

It is vitally important that government, industry, innovators, and consumers have a **clear understanding of the supply chain requirements** for each of the sectors critical for delivering net zero. Once this direction is clear, steps can be taken to ensure these supply chains are **internationally diverse and, where possible, contributing to a growing domestic circular economy**. The *Critical Minerals Strategy* goes a long way to progress this, but government can and should do more to ensure the same is being applied across all relevant supply chains critical for delivering materials to meet net zero by 2050.

This section recommends that the Government should, by autumn 2023, **undertake net zero infrastructure and technology critical supply chain analyses** to inform decisions at the next Spending Review on where support akin to the Automotive Transformation Fund could add value.

176. **In the longer term, energy security will look different.** As we transition to net zero we will encounter new concerns relating to the resilience of our critical supply chains (including, critical minerals). The International Energy Agency's *World Energy Outlook 2022* highlighted the need to manage new vulnerabilities as one of the key principles needed to enable a secure transition. It is therefore vital that the UK ensures our net zero supply chains are resilient.

177. **The UK's supply chains for critical minerals are not as resilient as they could be.** Stakeholders from across sectors including Rolls-Royce plc, Imperial College London, Royal Academy of Engineering, and participants attending a critical minerals roundtable hosted by the Review were clear that the UK could experience limited access to critical minerals necessary for the delivery of net zero technologies and infrastructures. Many net zero technologies and infrastructure – from batteries to offshore wind farms – rely on the incorporation of critical minerals such as lithium, graphite and cobalt. A typical electric car alone requires six times the mineral inputs of a conventional car.[151] Moreover, extraction and processing of critical minerals required for decarbonising technologies are highly concentrated globally. This has bottle-neck potential and geopolitical implications. Disrupted supply chains and rising mineral costs created through limited diverse suppliers could increase the cost of clean energy technologies and slow deployment.[152]

> *"…emerging "import dependency" on critical minerals required in key decarbonisation technologies should be a priority energy security question. Ensuring stable access to these resources, and the development of alternatives where appropriate, to manufacture products such as electric vehicles and wind turbines is essential to maintaining net zero progress and momentum. The failure to secure appropriate supply risks slowing the transition, with associated risks to technology development and innovation and price if it is not possible to produce or deploy at scale."* – Royal Academy of Engineering[153]

2.2.1 Investing in a domestic circular economy

178. **Making supply chains more resilient through enhanced domestic midstream (processing of materials) and recycling capabilities will create export potential and reduce consumer costs.**[154]

179. Stakeholders argued that investment into such capabilities will increase the number of green jobs. For example, the UK EV battery production workforce is predicted to increase to 78,000 new roles by 2040.[155] Additionally, stakeholders highlighted that recycling materials through supply chains will strengthen the UK circular economy (see ***Pillar 3***) and lessen reliance on more volatile networks, in addition to creating opportunities for stable business growth.

180. **The UK Government has already started to act in this space.** It published the *Critical Minerals Strategy* in 2022 which acknowledges the need to make UK supply chains more resilient and the importance of diversification in doing so. However, stakeholders advised that it is important that the Government sets a precedent for other sectors to follow through its procurement processes. For example, the British Metals Recycling Association outlined that the UK Government has an opportunity now to "put in place strong green procurement policies, especially within national infrastructure projects where the Government could require certain levels of recycled metals to be used."[156]

2.2.2 International diversification

181. **The UK relies on a handful of nations to deliver its net zero supply chains.** As pointed out by stakeholders in the critical minerals roundtable, this lack of diversity creates risk and undermines the resilience of the supply chains. Demand for these minerals will only increase as more nations, including the UK, transition to net zero. It is therefore vital that the UK diversifies its partnerships for sourcing critical minerals throughout the supply chain process (i.e. raw materials, components etc.). The *UK Critical Minerals Strategy* aims to achieve diversification via diplomatic multilateral and bilateral collaboration with international partners, and through support to private UK companies. This work should continue to be prioritised, and such diversification should be reflected in other critical net zero supply chain analyses and strategies.

2.2.3 Analyses to understand critical supply chains for net zero delivery

182. **Whilst it is promising to see a focus on net zero considerations in the *Critical Minerals Strategy*, stakeholders such as the Royal Academy of Engineering advised that a wider and more holistic understanding of critical supply chains for net zero is lacking.**

> *"…There is an urgent need for a coordinated strategy that sets out the role of different materials in the net zero transition... A coordinated strategy would prioritise scarce materials that will be key to a successful net zero transition."* – Royal Academy of Engineering[157]

183. **We do not fully understand what the critical supply chains for net zero will look like.** Stakeholders told the Review that there is insufficient clarity regarding which parts of the supply chains for net zero technologies and infrastructure will be housed within the UK, and therefore regarding what the demand for critical mineral importation will be (i.e., whether the UK will require critical minerals raw, or processed, or as part of a component etc.). Understanding the composition of supply chains is vital to understanding how the net zero transition will be materially delivered. Investing in and securing critical net zero supply chains now will send strong assurance to investors and consumers of guaranteed uninterrupted production of our net zero technologies between now, to 2050 and beyond.

2.2.4 Consider funding approaches

The Government should, by autumn 2023, **undertake net zero infrastructure and technology critical supply chain analyses to inform decisions at the next Spending Review** on where support akin to the Automotive Transformation Fund could add value.

184. **The UK relies on just a few countries to supply, process, and refine many of the materials required to deliver net zero technologies and infrastructure.** For example, China accounts for 75% of manufacturing and assembly of solar PV modules and electric vehicle batteries.[158][159] The Democratic Republic of Congo supplies more than 60% of cobalt.[160] And between now and 2035 global demand for critical minerals such as lithium and cobalt will require production to quadruple and double respectively.[161]

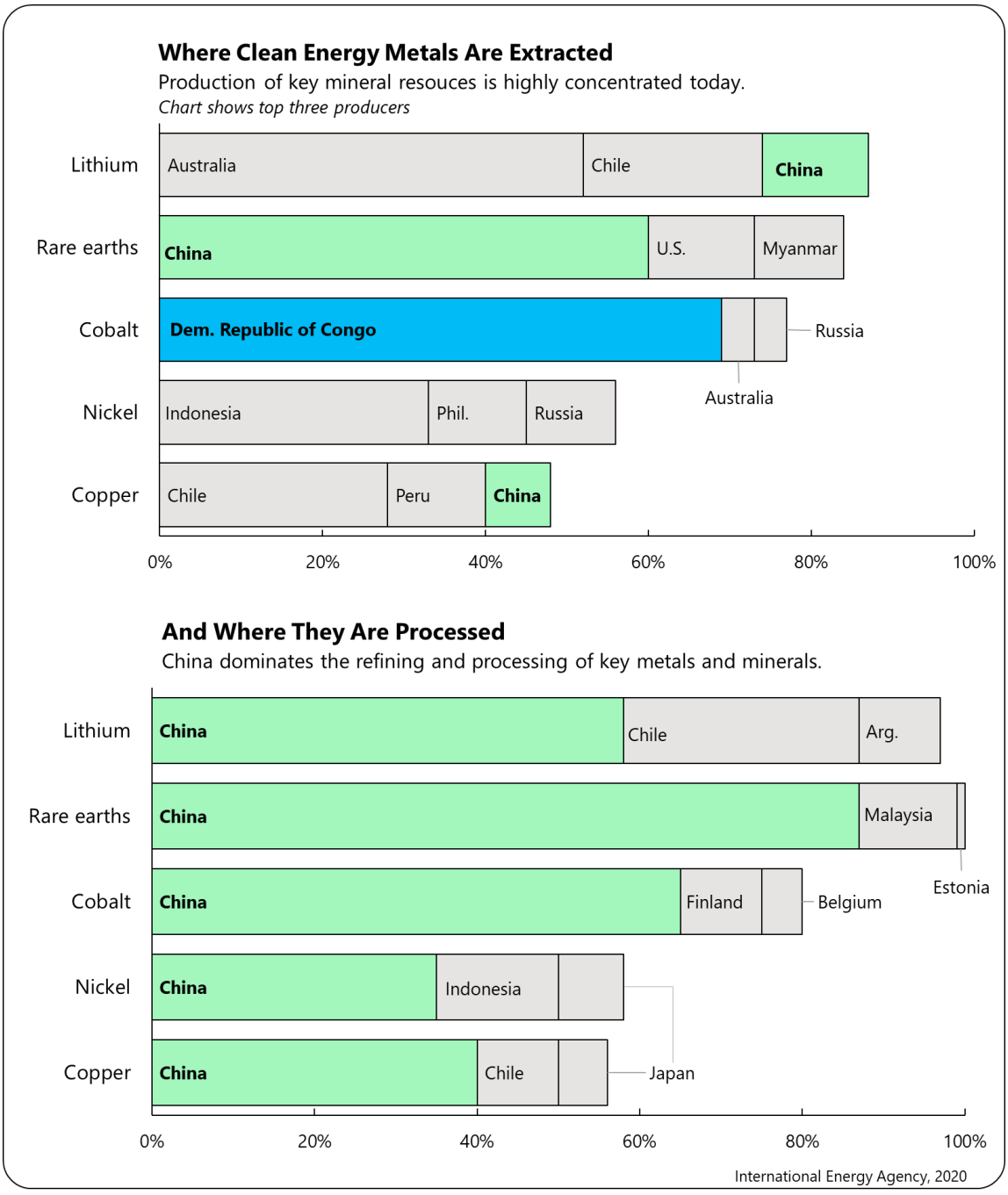


Figure 2.4 – ***Top three producers and processers of key materials and minerals***

185. This Review heard that the **UK has potential to become a global player in the critical minerals midstream market**. By increasing midstream and recycling capabilities the UK could create a secondary source of critical minerals and avoid the export of materials, thus supporting a circular economy.

186. **We have already seen the success of support for critical mineral supply chain domestic capabilities in the Automotive Transformation Fund (ATF).** The ATF provides up to £850 million to support the development of a zero-emission vehicle supply chain in the UK, which includes sourcing of the critical minerals used. The ATF supported the development of 'Green Lithium', the first lithium refinery which will provide over 1000 jobs, export opportunities, and reduce reliance on China.[162] If this fund were to be replicated in other critical net zero technology sectors it may have a similar success in increasing the domestic resilience of critical minerals and other essential supply chains they require. For example, the British Metals Recycling Association were confident that the grant application approach would benefit domestic recycling capabilities, advising:

> *"The Government should consider the development/implementation of sector-specific grants to support decarbonisation projects thereby creating the first metal recycling industry to be net zero in the world"*[163]

187. This Review recommends that the Government should, by autumn 2023, **undertake net zero infrastructure and technology critical supply chain analyses to inform decisions at the next Spending Review** on where support akin to the Automotive Transformation Fund could add value.

2.3 Energy Infrastructure

Decarbonising our energy supply requires **a fundamental rethink of our energy infrastructure and how we deliver power and fuel to the consumer**. Accelerated renewables deployment is not possible without ensuring that these **new production sites are connected to the power grid**. Moving to greener fuels will also have consequences for **our existing gas networks and fuel distribution**. Finally, we need to ensure that **our markets set the right signals** to support the changes.

Key recommendations:

- Government to update Ofgem's remit to incorporate the Government's net zero target as set out in the 2008 Climate Change Act.
- Government and Ofgem to work with network companies to facilitate anticipatory investments in grid infrastructure
- Develop by 2025 a long-term cross-sectoral infrastructure strategy by 2025, to adapt and build respectively the distribution of liquid and gaseous fuels, electricity and CO2 networks over the next decade.
- Deliver government's Review of Electricity Market Arrangements (REMA) as a priority to scale up electricity sector investment, unlock the benefits of renewables, reward flexibility and maintain security of supply
- Commit to outlining a clear approach to gas vs. electricity 'rebalancing' by the end of 2023/4 (depending on the fossil fuel prices), and should make significant progress affecting relative prices by the end of 2024.

188. **Securing net zero is a key part of the energy infrastructure that underpins how we need to reimagine the energy transition – not as an additional phasing in of green and clean power, but as a fundamental overhaul of the existing network.** The success of the National Grid in the 1960s, in bringing onstream more capacity than was needed at the time, now needs to be replicated with a similar 'National Net Zero Grid' mission or challenge. Just as National Grid led the way in establishing the UK as a global leader in how to deliver electricity at scale, we need to replicate this with the National Net Zero Grid. The National Net Zero Grid needs to demonstrate the ability – and above all agility – for renewable energy projects to secure a timely connection to the grid; for battery and other storage options such as hydrogen have access to that grid; and for the underpinning infrastructure requirements either at a transmission or at a distribution network operator level to be consistently and comprehensively operational without causing any further delays to decarbonisation. The Review has heard from multiple stakeholders, covering demand, flexibility, storage, and generation assets about the bottlenecks in grid connections, the constraints on the wider system and the limitations of current regulatory processes to build out networks at pace.

189. With costs for many renewable technologies coming down, the challenge is unlikely to be building new power capacity but how to integrate new, dispersed, intermittent renewable electricity generation to a grid designed for last century's needs. The problem extends beyond electricity to development of key infrastructure for fuels like hydrogen, where end use may vary into a wider system. Similarly, new technological hubs and clusters pose new challenges to our energy networks and distribution systems as well as markets, supply chains and skills.

2.3.1 Re-thinking electricity networks

Getting the network ready for net zero

190. According to National Grid, to deliver the Government's ambition of up to 50GW of offshore wind by 2030, industry must deliver more than six times the amount of electricity transmission infrastructure in the next eight years than has been built in the past 30 years.[164] Additionally, the UK will have to decarbonise whole sectors where electrification plays a key role ***(see Pillar 3)***, making the availability of clean, reliable power paramount to the whole economy.

191. **The Review heard from potential investors in renewables projects who are constrained by an inability to connect to the network at both transmission and distribution levels.** It is essential that electricity network capacity keeps pace with renewable generation ambition otherwise we will lose the confidence of investors, and consumers will be stuck paying costs of constraint management for years to come. UK consumers are already paying too much to constrain wind output. National Grid ESO modelling has estimated that constraint costs could increase from around £500 million per year in 2021 to a peak of between £1-2.5 billion per year in the mid-late 2020s, before falling away at the end of the decade when new major transmission investments are assumed to come online.[165] A policy and regulatory framework that continues a 'business as usual' approach will not be able to deliver the step change foreseen to meet our net zero ambitions. Government analysis suggests that overall electricity demand could increase from its current level of 330 TWh per annum to between 450-500 TWh by 2035 and between 570-770 TWh by 2050.[166][167] **In order to secure investment in transition and development of the electricity network, the Government and Ofgem must move faster, avoiding a piecemeal project-by-project approach and towards a wider programmatic framework.**

Network design, transmission, and distribution

Government and Ofgem should **work with network companies to facilitate anticipatory investments in grid infrastructure.**

192. **Long-term planning and a system-wide approach is needed to secure investments in the UK's electricity infrastructure now.** Under the current system, grid development only takes place once considerable demand has been identified, minimising investment. This slows down the pace of renewable energy development.

> *"The need for grid updates remains one of the largest blockers in the critical path of our offshore wind projects."* – BP[168]

193. As the UK's energy system transitions to net zero, investors and businesses need the Government and Ofgem to plan much more long-term to secure investment in future network capacity. Delays in expanding grid capacity mean that cheap, low carbon power is wasted. The Review heard that the lack of anticipatory investment in the electricity grid is already hampering deployment. It also heard warnings that similar challenges would beset the roll out of heat pumps and electric vehicles (EVs) at distribution grid level if we do not act swiftly. **The Review recommends that government and Ofgem work with network companies to facilitate anticipatory investments in grid infrastructure, to unlock renewables deployment and to build the necessary infrastructure for heat pumps and EVs.**

194. **The lack of a system-wide approach to grid development means that investments in renewable energy have been delayed**. A large pipeline of renewable projects has been

unable to connect to the grid and the Review has heard from numerous stakeholders that the lack of grid investments in the transmission network has created constraints on the network and led to delays in new renewables investments. The Government's *British Energy Security Strategy* (BESS) acknowledges this and included the Holistic Network Design (HND) to accelerate connecting network infrastructure and reform the UK's approach to grid development to support renewable deployment and benefit consumers.

195. **Government must accelerate delivery of its commitments made in the *British Energy Security Strategy*.** Rolling out the HND is critical to deliver the Government's ambition of up to 50GW from offshore wind by 2030 and ensuring long-term certainty for businesses.

196. The scale and interconnectedness of the transition needed in energy networks is too great to be left to individual projects to deliver without a strategic framework. The Review welcomes the re-introduction of the Energy Security Bill into Parliament and the inclusion of the Future System Operator (FSO). The Review heard from multiple stakeholders that creation of an FSO is an essential building block to support the development of a net zero energy system and taking a strategic approach to planning and development.

197. **The Review heard that the Future System Operator should be set up as quickly as possible and that its duty to advise government and Ofgem is used to support decision-making on key policies, including how network development across electricity, gas, hydrogen, and CO_2 network development can be co-ordinated and accelerated.**

Mission: A strategic framework and delivery plan for the critical grid and infrastructure networks of the future to turbocharge onshore and offshore development	
Issue heard by the Review	**Action recommended**
As a regulator **Ofgem is currently limited in its remit** and therefore cannot prioritise net zero accordingly.	Government should update Ofgem's remit to incorporate the Government's net zero target as set out in the 2008 Climate Change Act.
Delays in getting new power generation sites connected to the transmission and distributions grid risk undermining UK renewable and clean energy ambitions.	Government and Ofgem should work with network companies to facilitate anticipatory investments in grid infrastructure.
There is currently **no comprehensive overview of how infrastructure for different gaseous and liquid fuels and CO_2** will need to develop in the future, alongside changes to the power grid.	**Develop by 2025 a long-term cross-sectoral infrastructure strategy** for the transport and distribution of liquid and gaseous fuels, electricity and CO_2.

Mission: A strategic framework and delivery plan for the critical grid and infrastructure networks of the future to turbocharge onshore and offshore development	
Market design and regulations need to be adapted to increase further investment in generation capacity, system flexibility and provide more locational signals, whilst ensuring the system retains system operability.	**Deliver REMA as a priority**, to scale up electricity sector investment, unlock the benefits of renewables, reward flexibility and maintain security of supply.
The price of electricity needs to provide a clear signal to encourage use of low carbon technologies.	**Commit to outlining a clear approach to gas vs. electricity 'rebalancing' by end 2023/4** (depending on the fossil fuel prices), and should make significant progress affecting relative prices by the end of 2024. In outlining this approach, ensure that the distribution of the costs which make up energy bills are passed through to consumers, through their suppliers, in a way which is fair, affordable, and supports competition, decarbonisation and economic growth

Regulation and planning

Government should **update Ofgem's remit to incorporate the Government's net zero target** as set out in the 2008 Climate Change Act.

198. **Enabling businesses to make the best long-term investments requires the right regulatory framework. We risk failing to deliver the investments needed on time unless the regulatory and policy framework is updated**. Connecting the necessary low carbon power to the system to achieve our energy goals requires regulation change within the planning and energy regulatory systems, including reforming the remit and decision-making criteria of Ofgem.

199. **The Review recommends that Ofgem's remit is updated to incorporate the Government's net zero target as set out in the 2008 Climate Change Act.** Whilst doing this, the Government should consider whether this change could provide Ofgem with further opportunities to change its working practices to put even greater emphasis on investments and planning needed for the transition to low carbon electricity. This would support the BESS commitment to ensure that Ofgem "expedites its approvals process to build networks in anticipation of major new sources of generation and demand."[169]

200. **The UK planning regime needs to reflect the importance of energy networks expansion.** Stakeholders across the industry have highlighted planning as a key barrier for investments in renewable energy and energy networks. For the UK to build the network capacity needed for 2030, the timeframe to receive planning consent across both renewables and network expansion needs to be reduced significantly.

201. **The National Policy Statements (NPS) for Energy sets out the Government's policy for the delivery of energy infrastructure. In the BESS the Government committed to update**

these to recognise the strategic infrastructure needed as set out by the HND. This should reduce ambiguity, providing a clear direction on decision-making, including the role and expectations of stakeholders involved in the planning process. This would increase certainty for developers, speeding up delivery of renewable energy and energy networks expansions, vital to achieving the Government's renewables commitment.

202. Additionally, achieving a smoother planning process requires central government to work closely with local authorities which will be addressed further in ***Pillar 4***. Some stakeholders highlighted the need for locational pricing in order to ensure that local communities can benefit from the development of infrastructure in their area. This ties into wider needs for improving flexibility of the energy system (see below).

203. Government should act swiftly to implement the BESS, including updating the National Planning Statement to recognise critical infrastructure identified by the Holistic Network Design. This would enable a smoother process for renewable energy projects and energy infrastructure projects. This is needed to deliver the Government's ambition to decarbonise the UK's power system by 2035.

2.3.2 Gas networks and fuel distribution – challenges ahead

Government should develop a **long-term cross-sectoral infrastructure strategy by 2025**, to adapt and build respectively the **distribution of liquid and gaseous fuels, electricity, and CO_2 networks** over the next decade.

204. **There is still significant uncertainty as to the composition of future fuel demand across different economic sectors**. Government should consider how further certainty could be provided, including on future infrastructure requirements.

205. It will not just be electricity networks that power the green economy. We will need to repurpose old and build new infrastructure to support hydrogen networks for new industrial processes, a CO_2 network as the backbone of our CCUS facilities and we will still use our natural gas and fuel distribution network for many years. Work is underway to better understand the infrastructure needs of future sectors, including as part of the Government's *UK Hydrogen Strategy*, the *Future of Gas* programme and DfT's *Low Carbon Fuels Strategy*. However, there is currently no comprehensive overview of where there might be synergies between different fuels and how existing infrastructure might be repurposed. This carries the risk of stranded assets as well as infrastructure costs acting as a barrier to greener fuels. It also raises questions as to the distribution of costs, including for continued use of legacy infrastructure and its decommissioning.

206. While this work is highly dependent on technological progress and deployment of different technologies, government should consider how to foster cross-sectoral collaboration in this area.

207. This Review recommends developing by 2025 a long-term cross-sectoral infrastructure strategy to adapt and build respectively the distribution of liquid and gaseous fuels, electricity and CO_2 networks over the next decade.

208. The strategy should consider future use of hydrogen, biofuels and other low carbon fuels as well as oil and gas across sectors including power, heating and transport. This could help

identify potential synergies as well as infrastructure gaps, helping address barriers to new projects.

2.3.3 Developing energy markets to meet future needs

Government should commit to outlining a clear approach to **gas vs. electricity 'rebalancing' by the end of 2023/4** (depending on the fossil fuel prices), and should make significant progress affecting relative prices by the end of 2024. In outlining this approach, **ensure that the distribution of the costs which make up energy bills are passed through to consumers**, through their suppliers, in a way which is fair, affordable, and supports competition, decarbonisation and economic growth.

Government should **deliver REMA as a priority**, to scale up electricity sector investment, unlock the benefits of renewables, reward flexibility and maintain security of supply.

209. **We need to ensure that energy markets provide the right signals to market participants and investors in the transition to net zero.**

210. **The UK has been leading in the design of liberalised energy markets. However, the integration of new technologies also poses new challenges.** The ongoing review of electricity market arrangements (REMA) considers what changes are necessary to increase further investment in generation capacity, increase system flexibility, provide more locational signals to minimise costs, **ensure the system retains system operability and how to manage price volatility.**

211. **The REMA reforms, which government has consulted on, were generally welcomed by respondents to the Review**. Respondents highlighted the possibility for REMA to unlock smart energy systems and digital energy innovation. Stakeholders also highlighted the need for a more holistic perspective in the future, including how the electricity market of the future is to interact with other markets, such as gas and hydrogen. Alongside reforms to the wholesale energy market, the retail market will also need to play a crucial role in enabling the transition to a net zero energy system as it is the main interface between energy users and energy suppliers.

212. **The past approach of levying policy costs and taxes onto electricity bills keeps the price of electricity artificially high and can stifle the signal for the use of low-carbon technologies,** from electrifying industrial fuel use to vehicles and heat pumps. Analysis conducted for the Review shows that keeping the relative price of electricity vs. gas consistently competitive on a long-term basis will be the single biggest determinant of ensuring that the transition brings a significant amount of savings to the average household. For example, we found that a gas price below 150p/therm[viii] is a reasonable tipping point beyond which rebalancing would make a difference in helping many more households save after installing a heat pump.

213. Recent BEIS fossil fuel price assumptions made available to the Review expect the price of gas to drop towards 2019 levels by 2024 in most scenarios, except in the extreme scenario where it

[viii] For reference, the UK gas price average in 2022 has been at around 200p/therm, Source: Bloomberg, UK NBP day-ahead prices last price settlement.

remains high. Government should, therefore, use this as a trigger, and commit to making significant progress on gas vs. electricity price rebalancing by the end of 2023, or by the end of 2024 if the gas price remains at a clearly elevated threshold.

214. **The Government previously stated an intention to consider rebalancing these costs, but it should provide more policy certainty and use the opportunity of REMA to complete this ambition.** Solutions previously discussed by government in the *Net Zero Strategy* include shifting or rebalancing energy levies (such as RO and FiTs) and obligations (such as ECO) away from electricity bills, but the options are manifold, as described in the international examples below.

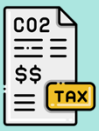
Option	Description	Examples	Advantages	Disadvantages	Key considerations
Lower tax on electricity for heating 	Lowering the tax rate applied to electricity that is used for heating	Denmark	Simplicity No negative impact on low-income customers	Loss in revenue If tax rate is low to start with, impact is limited	Potential for incentivising excessive electric resistive heating
Shift levies to fossil fuels 	Levies are shifted from electricity to fossil fuels	Netherlands	Simultaneously lowers cost of clean heating and increases cost of fossil heating	Impact on low-income customers using fossil fuels	Need to ensure low-income customers are not disadvantaged, and protected from impact
Shift levies to public budget 	Levies are shifted to the public budget	Germany	No negative impact on low-income customers	Additional cost item in public budget	Potentially less stable funding for clean energy programmes previously funded through levies
Environmental taxation 	Fossil fuels are taxed based on environmental impacts	Swedish carbon tax	Simplicity Source of additional revenue to support heat decarbonisation	Impact on low-income customers using fossil fuels	Need to ensure low-income customers are not disadvantaged, and protected from impact

Figure 2.5 – *Regulatory Assistance Project analysis – Options to rebalance electricity and gas price*[170]

2.4 Energy Supply

A **secure energy supply is the foundation for all our economic activity**, as we need power and fuels to manufacture products, transport goods and people, and deliver power and heat to homes. Decarbonising our energy supply has wider, positive impact on our economy and society, and **we need to go further faster to build new, clean power supply, increase the power system's flexibility and replace our fuels with greener alternatives**.

215. **Energy has historically been the biggest source of carbon emissions in modern society.** The UK has made significant progress in moving away from fossil fuels as a primary energy source. Evidence shows that carbon emissions from the power sector alone have fallen by more than 70% since 1990 (see Figure 2.6 below)[171] and the Review has heard support for the high ambitions set out by the Government to go further in both power and other energy uses. However, more will still need to be done to deliver on these ambitions and ensure that the UK benefits from the economic growth opportunities these changes offer.

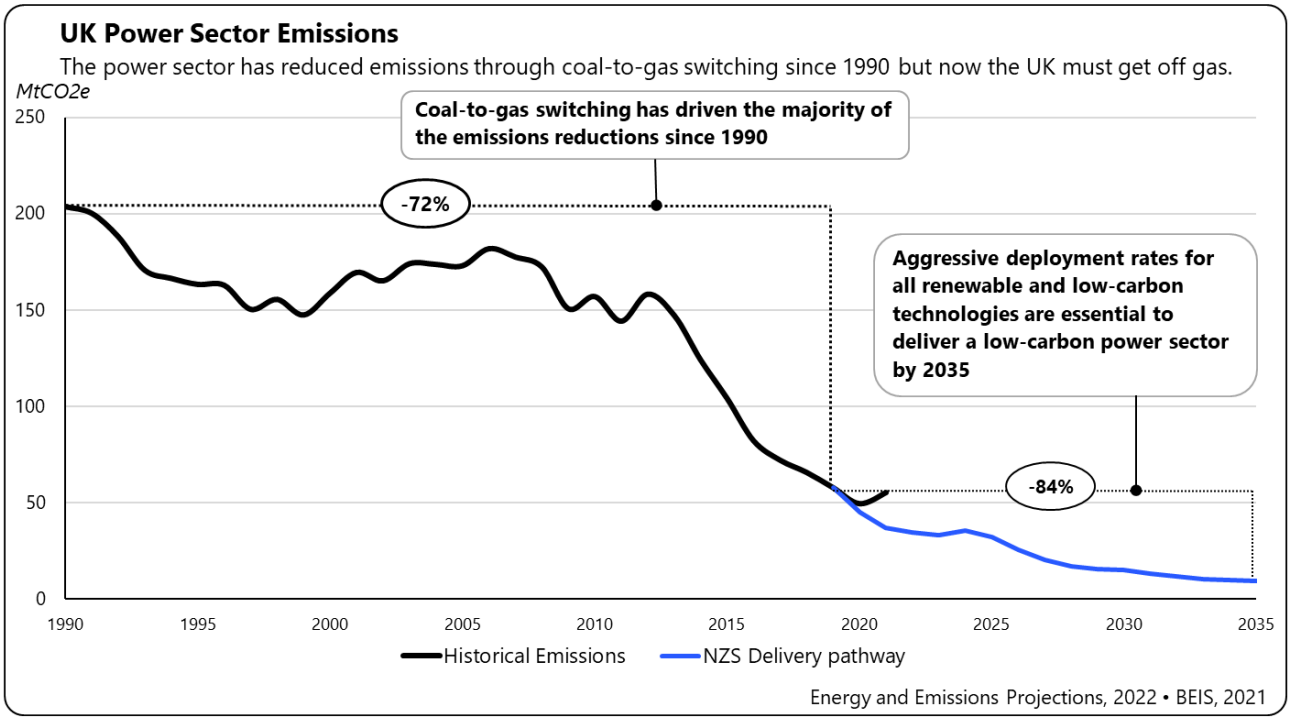


Figure 2.6 – *UK power sector emissions over time*

216. **The costs for renewable technologies have fallen dramatically and their use will reduce overall costs**. In the last decade, costs for solar PVs and onshore wind in the UK have come down by 78% and 36%, respectively (see Figure 2.7 below).[172] For most of the world's population, solar and onshore wind are the cheapest source of new-build power generation,[173] and most renewable technologies are now cheaper than coal-powered plants.[174] Once installed, renewable energy generation typically needs no further fuels[ix] and therefore reduces dependence on volatile fuel prices. Modelling by the International Energy Agency estimates that achieving net zero will reduce the impact of fossil fuel price shocks on household energy bills.[175]

[ix] The exception to this is for example biomass.

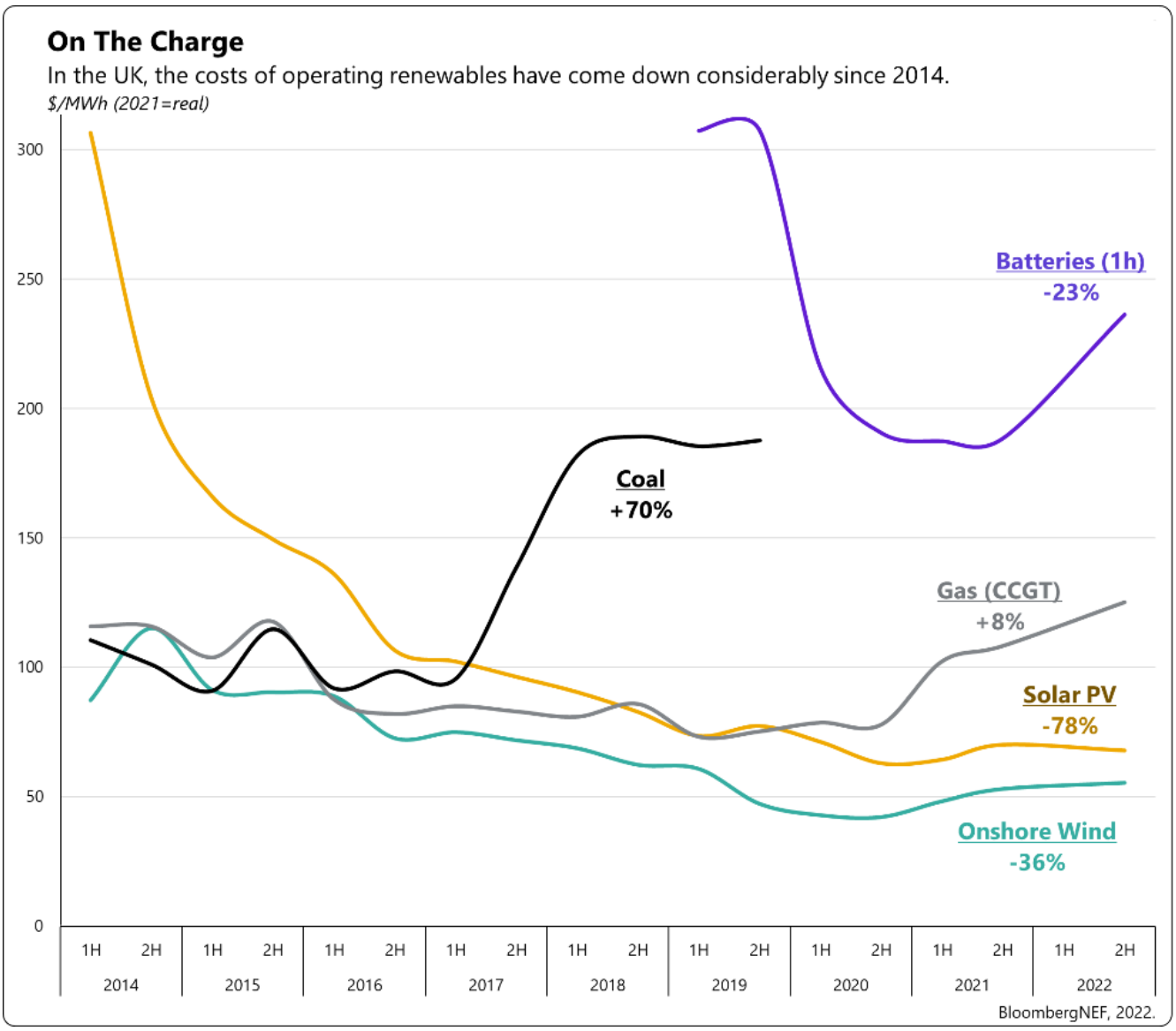


Figure 2.7 – *UK levelised cost of electricity (LCOE) data*

217. **The growth in clean energy sources has opened up new economic opportunities in the UK.** According to industry figures, 1 in every 48 jobs is in the energy sector or 138,000 direct and 605,000 indirect jobs, with the sector contributing £40bn of the UK's gross value added (GVA).[176] The five-fold increase in renewable energy generation since 2010 created new jobs across the country. ONS data suggests that in 2020, more than 200,000 people were employed in the UK low carbon and renewable energy economy, which had a turnover of £41.2bn.[177] Bloomberg New Energy Finance (BNEF) estimate that in 2021 alone, around $31 billion of new investment was committed in the UK across low carbon sectors.[x178] Research suggests that investments in renewables over the last decade have led to a return of over 400%, compared to 59% for investments in fossil fuels.[179]

218. **The UK is attracting significant investments and leading in the deployment of renewable technologies.** In EY's 2022 *Renewable Energy Country Attractiveness Index*, the UK ranked third, after US and China.[180] In particular, the UK has been leading on the development of offshore wind.[181]

[x] Low carbon sectors covered renewable energy sources, hydrogen, carbon capture and storage, nuclear, sustainable materials, energy storage, electrified transport, and heat.

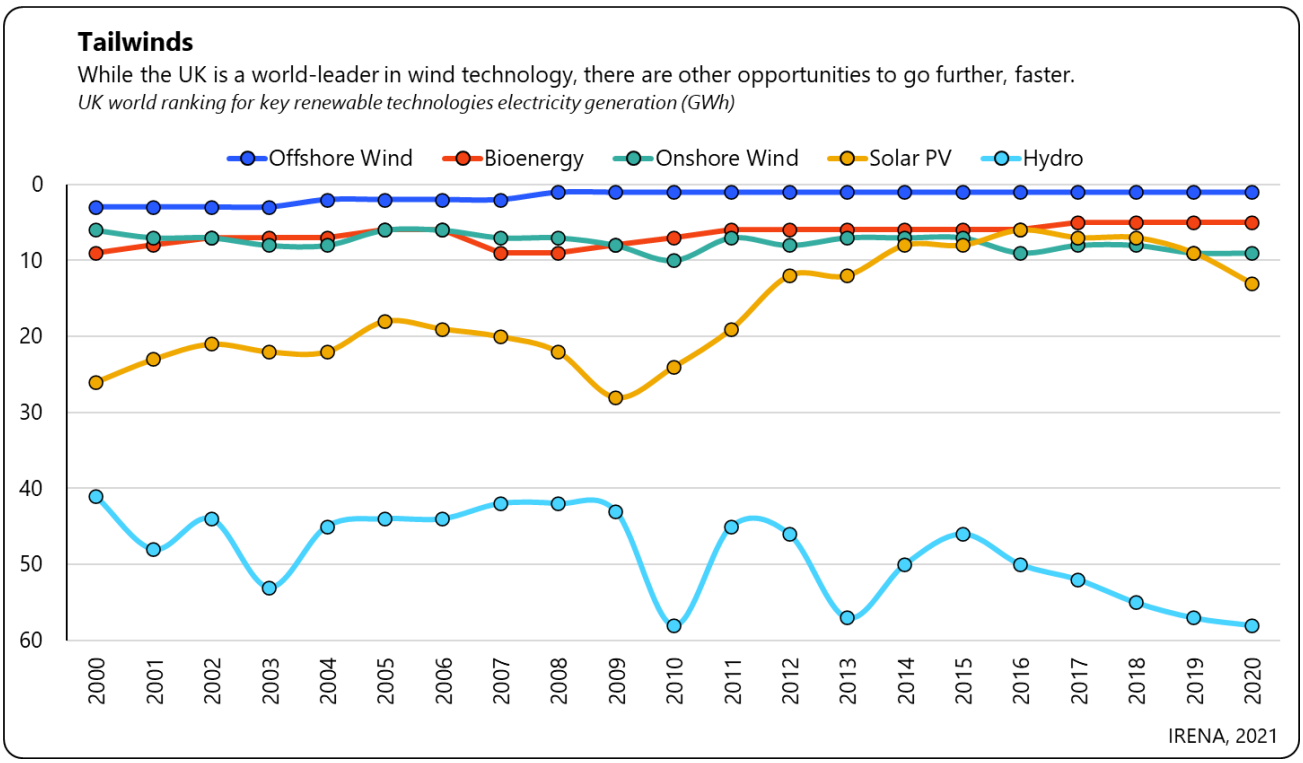


Figure 2.8 – *UK's world ranking in key renewable energy technologies*

219. **However, the UK is in a global race to transition to cleaner and greener energy sources.** The IEA estimates that to reach net zero, global annual clean energy investments will need to triple to around $4 trillion by 2030.[182] Around the world, countries have enacted ambitious policies, including for example the US Inflation Reduction Act, the EU's 'Fit for 55' package, Japanese plans to build new nuclear or Chinese investments in renewable energy. Growth in these markets can be an export opportunity for UK supply chains but may also negatively impact on the UK's access to components and skills. To profit from the export opportunities these global changes offer, the UK must act decisively now to develop these supply chains. Otherwise, we will end up buying in technologies from abroad and missing the chance to create high quality British jobs.

220. **The UK will need to move fast to lead on development and deployment of technologies as well as to build up the necessary supply chains and skills.** In doing so, the UK also needs to reduce the risks of creating bottlenecks and resource dependencies that may affect prices in the long-term. The Review heard from industry that:

> *"Increasing investment and growth in the UK supply chain is also a necessity if we are to develop the renewable energy required […], and mitigates the risk of fluctuating availability in global supply chains."* – RenewableUK[183]

221. According to an estimate by National Grid, the energy sector will need to recruit for 400,000 jobs between now and 2050.[184] These roles will be spread across every nation and region – 60,000 in the North West linked to offshore wind, 40,000 in the North East, Yorkshire and the Humber linked to offshore wind and carbon capture, usage and storage (CCUS), 50,000 in Scotland for both onshore and offshore wind, and 25,000 across a number of possible net zero hubs in Wales. Many of these jobs will be highly skilled and well-paid.[185]

222. **Recognising the importance of decarbonising our energy sources, the Government has ambitions for a fully decarbonised power sector by 2035**. This requires the installation of

new clean power production capacities such as renewable energy sources and nuclear. These new installations will also need to meet new demand from sectors such as heating, transport and industry, as electrification is expected to play a major role in their decarbonisation.

223. **Not all our energy needs can be met with electricity and so we will continue to need liquid, gaseous and solid fuels**. Government has therefore set ambitious targets for greener fuels, including hydrogen, low carbon fuels produced from biomass and other waste resources for use in different sectors such as transport, heating, power and wider industrial applications.

224. **The transition will also need to be supported by wider changes to the energy system, including changes to markets, transmission and distribution networks**, which support the building of new production capacities and transport the energy to where it is needed. Indeed, as prices for renewable electricity have come down, many stakeholders consider expansion of enabling infrastructure including electricity grids to be the key to unlock further investments. For the power sector, the upcoming Review of Electricity Market Arrangements (REMA) should address some of the changes needed. Further changes are needed to ensure that the distribution of policy costs added to bills are passed through to consumers, through their suppliers, in a way which is fair, affordable, and supports competition, decarbonization, and economic growth.

225. **Respondents to the Review's call for evidence and participants at the roundtables generally welcomed the Government's ambitions to decarbonise UK energy supply. However, businesses and other stakeholders were also clear that more concrete steps still need to be taken to deliver on these ambitions** and support growth in the UK. Stakeholders involved in new energy projects highlighted that current ambitions are at risk due to administrative, infrastructure and supply chain constraints that can significantly slow down and delay projects, and that streamlining planning decisions or environmental permitting would speed up delivery. Businesses also made clear the need for long-term certainty on policies and support available to unlock investments. Many respondents highlighted the benefits of taking a long-term view connecting energy, industry and innovation policies to help build UK production, supply chains and skills. Given the challenges ahead, many also stressed that the regulatory framework needs to allow for more innovation and risks.

2.4.1 Decarbonising our power supply- expediting renewables

We need to go further, faster to achieve government's ambitions set out in the ***British Energy Security Strategy*** **of 50GW of offshore wind by 2030** and **up to 70GW of solar power by 2035**.

Key recommendations:

- Together with regulators and industry, set up a task force and develop deployment roadmap for onshore wind in 2023 including clear milestones to reach required deployment levels for 2035 net zero grid, following the example of the offshore wind sector.
- Together with regulators and industry, set up a task force and develop deployment roadmap for solar power in 2023 including clear milestones to reach up to 70GW by 2035.
- Work with regulators, devolved administrations, local authorities, industry and key stakeholders to streamline the planning and environmental permitting processes to ensure new power generation can come online as soon as possible.

226. The proportion of annual electricity generated from renewables in the UK has grown fivefold between 2010-2021,[186] with 2020 marking the **first year in the UK's history that electricity came predominantly from renewable energy.**[187] Costs for leading renewable technologies, such as wind and solar, have dramatically fallen over recent years, making them a cost-effective way to reach net zero. The UK is attracting significant investments and leading in the deployment of renewable technologies.[188]

227. **Renewables projects create jobs and growth across the UK.** According to figures by the Association for Renewable Energy and Clean Technology (REA), over 140,000 people were already employed in the renewable energy and clean tech sector in 2021/22, with more than half in the power sector.[189] They also predict that by 2035, the sector could support a further 70,000 jobs and the market value could double to £46bn.[190] According to RenewableUK the offshore sector alone currently invests "around £10bn to the UK economy each year, supporting 31,000 jobs at present – but this is set to rise to 97,000 jobs by 2030, supported by £17bn a year of investment".[191]

228. **As a first mover, the UK has specific advantages and export opportunities in offshore wind. The UK is home to hundreds of supply chain companies in offshore wind and is already exporting offshore wind goods**. The UK has particular expertise in the second-largest sub-sector market, operations and maintenance. The value of those exports could increase fivefold to £2.6 billion by 2030 as global markets are expected to increase rapidly to £30bn per year and with potentially 380GW by 2030.[192]

229. **The UK is also a first mover on floating offshore and tidal stream technologies**, and further investments in those technologies could create distinct advantages. The ambition of 5GW floating offshore by 2030, as expressed in the *British Energy Security Strategy*, could deliver a GVA of £43.6 billion and 29,000 jobs in the UK, while tidal stream (which currently uses on average 80% of UK content[xi]) could support 14,500 jobs by 2040.[193]

230. **We will need action to scale up across all renewable technologies to ensure a diversified energy mix.** The Review heard that more can still be done to increase local content in the jobs and reduce dependency on technology imports. In an international comparison, the UK is also lagging in the deployment of other established, low-cost technologies such as onshore wind and solar.

231. Stakeholders told the Review that **there are still further opportunities for established, low-cost technologies, such as onshore wind and solar** (which stakeholders believe could achieve as much as 30GW by 2030 and 70GW by 2035 respectively). The Review heard that

> *"Introducing new policy measures, such as, allowing solar panels and onshore wind to be more readily approved are key for quicker decarbonisation of the grid."* – UK Corporate Leaders Group[194]

232. Several argued for a specific onshore wind target, alongside government ambitions set out for offshore wind and solar:

> *"Building the new onshore wind farms needed to meet 30GW by 2030 would support 27,000 high value jobs across development, supply chain and operations activity."* – RenewableUK.[195]

[xi] This term relates to UK contributions to the manufacturing of key technology parts, installation, commissioning as well as operation and maintenance services deployed at a site.

233. Similarly, stakeholders highlighted the importance of technologies such as hydro or biomass combined with carbon capture and storage (CCS), which could help balance the grid and provide wider benefits such as energy storage and negative emissions, respectively. Stakeholders also raised opportunities related to technologies that are not widely deployed to date, such as geothermal or tidal range.

234. **Industry has made clear commitments to further investments in the renewable sector and have many projects are in the pipeline**. However, projects are slowed down by administrative, infrastructure and supply chain constraints that put the Government's 2035 ambitions at risk. Tackling this requires a root and branch rethinking of the nation's future energy requirements, based mainly on the transition to an electricity-only power supply, and what that will mean if we are to guarantee that the lights stay on in a more electricity-dependent society. It is clear that renewable and clean power provide more than enough opportunity to meet the needs that gas and fossil fuels have done in our power supply; it is essential for public confidence that this can be demonstrated clearly and consistently along the net zero transition pathway.

235. **This Review sets out a range of areas for action to help deliver further faster on our renewable ambitions, including catalysing action through missions on onshore wind and solar.** Further detail on these missions is at the end of this section. Alongside the implementation of ambitious policies for offshore wind, these missions will enable a renewables revolution with wider economic benefits in the short-term.

Securing long-term policy certainty

Government, regulators and industry should **set up taskforces and develop deployment roadmaps for onshore wind and solar respectively in 2023** to reach required deployment levels for 2035 net zero grid, following the example of the offshore wind sector.

236. The UK government has set ambitious targets for renewable electricity. In their responses to the Review, businesses confirmed their commitment to invest further**. However, many businesses made it clear that government will still need to set out more concrete steps on how ambitions are to be met.** The Review heard that:

> *"There is no shortage of investors wanting to enter the market, but a lack of policy stability and suitably de-risked business models is stopping such finance entering the market."*
> – Association for Renewable Energy and Clean Technology[196]

237. **While there are interim targets and a roadmap for offshore wind, the Review found that it is less clear how the Government plans to deliver on ambitions for other technologies, including solar and onshore wind**, in a way that will also support UK growth and jobs. Many respondents to the Review highlighted that collaboration between government and industry in the Offshore Wind Acceleration and Floating Wind Taskforces has "been very effective in establishing opportunities for supply chain development, the necessary enabling policy measures to unlock investment and the coordination of initiatives".[197] They suggested establishing similar bodies for technologies that "would benefit from a more strategic discussion about how potential industrial growth could be maximised"[198] such as the onshore wind industry.

238. Following the example of the offshore wind industry, **the Review therefore recommends that government sets up joint task forces with the respective industries on onshore wind and solar and develops a roadmap for their deployment to support supply chain development.**

239. At the same time, government should continue to work with industry to explore deployment opportunities in other renewable sources, including ocean energy, hydro, geothermal to support their development and deployment. Some of these technologies may be at a slightly earlier stage of development or provide opportunities in terms of balancing the grid (e.g. hydro, geothermal, biomass with CCS).

CASE STUDY: Offshore Wind Sector Deal

Building on the UK's leading role in offshore wind deployment, government and industry agreed in 2019 the Offshore Wind Sector Deal.[199] *Built around key pillars of the* Industrial Strategy *(Ideas, People, Infrastructure, Business Environment and Places) it contains a number of commitments on both sides to maximise advantages for UK industry.*

This includes a government commitment for regular Contract for Difference (CfD) auctions as well as the sector's commitment to increase UK manufactured content to 60%, improve the representation of women in the work force and set an ambition to increase exports fivefold to £2.6 billion by 2030 and investments of £250 million in the UK supply chain, supported by the Offshore Wind Growth Partnership.[200]

240. **Stakeholders responding to the Review were also clear that a stop-start policy needs to be avoided at all costs**. The Association for Renewable Energy and Clean Technology (REA) highlighted for example that *"sudden policy changes, or reducing support for most affordable renewable technologies, including solar and onshore wind, reduces investor and developer confidence, increasing the cost of capital and overall cost of decarbonisation."*[201]Businesses understood that reforms to policy and support mechanisms will become necessary over time. However, they highlighted the need for any reform to be well-thought through before being announced and, once announced, the need for swift implementation to keep uncertainty to a minimum. Stakeholders also pointed out that *"the current political uncertainty and change of government has seen crucial legislation delayed"*[202] and urged for *"creating certainty by passing the draft Energy Bill (HL Bill 39) and moving ahead with wider planned reforms".*[203]

241. **Industry also asked for long-term certainty on the support available.** In particular, they raised the need for an early indication from government whether further support will be available when support schemes come to an end, such as the Renewables Obligation for landfill gas in 2027. There is a risk that, without any clear signals from government, businesses will put all investment decisions on hold for the time being. Similarly, the Review heard that *"to increase investor confidence in net zero infrastructure projects, a clear forward view of the regulatory and policy landscape is vital."*[204]

242. **To bring a higher number of projects forward at a faster pace, stakeholders also raised potential reforms to the existing CfD mechanism.** Many stakeholders stressed the need for a *"well-communicated timeframe for allocation rounds so as to drive investor confidence and grow the UK supply chain".*[205] Some respondents suggested that *"having six monthly CfD auctions, with clear rolling timetable and sufficient budget could see a significant pipeline of projects developed"* and *"ensure a route to market for all low carbon technologies"*. [206] Similarly, respondents called for *"a clear schedule of CfD auctions for the next 5 years"* to *"provide the certainty developers and the supply chain need to collaborate and partner well-ahead of annual auction cycle".*[207] Others criticised that:

> *"The existing CfD model focusses solely on lowest cost electricity. This in turn drives developer procurement activities to seek lowest cost supply markets (e.g. from China/wider*

global markets) to enable projects to remain economically viable at such low electricity pricing. […] The current CfD model thus misses the opportunity of helping foster the UK supply chain, with all the associated benefits this would bring such as jobs and the potential for export once that UK capacity has developed." – BP[208]

243. Stakeholders argued for the CfD mechanism to consider wider economic, supply chain and environmental impacts when contracting projects to ensure investments in the UK, as done in other countries. Some also pointed out that current Supply Chain Plans as a measure would be *"limited in its ability to support collaborative investment as every developer's pipeline is subject to the risk of failing to secure a CfD contract in any given allocation round"*[209] and that the CfD mechanism should be *"moving away from a single developer focus towards rewarding collaboration".*[210]

Streamlining planning, environmental permitting and grid access

Government should work with regulators, devolved administrations, local authorities, industry and key stakeholders to **streamline the planning and environmental permitting** processes to ensure new power generation can come online as soon as possible.

244. **Current ambitions to reach a fully decarbonised power sector by 2035 are at risk due to the time required for developers to go through securing planning permissions, environmental permitting and getting grid access.** Businesses highlighted that, taking offshore wind as an example, *"it currently takes around 3-5 years to move through the consenting phase which covers the work needed to secure consent and manage the development process through to financial close. This is due to a combination of under-resourcing within planning authorities and environmental regulators, unclear guidance to those bodies, and a lack of streamlining within the process".*[211] If we want to increase our renewable energy production to fully decarbonise the power sector by 2035, we need to shorten some of these timelines.

245. Whilst respondents noted that due process needs to be followed to ensure impacts of projects on communities and environment were fully considered, many saw significant opportunities to streamline and shorten current processes. Examples included, allowing for early engagement with the regulators and competent authorities to identify key issues to focus on, and allowing for anticipatory investments in regards to grids.

246. **The Review heard the need to build capacity and support for regulators and local authorities** to expediate processes. At the roundtables, stakeholders stated that it can currently take over 40 weeks for regulators to take a first look at an environmental permit. Stakeholders also highlighted the need to allow for more innovative approaches within existing frameworks and clearer guidance for local authorities. With applications increasing, the question of regulatory capacity becomes even more urgent. For example, over twice as many planning applications were submitted in 2021, compared to 2020 and nearly 1,000 applications in 2022.[212] This is also explored in ***Pillar 4.***

247. Different types of projects also need to comply with different processes, adding to complexity. Net Zero Review analysis found that over the past five years it took the average planning application over six months to be processed, with large applications (with capacity at 50 MW or above) taking over 1.5 years on average.[213] For the six offshore wind applications that have been processed since 2020, it took 2.5 years on average for a decision to be reached. Solar PV

and biomass applications are generally processed quickly, with the average application taking less than four months in the three years since 2020.

248. **While siting of renewable projects can be a sensitive area, technology-specific restrictions add unnecessary burden to the process**. The Review therefore recommends removing such restrictions where applicable and instead providing clear guidance on siting and potential measures to minimise impacts to support case-by-case decisions.

249. **Another key challenge for developers stems from the timelines for gaining grid access**. These can add major costs and delays to projects. Stakeholders therefore suggested more co-ordinated grid planning and roadmaps. Improving the grid infrastructure's ability to react to the needs of the industry will also ensure investment in UK renewables. Stakeholders highlighted that for developers, grid connection costs are a significant source of uncertainty:

> *"Indicated wait times for grid connections can be more six years, in some cases up to 10 years, creating a totally untenable position for renewable developers and financiers*." – Energy UK[214]

250. Respondents also pointed out that the current system design does not sufficiently account for local production and local and regional solutions.

Addressing supply chain constraints, skills and infrastructure needs

251. **The Review heard that the fast pace at which renewables need to be deployed across the country carries the risks of bottlenecks for technology parts, materials and skills, with some of these already appearing**. The lack of clear roadmaps means that projects compete for the same pool of labour and material. Some of the bottlenecks may apply across different technologies and sectors (for example cables, construction material and labour) whilst others may be very specific to a technology. Some of the constraints also relate to wider infrastructure.

252. **It is also important for the Government to help put in place the enabling infrastructure.** Businesses highlighted for example that the current UK port infrastructure does not support the assembly of offshore wind turbines. Investments in such infrastructure will be needed for more investments into UK offshore industry, particularly floating offshore wind.

253. To help address these issues, many respondents referred once more to the *Offshore Wind Sector Deal* as a good example of how government and industry could work together to identify, monitor and address these key issues. As highlighted above, the Review therefore recommends setting up similar task forces and roadmaps for other renewable technologies. This cooperation should identify potential bottlenecks in materials, infrastructure and skills and ways to address these. Similar to the offshore wind sector deal, technology-specific commitments to increasing resilience of UK supply chains should be considered.

254. Respondents also highlighted the need for this work to look at potential competition and synergy between sectors and encourage learning across different industries. Organisations like RenewableUK for example welcomed the Government's Green Jobs Taskforce and Power Sector Delivery group and highlighted that:

> *"It's important to recognise that, whilst renewables have specific skills requirements which have now been identified in detail, many of our skills shortages are shared with other sectors, and should be addressed holistically."* – RenewableUK[215]

Improving information and support to local authorities and businesses

255. **Throughout the Review, stakeholders highlighted the need for clear guidance on regulatory processes and support available.** In part, this related to the need for clear guidance, for example by central government to local authorities on the processes to follow (such as permitted development rights for smaller solar rooftop projects – see also above). Respondents also called for well sign-posted guidance by relevant authorities on what information would need to be included in applications. While many of these guidance documents exist, stakeholders often raised the general lack of awareness of these.

256. **The Review takes the view that Government, in cooperation with relevant authorities, should consider how to raise awareness,** including through running targeted information campaigns. In some areas, there may also still be the need to develop more guidance, for example more specific guidance for conservation areas or new rules and standards to prevent overshadowing of solar panels.

257. Many also stressed the importance of such guidance for households and small businesses that may be less familiar with processes and might be unsure who to employ. Government should work with local authorities, industry and certification bodies to explore how listings of certified installers in an area could be made publicly available.

258. **SMEs involved in the renewable sector may also require specific support and guidance.** Some stakeholders highlighted that the Government could do more to support SMEs. RenewableUK for example pointed out that *"many SMEs don't have a network to establish 'local partnerships' or the scale to create foreign subsidiaries,"*[216] calling for increased resource for DIT to help SMEs sell their products and services to export markets.

Unlocking benefits for communities and individuals

259. **For many households and smaller companies, upfront costs for installing renewable technologies like solar might also prove to be a barrier.** Government needs to ensure that these consumers have access to low-cost finance and are aware of the support measures available. This includes the Smart Export Guarantee (SEG) for small installations as well as tax benefits such as 0% VAT on solar panels.

260. **Small and medium-sized enterprises (SMEs) involved in the renewable sector may also require specific support and guidance.** Some stakeholders highlighted that the Government could do more to support SMEs. RenewableUK for example pointed out that *"many SMEs don't have a network to establish 'local partnerships' or the scale to create foreign subsidiaries,"*[217] calling for increased resource for DIT to help SMEs sell their products and services to export markets.

261. **Government will also need to ensure that the regulatory framework enables consumers and businesses to profit,** for example from any surplus energy they produce, and allow for new, innovative business models. Some examples of how consumers could benefit from different technologies and new types of services are set out in ***Pillars 4 and 5.***

262. This also includes paving the way and providing practical guidance on potential community benefits to communities. Organisations like National Grid stressed that *"it is important to recognise the vital role of communities in hosting energy infrastructure for the benefit of the wider society"*,[218] welcoming government's forthcoming consultation on community benefits. They highlighted that currently "significant community benefits cannot be provided in the current

regulatory regime due to the lack of a clear policy requirement and the associated regulatory funding".[219] This topic is also covered in ***Pillar 4***.

Creating an enabling regulatory environment

263. **Government will also need to make sure that the wider regulatory framework enables and, where appropriate, promotes the use of renewable energy.** Building standards could for example be used to make rooftop solar the norm for all new buildings, potentially starting with public and other suitable buildings. For example, France and parts of Germany have made solar panels mandatory for new car parks.

264. For certain technologies, there may also be specific regulatory issues. For example, there is the potential risk of wind turbines interfering with aviation radar. Businesses pointed to the joint Ministry of Defence and industry roadmap to ensure coexistence between offshore wind and military aviation, highlighting the need for this work to continue at pace as well as to be extended to civil aviation. In order to prevent these issues from slowing down renewable deployment, the Government should work with all stakeholders to identify viable compromises as soon as possible.

Promoting further technology development

265. **There is a clear need for continued support for R&D and technologies that are not yet fully commercialised and cost-competitive**. In particular, tidal stream, tidal range and wave are technologies that the UK could be leading on in the future. Similar to wind and solar, costs for tidal stream are forecasted to come down and the technology could become fully cost-competitive in 2030s. The technology has been included in the latest CfD round. For tidal range projects, one of the main barriers is the high upfront building costs, with suggestions that the sector would need similar deals as provided to the nuclear industry to become cost-competitive. The European Marine Energy Centre (EMEC), offering test facilities for marine energy in Scotland, stressed that:

> *"For commercialisation, the majority of the finance required will come from the private sector, but the risks and uncertainties associated with proving novel technologies will hold this back. The public sector has thus an essential role in supporting the deployment of pre-commercial technologies for demonstration purposes. Once successfully demonstrated it is inevitable that private investment will flow in and deliver at scale."* [220]

Mission: A solar roof-top revolution

266. **We need the full-scale deployment of solar, including through a 'rooftop revolution' that removes the existing constraints and barriers to solar panel deployment across residential and commercial buildings in the UK** (see also ***Pillar 5).*** To facilitate this, there should be no planning permission required to install domestic solar or commercial solar on the rooftops of buildings.

267. **New regulations and business models should be established to ensure that all current barriers to deploying energy back on to the grid from solar are removed.** As part of the 'solar revolution', the total number of installations and MW capacity per local authority should be monitored to drive deployment forwards, and local authorities with low deployment of solar generation should be supported by the Office for Net Zero Delivery (see ***Pillar 1)***.

268. **Separately, solar farms in the countryside should be not be planned piecemeal but in a co-ordinated fashion as part of a Land Use Strategy that the Review encourages in its**

section on land and agriculture. Stacking technology and appropriate use of solar farms on non-high grade agricultural land is entirely compatible with the wider expansion of solar farms. Once again, where located near communities, the utilisation of a consent process — that could be delivered through Local Area Energy Planning, a 'Net Zero Neighbourhood Plan' or equivalent — should aim to ensure that these projects are not imposed on local communities (see also ***Pillar 4***). In parallel, the issue of grid capacity needs to be unblocked and regulations changed so that wider and more flexible provision of solar demand is the norm for the future.

Mission: Government should facilitate solar, including a rooftop revolution, to harness one of the cheapest forms of energy, increase our energy independence and deliver up to 70GW of British solar generation by 2035.	
Issue heard by the Review	**Action recommended**
There is **no clear roadmap for the deployment of solar**, even though solar capacity is expected to grow fivefold in the period to 2030. There is currently **no target to make rooftop solar** a standard for buildings across the UK.	**Government, regulators and industry** should set up a **taskforce and deployment roadmaps** with clear milestones to reach up to 70GW by 2035. This should include: • Actions and milestones for the **different solar technologies** (rooftop solar PV, groundmount solar) • **Bring forward all consultations and work to mandate the Future Homes Standard (FHS) by 2025** (see ***Pillar 5***) to prevent further delays by ensuring standard applies to all developments. **This should include a consultation on mandating new homes to be built with solar and deliver the Net Zero Homes Standard**, ensuring that the planning system (discussed in ***Pillar 4)*** is flexible enough to enable this. • Government should **consider options to support homes to include roof solar panels installation as part of its retrofit support scheme provision** to support homes reach the Net Zero Homes Standard. (see ***Pillar 5***)
Upfront costs make it more difficult for **smaller businesses and households** to install solar and there is a lack of awareness of the **finance options** available.	Government to assess **how low-cost finance options can be provided to households and small businesses**. Government to raise awareness for existing initiatives such as the Smart Export Guarantee (SEG) and 0% VAT.
Delays due to **planning and environmental permits and grid access** add to timelines and administrative burden.	Government to work with regulators, devolved administrations, local authorities, industry and key stakeholders to **streamline the planning and environmental permitting processes** to ensure new power generation can come online as soon as possible. Government to ensure there is **clear guidance to support case-by-case decisions,** for example on sensitive issues such as siting and to allow new, innovative solutions, instead of technology-specific restrictions

Mission: Government should facilitate solar, including a rooftop revolution, to harness one of the cheapest forms of energy, increase our energy independence and deliver up to 70GW of British solar generation by 2035.	
Regulatory framework may involuntarily disadvantage new business models (for example in term of business rates) and there is a lack of guidance on **community benefits**.	Government to set out **a framework for community benefits.** This could include for solar and other technologies to support communities, acknowledging that these will be specific to the local situation.
Households and businesses may struggle to find **trained installers** as demand increases.	**Build UK capability** and provide the necessary training and certification. Government, local authorities, industry and certification schemes to consider how listings of certified installers could be made available at a local level.

Mission: Pave the way for an onshore wind revolution

269. **Now is the time to turbo-charge a drive towards greater onshore wind provision.** The Review heard many instances of both local community energy projects, housing developments and regional wind projects in remote areas of the country, that wish to deploy onshore wind, yet are being held back from doing so. The review is of the view that if local communities wish to have onshore wind as a solution, and can work with energy suppliers and distribution network operators (DNOs) to find an agreeable mutually beneficial solution that delivers long-term benefits for local residents, then there is no reason why onshore wind should not be deployed at scale.

270. **At the same time the planning system needs to be reformed to achieve rapid deployment, as is discussed in *Pillar 4*.** Onshore wind would be one of the fastest, lowest cost solutions to rapid delivery of net zero making the transition more affordable.

Mission: Set up taskforce and deployment roadmaps in 2023 for onshore wind in to reach required deployment levels for 2035 net zero grid	
Issue heard by the Review	**Action recommended**
There is no clear roadmap or targets for the deployment of onshore wind, in contrast to offshore wind, despite onshore wind being one of the cheapest technologies.	**Government, regulators and industry to set up a taskforce and deployment roadmaps** with clear milestones for onshore wind to reach required deployment level for 2035 net zero grid.
Delays due to planning, environmental permits and grid access add to timelines and administrative burden. In England and Wales, **additional requirements** as part of the planning process slow down deployment of onshore wind.	Government to work with regulators, devolved administrations, local authorities, industry and key stakeholders to **streamline the planning and environmental permitting processes.** This work should also facilitate grid access in line with recommendations in Energy Infrastructure chapter. Government to ensure there is **clear guidance to support case-by-case decisions,** for example on sensitive issues such as siting and to allow new, innovative solutions, instead of technology-specific restrictions.
There is a **lack of awareness of the guidance on community benefits**.	Government to set out **a framework for community benefits**, acknowledging that these will be specific to the local situation.
Businesses may struggle to **access the required skills**.	**Build up UK capability** and provide the necessary training and certification.

2.4.2 Nuclear power – the no-regrets option

Investment in **new nuclear is a no-regrets option given expected increase in power demand and retirement of existing plants**. Delivering on government's ambitions set out in the *British Energy Security Strategy* is key to support development of new UK projects, jobs and skills. But the **commitments need more detail to ensure their implementation and we need nuclear deployment targets for 2035 rather than 2050** to capitalise on the opportunities for small modular reactors, advanced modular reactors, fusion technology and nuclear uses outside of the power sector (e.g. heat, hydrogen).

The Government should therefore **implement reforms set out in the *British Energy Security Strategy* to double down on achieving UK's nuclear baseload requirement:**

1. Expedite the set-up of Great British Nuclear in early 2023, ensuring required funding and skills are in place.
2. Government and GBN to set out clear roadmap in 2023, including interim targets to reach 2050 ambition, and government to ensure funding is in place. As part of the roadmap, government should assess the possibility to increase the current ambitions, supporting the development of supply chain to service a fleet of projects.
3. Roadmap to set out clear pathways for different nuclear technologies (including small modular reactors) and the selection process. This should consider how to use programmatic approach to deliver further cost reductions in a competitive environment.
4. Government to deliver on siting strategy by 2024

271. **The UK was the first country in the world to develop civil nuclear power plants** and for decades, nuclear energy was the main zero emission energy technology in the UK. However, since the 1990s the role of nuclear in the energy mix has been in decline, with new projects struggling to come through. Currently, about 15% of our power supply comes from nuclear plants, as seen in Figure 2.9.[221] Within the next 10 years, four of five nuclear plants are scheduled to retire, with only one new plant currently under construction and one more in the pipeline. Significant efforts are therefore needed to not only maintain the current role of nuclear energy but also for nuclear to help meet rising energy demand.

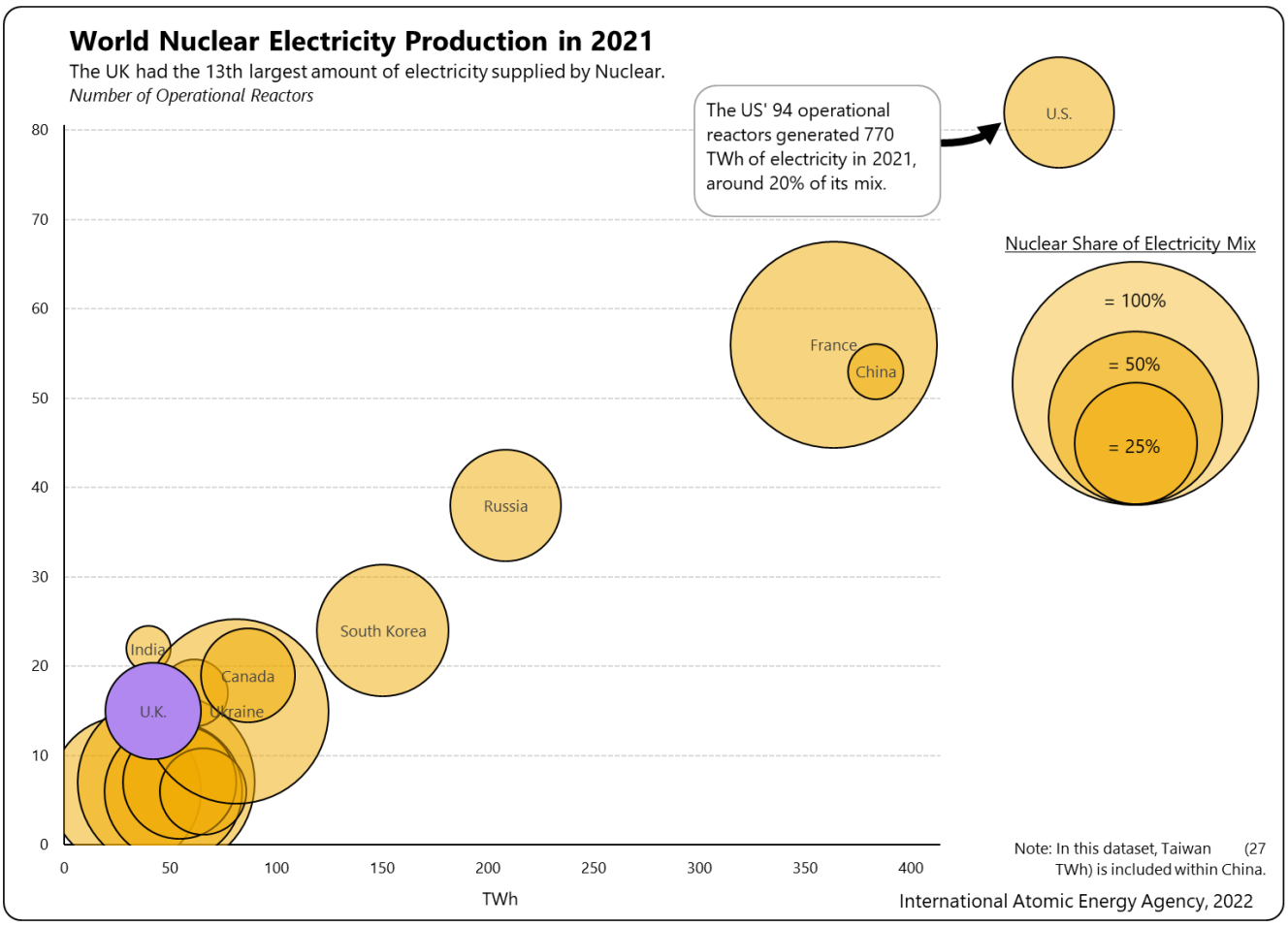


Figure 2.9 – *World nuclear electricity production in 2021*

272. **Most experts agree that building new nuclear is a no-regrets option, despite high up-front costs and long construction times**.[222] In view of rising power demand, nuclear energy can provide reliable baseload power which is not weather dependent and can provide other services to power networks (e.g. inertia[xii]). Nuclear sites also have low land use requirements and can often make use of existing power network infrastructure.

273. As part of the *British Energy Security Strategy*, the Government set out a nuclear ambition for up to a quarter of power consumed in the UK. This Review heard from industry that there is a lack of clarity on the pathway and interim milestones to achieve UK's ambition. To achieve affordability and efficiency, the Government needs to commit to funding a fleet of projects. Recognising the start times for new build nuclear, a clear roadmap for nuclear deployment up to 2035 is required.

Providing a stable, long-term policy environment

274. **The main barrier for new nuclear projects is the need for stable, long-term policy and funding commitments given the long timeframes involved in the building of nuclear plants**. The high up-front costs generally require government involvement to make investments attractive and cost competitive. Stakeholders responding to the Review pointed out that a long-

xii Inertia in relation to the power system refers to the energy stored in the rotating parts of a power plant, which keeps those spinning for a while even when the generator fails. In case of a power plant failure, inertia therefore provides the grid operator with some extra time to restore balance in the system.

term programme and roadmaps could further increase investment certainty, stressing the need for clear interim steps to track progress.

275. **Businesses highlighted the need for Great British Nuclear to be set up as soon as possible and for its role to be confirmed.** They also suggested that Great British Nuclear (GBN) could help in understanding the timings of different projects so that any supply chain and skills pinch points could be identified early, allowing for coordinated action to prevent bottlenecks (see below). EDF for example highlighted that:

> *"GBN can help bring forward nuclear projects by developing a 'programmatic' approach to nuclear with a long-term strategy ensuring appropriate focus on, and timely identification and resolution of, key issues related to new nuclear development".*[223]

276. Referring to the Government's commitments in the *British Energy Security Strategy*, participants to the Review's nuclear roundtable also stated the need for a clear government siting strategy, starting from existing sites. Similarly, commitments on funding would need to be maintained.

277. The Review therefore recommends expediting the set-up of Great British Nuclear in early 2023, ensuring the funding and skills required for Great British Nuclear to deliver on its role are in place as soon as possible. In order to provide more investment certainty, the Government and Great British Nuclear will need to set out as soon as possible in 2023 a clear roadmap with interim targets and details of how the 2050 ambition are to be met, with pathways for different technologies. They will also need to deliver on a siting strategy.

Streamlining regulatory processes

278. **To ensure nuclear projects are not unnecessarily delayed, government should streamline planning and consenting decisions**, in line with its commitments set out in the *British Energy Security Strategy*. These measures should seek to cut down timelines, whilst continuing to drive compliance with the highest security standards. Sizewell C, a current nuclear project under development, pointed out that *"some issues are considered by more than one permit/ consent granter, and on occasion the granters tale very different views on the issues and the appropriate course of action for a project."*[224]

279. **In response to the Review, stakeholders stressed the need to overcome bottlenecks in approving new reactor design** through the Office for Nuclear Regulation (ONR), citing resourcing issues at the ONR as well as the option to strengthen international cooperation on reactor design, which could allow for a reactor design approved in one country to be equally recognised in another. Government should ensure that the ONR is appropriately resourced to match the 2050 ambition and explore the option for mutual recognition of reactor designs with partner countries.

Strengthening domestic capability and supply chains

280. **A growing nuclear industry can make a significant contribution to UK jobs and growth, but rapid expansion of nuclear power could lead to some bottlenecks in supply chains and skills pools.** Many responses to the Review highlighted how the existing industry supports UK jobs and growth, across a variety of skill sets, from construction to decommissioning. However, they also highlighted that to match government's ambitions, UK supply chains and skills pools will need to grow significantly to meet demand over the coming years. In particular in relation to skills, industry representatives agreed that cross-sectoral collaboration rather than

competition would be beneficial, requiring some government involvement and potentially taking a wider view than just the nuclear industry.

281. The responses to the Review also highlighted the need for more to be done to develop domestic fuel enrichment capability, including the potential for UK processing facilities for uranium and high-assay low-enriched uranium (HALEU) used in advanced reactors to reduce supply chain risks. Stakeholders also highlighted the need for further government support for businesses exploring export opportunities.

282. Based on the nuclear roadmap referred to above, Government, Great British Nuclear and industry should **identify potential bottlenecks and issues as relates to supply chain and skills and agree actions to address these**. They should also consider appropriate commitments to boost the resilience of the UK supply chain.

Investing in technologies and exploring new opportunities

283. **The Review heard about the opportunities that advanced modular reactors, and small modular reactors, offer**. Rolls-Royce, a developer of small modular reactors, stated that "*these could create 40,000 UK jobs, add £52 billion of value to the economy and represent a significant growth opportunity for the UK".*[225] These types of reactors can be delivered in shorter timeframes and lower costs, though technologies are still to be proven and costs are uncertain, particularly that of advanced modular reactors.

284. The Government has already stated its ambition for at least one of the two projects achieving final investment decision in next Parliament to be a small modular reactor. To achieve this, Government should take forward a programme-based approach in line with the nuclear roadmap. This is to drive down costs and encourage competition whilst building UK export capacities. A similar approach should also be taken for nuclear technologies at an earlier stage of development, such as advanced nuclear reactors or fusion technologies.

285. **The Review also agrees with stakeholders that maintaining UK funding for nuclear R&D would be essential to help the UK maintain a competitive edge**. The UK is well positioned on nuclear R&D with dedicated research facilities, including for example the National Nuclear Laboratory, on both fission and fusion. In addition, the UK has been leading on research to decommission and clean up former sites.

286. When developing business models and programmes, government should also take into account that different technologies may have different need. It will also be important for industry and government to take a wider view and consider the role nuclear reactors could play in the wider economy's transition, for example as relates to heat, hydrogen or integration in particular of small reactors in other technology hubs. As EDF pointed out:

> *"In addition to generating electricity, nuclear stations also produce very large volumes of low cost, low carbon heat. Historically this heat has not been utilised in the UK. But in the net zero context, there are a range of future opportunities to take advantage of it, through for example improving the efficiency of hydrogen production, providing energy for Direct Air Capture processes, for synthetic fuels production and to support other industrial and commercial heating requirements."*[226]

Mission: Set a delivery plan to double down on achieving the UK's baseload requirement through a programmatic approach for a next generation fleet of nuclear, supporting a high-tech British industry covering the whole supply chain.	
Issue heard by the Review	**Action recommended**
Nuclear investments require **stable, long-term policy and funding commitments** to ensure investor confidence given long lead-in times.	Government should implement reforms set out in the **British Energy Security Strategy to double down on achieving the UK's nuclear baseload requirement** • Expedite the **set-up of Great British Nuclear (GBN) in early 2023,** ensuring required funding and skills are in place. • **Government and GBN to set out clear roadmap in 2023,** including interim targets to reach 2050 ambition. Government to ensure funding is in place. As part of the roadmap, government should assess the possibility to increase the current ambitions supporting the development of supply chain to service a fleet of projects. • Roadmap to set out **clear pathways for different nuclear technologies** (including small modular reactors) and the selection process. This should consider how to use programmatic approach to deliver further cost reductions in a competitive environment. • Government to deliver on **siting strategy** by 2024.
Delays in obtaining planning permission, environmental permits and grid access add to timelines and administrative burden.	Government should work with regulators, local authorities, industry and key stakeholders to **streamline the planning and environmental processes whilst maintaining highest security standards.**
Timelines for receiving reactor design approval can delay projects.	Government should ensure Office for Nuclear Regulation (ONR) has necessary capacity to progress applications. **Government to explore potential to reduce timelines through international cooperation** that would allow recognition of approvals by partner countries.
Bottlenecks to the supply chain may impact on delivery timelines and businesses may struggle to access skills. There could be a lack of local content.	Government should work with GBN and industry on UK supply chain & skills. This includes: • On basis of the roadmap, identify key issues and potential dependencies to address; • Agree commitment to boost resilience of UK supply chain and monitor supply chain; • Build UK capacity and skills, provide the necessary training and certification and explore synergies with other sectors.

Mission: Set a delivery plan to double down on achieving the UK's baseload requirement through a programmatic approach for a next generation fleet of nuclear, supporting a high-tech British industry covering the whole supply chain.	
Some nuclear **technologies with significant potential require further development** to reduce costs and opportunities for nuclear energy outside the power sector are underexplored.	Government should ensure **continued funding and support for new technologies** such as advanced modular reactors (AMRs) and fusion that could play an important role in the future. Government should consider how a **programme-approach** could be used to drive down **costs for AMRs in a competitive setting.** Government should also look at the **opportunities the nuclear industry provides outside the power sector**, for example heat or hydrogen.

2.5 System flexibility

The high penetration of renewable generation within the energy system comes with the **challenge of supply side variability**. Addressing this requires **new thinking, smart systems** and **balancing demand and supply**, to meet the 2035 fully decarbonised power sector ambition and phase out current, carbon-emitting sources of flexibility.

Overall, the Review finds this to be an **opportunity for the UK, delivered by UK businesses and benefiting consumers across the country**. Estimates suggests flexibility services can lower the costs of our system by £10 billion-£17 billion a year by 2050, by reducing the amount of generation and network build needed to meet peak demand. It will create jobs, estimated at 24,000 by 2050, and drive investment across the UK.

Schemes being rolled out across major energy providers this winter provide an insight to the possibilities for households to access some of these benefits. **Consumers will play an active role**, taking up new tariffs and adopting smart appliances that reward flexibility and balance supply and demand variability in a hands-off way. This will all be made possible by **harnessing the power of data and digitalisation across our energy system**.

Key recommendations:

- By 2024, government should set a strategy for its market for flexible capacity, including pathways for different technologies to 2035.
- Government should continue to set ambitious targets for the remaining years of the four-year smart meter framework.
- Ofgem should maintain focus on a timely implementation of its market-wide half-hourly settlement.

287. **There is a clear and rising need for flexibility in the UK's electricity system**. Most studies suggest electricity demand by 2050 could be roughly double today's level of total electricity demand.[227] The electricity system needs to match generation and demand on a second-by-second basis to keep system frequency stable and in balance. This can be particularly difficult given the behavioural patterns of residents, which tend to consume electricity at similar times as shown by Figure 2.10.[228] System flexibility is the ability to adjust supply and demand to achieve that balance, and to help manage locational constraints on the networks over different timescales, from minutes or less to across seasons or even years. This is essential to keep the grid operational in periods of high stress and to ensure security of supply. Improving energy system flexibility is necessary for enabling cost-effective integration of low-carbon electricity generation, particularly renewables.

288. A flexible system is underpinned by data and digitalisation and Government set out a first *Energy Digitalisation Strategy* in 2021. Digitalisation is key to be able to handle the millions of energy flows and data points every second from low carbon technologies, such as heat pumps, solar, batteries, and electric vehicle charge points, connecting to the grid over the coming years.

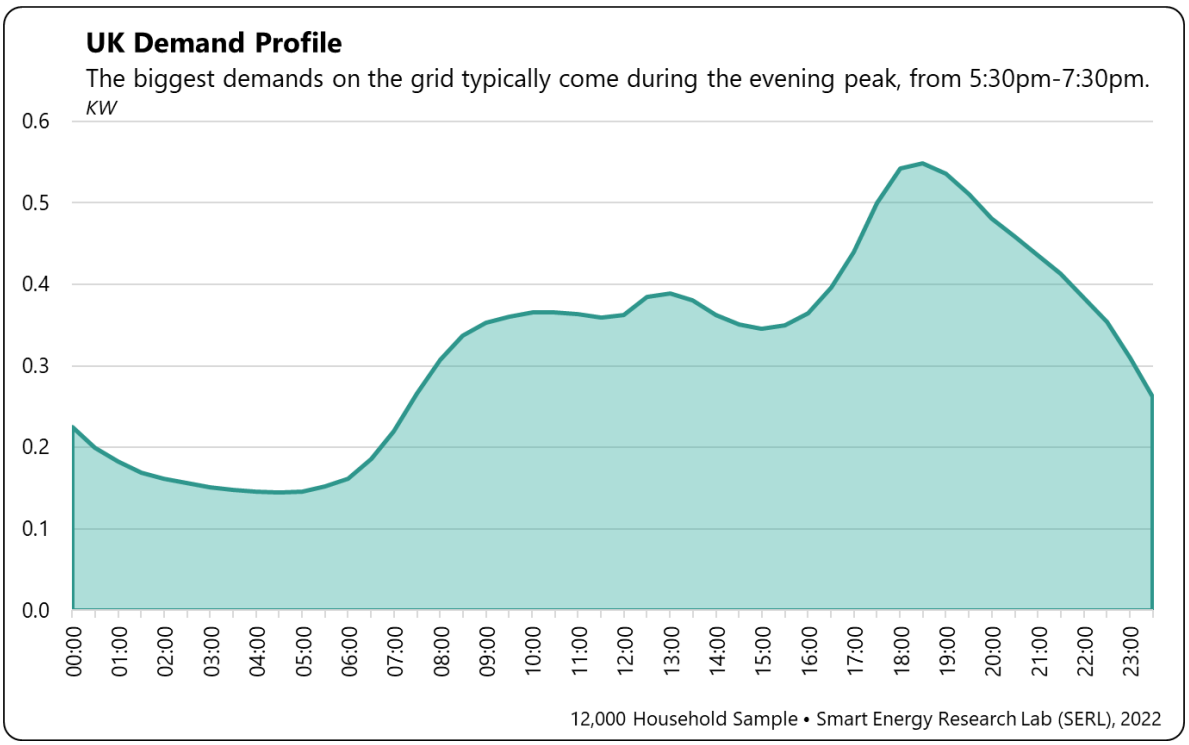


Figure 2.10 – *Typical daily electricity demand profile for a UK household*

289. **The UK needs to change the provision of flexibility in the grid.** Traditionally, flexibility has been provided through supply, by decreasing or ramping up supplies to meet incremental demands throughout the day. In this system, incremental increases in energy demands – or peaks – have typically been met by fossil gas peaker plants that provide the flexibility the grid needs. At current prices, these gas plants are extraordinarily expensive to run, feeding through to higher prices for households. Also, to ensure the UK meets its target to provide affordable, clean and secure electricity by 2035, gas or coal can no longer be called upon in the same capacity. Therefore, the UK needs to replace the role that gas plants currently hold – both the mid-merit roll to fill in the gaps between routine drop in wind and solar output, and as a hedge against longer, more sustained periods of supply gaps. To do this, a mixture of supply-side technologies will be required to perform these different roles, while smart management of energy demands will ensure undue costs are not passed on to households.

290. **This is an opportunity for the UK.** It will be delivered by UK businesses and will benefit consumers across the country. Studies show that a flexible grid could save the UK £10-17 billion per year by 2050 by reducing the need for dedicated back up generation for severe weather events and grid reinforcement requirements to meet peak demand,[229] create an estimated 24,000 jobs by 2050, and drive investment across the UK.[230]

2.5.1 Supply-side flexibility

291. Future supply-side flexibility will be provided by storing renewable energy when it is abundant for use when it is scarce (temporal shift); draw-down from areas of high abundance to those where it is needed most (locational shift); or converting electricity into another low-carbon fuel using electrolysis for either direct use or storage (vector shift). This will need to happen at different scales; from multi-GW storage options and international interconnectors to domestic batteries and more local flexible solutions.

292. The Government and Ofgem set out their plan for managing supply side variability in the *Smart Systems and Flexibility Plan*.[231] The Review found this comprehensive in setting out short duration (intra-day) solutions.

293. Stakeholders told the Review that government could provide more clarity on long duration (between day and beyond) solutions for managing so called *dunkelflaute* events, periods of low wind and low solar generation potential. There are a variety of methods that could be deployed to manage these events.

294. **Long-duration storage** of low carbon power could be achieved through various technologies, including pumped hydro storage, flow batteries and the conversion of power to hydrogen and back to electricity. Many of these are emerging technologies which have the potential to support growth and jobs. Government has not given indications of the proportional mix to deliver the required storage nor set out a market framework. This is impacting investment through insufficient demand signalling.

295. **Multi-purpose interconnectors** could provide the required flexibility drawing from international sources when conditions in the UK will not generate the required power from renewables and similarly can be used to export power at times of excess generation in the UK.

296. **Dispatchable power** may also play a role, including hydrogen, pumped hydro and gas, which will increasingly be abated with carbon capture technologies, known as power CCUS. According to BP, there remains *"uncertainty of future demand for power CCUS capacity".*[232] General Electric recommends the Government clarifies expected volume for power CCUS by 2035 to provide confidence to investors and technology companies.[233] Analysis shows that investment in 5GW of power-CCS by 2030, as opposed to the counterfactual of 1GW, would save £1.5 billion and 10MtCO2 by 2040, even if gas prices stayed at 2022 levels.[234] The Government's call for evidence on the future policy framework for the delivery of power with CCUS stated that we may need to deploy up to 10GW of power CCUS by 2035. Currently however, investment and government support does not necessarily reflect this ambition since it is unclear how much of this will be deployed. **Clarity on expected deployment would create an important demand signal for investors into power CCUS.**

CASE STUDY: National Grid ESO'S Future Energy Scenarios

While the Government remains agnostic to the mix of supply side solutions, National Grid ESO's Future Energy Scenarios *provide an indication as to how future flexibility may be provided. In the most ambitious scenario,* Leading the Way*, the National Grid reaches 98% clean power by 2030 and energy storage capacity reaches 30GW (130 gigawatt-hours) by 2030, which would be dispatched instead of fossil gas. This storage is predominantly met by 20 GW (37 GWh) of batteries in 2030, up from 1.6 GW (1.6 GWh) in 2021 and 5GW (65GWh) of pumped hydro in 2030 up from 2.4GW (26 GWh) in 2021.*[235]

Although gas will remain important to the broader energy system as a transitionary fuel, by 2035 unabated gas usage in the power sector makes up no more than around 2% of domestic generation under all scenarios, and in Leading the Way *all unabated gas generation capacity is phased out by the end of 2035. This is mitigated by growth in interconnection, storage and hydrogen generation, as well as additional demand reduction from Demand Side Response technologies.*[236]

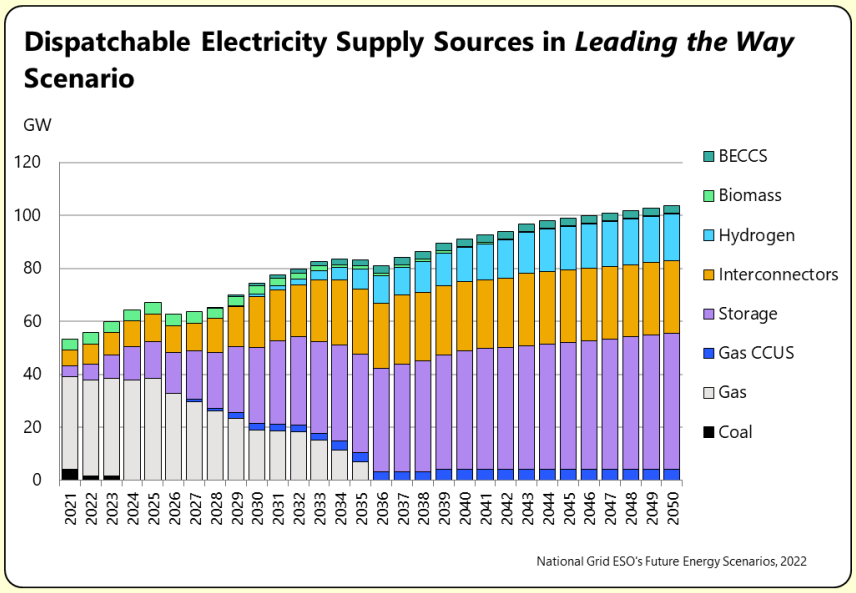


Figure 2.11 – *Dispatchable electricity supply sources in* Leading the Way *scenario*

Provide greater clarity on the market for flexible capacity

By 2024, government should set a **strategy for its market for flexible capacity**, including **pathways for different technologies to 2035.**

297. This Review recognises the inherent uncertainty over predicting exact energy mixes, and does not therefore propose a specific target for technological solutions to address the challenge of providing energy during long periods of low renewable generation. However, acknowledging what we have heard from stakeholders, the Review proposes a more holistic solution that could help provide investor certainty.

298. The Review recommends that, by 2024, government should set a strategy for its market for flexible capacity, including pathways for different technologies to 2035 and a market framework. This will give confidence to investors in different technologies and provide the necessary signals to network infrastructure providers. At a minimum this should cover long-duration

storage (including whether current levels of R&D funding are sufficient) and the different roles of dispatchable power (power CCUS and hydrogen).

2.5.2 Demand-side flexibility

299. **A smart and flexible energy system will empower households and industrial actors alike.** Smart meters, technologies, tariffs and services– driven by greater access to high quality energy data – will enable consumers to change their consumption patterns to match times of cheap and abundant low carbon electricity, give consumers greater control over their energy use and save money by helping to balance the energy system.[237] These actions will become increasingly important and beneficial as electricity demand is expected to roughly double due to the electrification of transport, heat and industrial processes.[238] They will reduce the need to overbuild the grid to account for winter days where demand could be double that of milder days.

300. **Today, industrial and commercial consumers are already providing demand side flexibility whereas participation from households is still relatively nascent.** During the Review, we have consistently heard that consumer flexibility provides broader benefits to the energy system and households.

301. **To be successful, consumers need the tools and incentives to offer flexibility.** Smart meters underpin a flexible energy system by providing consumers and energy providers data to inform decisions on shifting demand.[239] For instance, if consumers charge their electric vehicles (EVs) at low demand/high supply times of the day, drivers would be able reduce their costs whilst the costs of operating the energy system would be reduced.[240] Some services may do this in a smart way.[241]

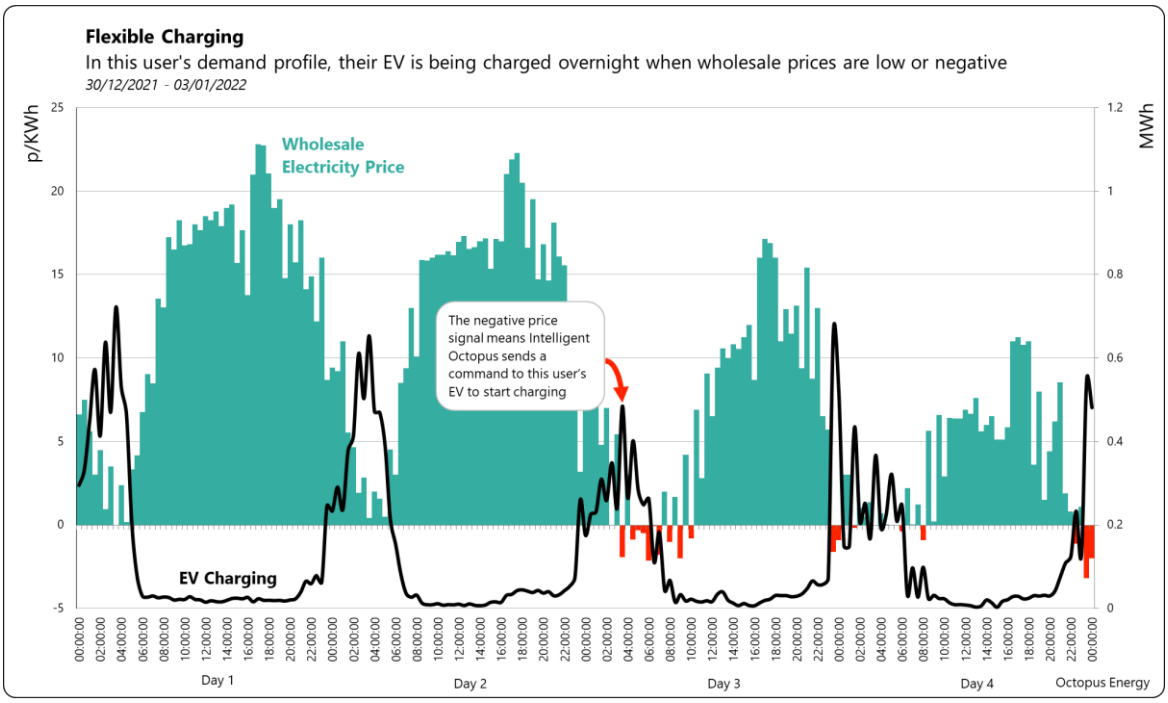


Figure 2.12 – ***Graph of wholesale electricity price (bars) against an Intelligent Octopus user's EV charging profile (black line)***

302. Heat pumps can also load shift to a degree. This is partly determined by the thermal mass of the building they're heating but mostly by the ability to pre-heat homes and have access to a thermal storage medium such as a hot water tank or phase change materials. Octopus Energy

analysed the consumption data for around 1000 heat pump users on their Agile Octopus tariff and found they were able to reduce their peak usage by 73% by automatically programming their heat pump to come on at off-peak times.[242] This saved users 20% on average on their annual heating bill versus the equivalent flat rate tariff – £210 per annum for an average home at current prices.[243] These savings are already possible with a basic programming feature (standard in all new heat pumps) and a smart tariff. However, they could be even greater with more intelligent controls, which consider factors such as weather, home profile, heat pump operation/efficiency and linking to grid flexibility services.

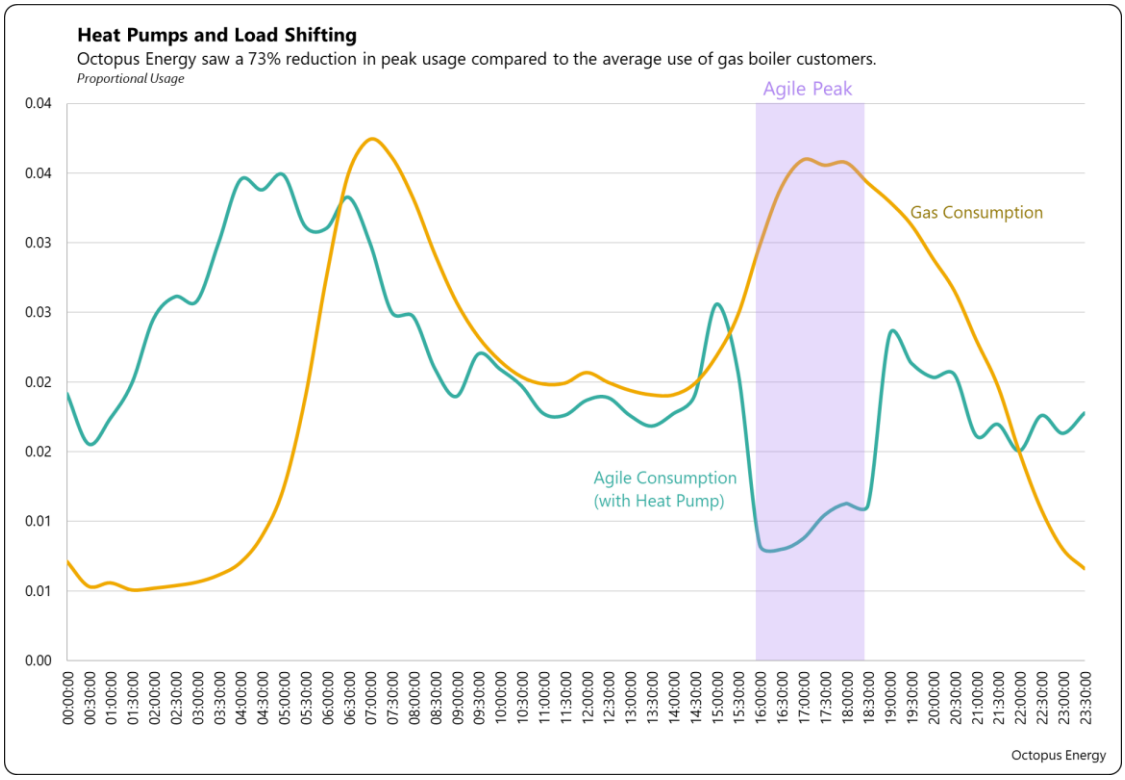


Figure 2.13 – *Heat pump potential to load shift*

303. The potential for consumer demand flexibility is being trialled this winter by major energy providers in the UK through the ESO's demand flexibility service, which allows households to get paid for shifting their energy usage out of peak times.

Give households the technical capability to participate in providing flexibility to the system

Government should **continue to set ambitious targets for the remaining years** of the four-year smart meter framework.

304. To build on the successful consumer demand flexibility trials, the Government should continue to set ambitious targets for the remaining years of the four-year smart meter framework. The widespread provision of smart meters acts as a pre-cursor for the adoption of time-of-use tariffs, as it allows for major utility companies to have the data points that facilitate signals being sent to consumers. As of the end of September 2022, about 30 million energy meters (about 54%) were smart or advanced. The smart meter rollout is estimated to generate total bill savings to households of £5.6 billion over the course of the rollout, which will likely have improved given high forecasted energy prices.[244]

Accelerate market reforms to provide financial incentives for consumer flexibility

Ofgem should maintain focus on a **timely implementation of its market-wide half-hourly settlement.**

305. **The Review also supports the findings of BEIS' and Ofgem's *Smart Systems* paper (2021). Ofgem should maintain focus on a timely implementation of its market-wide half-hourly settlement**. Half-hourly settlement is a key requirement for the smart tariffs that support flexibility services and is already in place for larger consumers (industrial, commercial, and public sector). However, most domestic customers are settled on a 'non-half-hourly' basis using estimates of when they use electricity, based on a profile of the average consumer usage and their own meter reads (taken over weeks and months). While we welcome Ofgem's market-wide half-hourly settlement reforms, we ask Ofgem to maintain or bring forward if feasible its implementation date in light of recent increases to customers' bills. Ofgem analysis predicts that market-wide half-hourly settlement (MHHS) will bring net benefits for consumers in Great Britain of between £1.6 billion and £4.5 billion over the period 2021-2045.[245]

306. **The Review also recommends that the wider reformation of markets within REMA should focus on rewarding flexibility, in line with the Government's objectives for retail markets.** The existing suite of balancing services is complex and increasingly unable to meet the operability challenges of a low carbon energy system. A more decentralised electricity system has also led to fragmented processes and inadequate coordination across markets. There is a need for improved alignment of procurement processes across distribution, transmission and ESO ancillary services as well as improved coordination across parties. Similarly, it is important that the energy retail market supports an efficient and flexible energy system and incentivises consumers to participate and benefit from the system transformation. As part of wider reforms to the energy retail market, Government will need to address remaining barriers to the development and uptake of new supply proposition, including smart tariffs.

2.6 Making our fuels greener

307. Whilst demand for power is set to increase, we will still need liquid and gaseous fuels in areas that are harder to electrify, alongside other measures such as energy efficiency measures and technologies which are explored throughout this Review.

2.6.1 Hydrogen – a clean, flexible energy carrier

Hydrogen will play a vital role in our future energy mix**.** Given the nascency of the sector, the UK could be a global leader, reaping huge growth and employment opportunities**. However, the UK faces a real risk of losing out on the international stage if it does not move quickly to implement its business models and regulatory frameworks.**

Key recommendations:

1. By the end of 2023, develop and implement an ambitious and pragmatic ’10 year’ delivery roadmap for the scaling up of hydrogen production.
2. Deliver transport and storage business models as soon as feasibly possible and take a pragmatic approach to support key ‘no regrets’ transport and storage projects.
3. Continue the hydrogen heating community trials, to inform decisions on the role hydrogen can play in heating. Additionally, by the end of 2023, government should update its analysis of the whole system costs of the mass roll out of hydrogen for heating, in order to ensure that the case for economic optimality and feasibility still holds.

308. Hydrogen is a critical component of our broader strategy to deliver energy security, create economic growth and reach net zero. The production of hydrogen provides an important transition moment for the offshore industries, at the same time as helping to decarbonise foundational and energy intensive industries. In a decarbonised energy system, there will be a need to replace high-carbon fuels in hard to abate industries and provide flexible energy for power, industrial processes and heavy transport.

309. Low carbon hydrogen could play a significant role, for example, in lowering the carbon intensity of steel production by providing an alternative to coking coal and other high-carbon fuels currently used for industrial heating. It could also be fundamental to achieving the full decarbonisation of shipping, aviation, and road transport, with potential in areas of heavy transport such as heavy goods vehicles, buses, and trains.

310. **The hydrogen transition presents a significant economic opportunity for the UK and could transform our North Sea energy industry and industrial heartlands**. In July 2021, the Hydrogen Council estimated total global investment into the hydrogen economy will reach $500 billion by 2030.[246]

> *“The UK is a prime global zone for low-carbon hydrogen. This is due to North Sea CO_2 storage, wind power, and proximity to European demand. There is significant potential for the UK to develop hydrogen as an export market –boosting investment in UK industries for production, transport, and storage, and supporting the government’s aspiration to become a net energy exporter by 2040.”*[247] – Shell

311. Investment in hydrogen to de-risk early projects is expected to unlock 12,000 jobs and over £9 billion of private sector co-investment by 2030 in production alone.[248] The market will also be on our doorstep. The EU's ambition is to import 40GW of H2 electrolysers by 2030, presenting a huge opportunity for the UK.[249]

CASE STUDY: Octopus Hydrogen and Geopura

Octopus Hydrogen and GeoPura have joined forces to deliver real alternatives to fossil fuels and accelerate the decarbonisation of a wide range of industries. Octopus Hydrogen provides a home-grown, reliable and cost-competitive source of green hydrogen.

New software from Octopus Hydrogen optimises electrolyser usage, helping to balance the electricity grid, drive efficiencies and reduce costs. Octopus Hydrogen has its first electrolyser pilot project at MIRA Technology Park in Nuneaton, with more sites in development for 2023.

GeoPura uses green hydrogen at off-grid locations where their Hydrogen Power Unit (HPU) converts it to zero emissions electrical power. This is used for operations that would traditionally be powered by diesel generators. For example, construction applications, film and TV production, and planned grid outages. Unlike diesel generators, there are no nitrogen oxides or particulate emissions and very little noise pollution. Over the next ten years Octopus Hydrogen plans to supply GeoPura with six tonnes of green hydrogen per month.[250]

312. **Electrolytic hydrogen (sometimes referred to as 'green hydrogen') presents a particular opportunity for the UK** on the global stage. Demand for electrolysers in the EU is expected to increase by a factor of 650 by 2050, compared to 2020 levels.[251] The EU is moving quickly to increase its market share in electrolyser design and manufacture, and the UK must follow suit. The UK has competitive strengths in the design and manufacture of electrolysers because of existing facilities and strong academic research,[252] and the UK has already proven it can export electrolysers with ITM Power winning multiple European contracts to date. The Offshore Renewable Energy Catapult estimate that the production and overseas export of electrolysers would produce up to £320bn of GVA and 120,000 jobs by 2050.[253] As discussed in Part 1, electrolytic hydrogen becomes ever-more crucial for achieving net zero in case high gas prices persist globally.

313. **However, low-carbon hydrogen production has yet to take-off.** Currently, the most common way hydrogen is produced is from steam methane reforming or coal gasification from fossil fuels, which releases CO_2 into the atmosphere ('grey hydrogen'). The main low-carbon methods of producing hydrogen, where CO_2 released from this process is captured using carbon capture and storage ('blue hydrogen') or where the hydrogen is produced through electrolysis of water using renewable electricity (electrolytic or 'green hydrogen'), are virtually non-existent.

314. This is down to a combination of:

- **Cost** – hydrogen is currently significantly more costly to produce and use than other fuels. Alongside 'blue' and 'green' technologies being nascent and lacking cost competitiveness with 'grey' hydrogen, the dependency on input fuel (natural gas for blue hydrogen, and electricity for electrolytic hydrogen) is a significant factor, and these have seen substantial price rises in the past 18 months.[254] Capital expenditure on hydrogen production is also significant and needs to fall quickly to reach competitiveness.[255]
- **Policy/regulatory uncertainty** – a range of legislative changes are necessary to give investors the confidence they need to establish and scale up hydrogen businesses. These

include establishing the legislative framework for business models across the value chain and an updated regulatory framework for production and end-use. Whilst some of these have been trailed, they are not currently in place, presenting a significant barrier to progress.

- **Delivery challenges** – slow growth has inevitably been caused by technical challenges associated with deploying first-of-a-kind technologies across the value chain and coordinating activity across a broad range of stakeholders and multiple levels of government.

315. **Government has made some progress in creating the conditions needed to kick start low carbon hydrogen production in the UK.** The *British Energy Security Strategy* set out the ambition to raise the UK's low carbon hydrogen production capacity to up to 10GW by 2030, signalling intent to be a global leader. To support this ambition, the Government has launched a £240 million Net Zero Hydrogen Fund to support low carbon hydrogen production, set out a plan for the Hydrogen Business Model to provide revenue support for low carbon hydrogen production, consulted on a business model for hydrogen transport and storage infrastructure, supported end use through the £315 million Industrial Energy Transformation Fund, and developed a low carbon hydrogen standard.

316. **However, we must move further and faster. For hydrogen to play a role in our journey to net zero, we need to transition quickly towards blue and electrolytic hydrogen.** The US Inflation Reduction Act, and more recently Canada's commitment to introduce a new tax credit of up to 40% for hydrogen production, has ramped up global competition for investment. If we are to secure a position as a leader in the global market, predicted to be worth $2.5 trillion by 2050,[256] we need to secure final investment decisions for notable projects in the early-mid 2020s.

CASE STUDY: HyNet

The HyNet cluster will provide the infrastructure to produce, transport and store low carbon hydrogen across North West England and North Wales. There will also be the infrastructure to capture, transport and lock away carbon dioxide emissions from industry. HyNet will both upgrade existing infrastructure, as well as develop new infrastructure. This includes underground pipelines, hydrogen production plants and storage facilities.

Cumulative CAPEX for the Project is £17.7 billion with OPEX of £29bn. Total GVA impact in the North West is calculated to be £17 billion to 2050. Overall, average annual job generation is projected to be 6,000 jobs for the North West and 11,000 for the UK. Average annual GVA generation for the North West is assessed at £528m and £954m for the UK.[257]

Provide long term certainty and visibility of funding for hydrogen production

By the end of 2023, the Government should develop and implement an ambitious and pragmatic '10 year' delivery roadmap for the scaling up of hydrogen production. This roadmap should include detail on the plan for Track-2 decisions and should also include clear indication of how much capacity government hopes to procure through each future allocation round, including for electrolytic hydrogen, and how the UK will support growth of the electrolyser supply chain.

317. A report for BEIS by Frontier Economics in 2020 concluded that **a business model to provide revenue support to hydrogen producers would be more likely to achieve our objectives than alternative models** of end user subsidies or obligations on fuel suppliers or end users.[258] At the evidence roundtables hosted by the Review, stakeholders welcomed government's recent confirmation that it will take forward this model.

318. However, we have also heard from a range of hydrogen stakeholders, such as Hydrogen UK, that the Government is not moving quickly enough to legislate for this to avoid investment going elsewhere.[259] It is crucial that deployment of this business model is not delayed.

319. Furthermore, in order to capitalise on our strong regulatory framework and continue competing for international investment, we must provide investors with long-term funding certainty.

320. The US recently introduced significant tax incentives as part of their Inflation Reduction Act to encourage hydrogen production and carbon capture technologies. This includes tax credits of up to $3.0/kg tax credit for hydrogen, and $85/ton for Carbon Capture and Storage (rising to $180/ton for Direct Air Carbon Capture).

321. Stakeholders are clear that this is part of the race to net zero, and will attract investment towards the USA and thus away from the UK. However, they have also reflected that the UK revenue focused model is equal to, or in some cases better than, the USA business model of tax credits, and that the UK regulatory environment is still more favourable than the US.[260]

322. However, stakeholders have told the Review that, **in order to remain competitive, the UK must quickly match the long-term funding certainty that the Inflation Reduction Act has brought.**

323. This Review therefore recommends that:

- Government should deliver hydrogen business models as soon as legislation allows, to provide Exchequer funding for hydrogen production and start awarding Hydrogen Business Model contracts to producers in order to rapidly scale production.
- Government must develop a long-term roadmap for hydrogen production.

324. Clear policy direction is vital for the growth of any new technology. In 2021, government published its *Hydrogen Strategy*, however we have heard from stakeholders that there has been a *"lack of direction from Government on hydrogen strategy".*[261] This includes a lack of clarity on the plan for production beyond 2030, details on Track-2 allocation, and how the Hydrogen Production Business Model will be implemented.

325. The scale up of **electrolytic hydrogen is dependent on electrolyser build rates and the supply of the critical raw materials required, but there is uncertainty in this area.** Research shows that most of these materials are subject to a moderate to high supply risk and are concentrated in a small number of countries.[262] Global competition is likely to increase for critical minerals, such as those used in Hydrogen technologies, and sustained supply constraints may lead to a slowing in down in the delivery of the UK's hydrogen ambitions. This is a concern that is being addressed through the UK's *Critical Minerals Strategy*.

326. This report therefore recommends that, by the end of 2023, the Government develop and implement an ambitious and pragmatic 10-year delivery roadmap for the scaling up of hydrogen production. This should be used to inform an overarching R&D roadmap, which we explore in ***Pillar 6.***

327. This roadmap should include detail on the plan for Track-2 decisions and should also include **clear indication of how much capacity government hopes to procure through each future allocation round, including for electrolytic hydrogen, and how the UK will support growth of the electrolyser supply chain.**

328. This could also consider amendments to the Renewable Transport Fuel Obligation (RTFO) to encourage greater levels of electrolytic hydrogen production. For example, we have heard though the Call for Evidence that the additionality rules currently restrict hydrogen production:

> *"Producers should only have to prove that hydrogen is produced in the same one-month window as renewable electricity, rather than 30-minute windows as the RTFO consultation had proposed. This would maximise green hydrogen production at best value for money."*[263]

Accelerate the plan for hydrogen transport and storage

Government to **deliver transport and storage business models** as soon as feasibly possible and **take a pragmatic approach to support key 'no regrets' transport and storage projects.**

329. The development of the transport and storage network is vital for the growth of the UK hydrogen industry.

330. The Government's plan is to design new business models for hydrogen transport and storage infrastructure by 2025. According to several stakeholders, including the Energy Networks Association and SSE, investment decisions are likely to be needed sooner than 2025 to support hydrogen production projects and allow appropriate construction time for the scale of infrastructure required.[264] Lead times for large scale transport and storage projects are long and there is therefore a risk of missing 2030 targets if investment decisions are not made soon.[265]

331. We recommend that government delivers the transport and storage business models as soon as feasibly possible.

332. **In the interim, government must take a pragmatic approach to support key 'no regrets' transport and storage projects, taking steps to enable anticipatory spending and progress these as quickly as possible**.

333. This could be supported via an extension of the existing natural gas RIIO framework, allowing optimisation at pace across methane and hydrogen network requirements ahead of a full framework being delivered.[266]

Take a system wide approach to develop hydrogen's strategic role in the power system

Future System Operator (FSO) to **take forward a role in setting out a system plan for hydrogen**, considering the interactions between hydrogen storage and balancing renewables for the decarbonised grid.

334. Hydrogen could play an important role in a fully decarbonised power system. Electrolytic production and hydrogen storage can provide flexibility, and flexible power generation can be facilitated by using hydrogen as a fuel – helping to balance a more variable renewables-based electricity grid. There are potentially multiple distinct roles[xiii] for hydrogen to play and the overall costs and benefits of some still need to be better understood (for example, of the interaction of hydrogen storage costs and its potential to act as inter-seasonal storage).

[xiii] These include: 1) flexible generation (i.e. using hydrogen to fire turbines in power generation plants); 2) using electrolytic production to help balance the intermittency and location of renewables which can result in economic curtailment or network constraints; and 3) using hydrogen storage to provide inter-seasonal long duration energy storage.

Future System Operator (FSO) to **take forward a role in setting out a system plan for hydrogen**, considering the interactions between hydrogen storage and balancing renewables for the decarbonised grid.

335. The UK's geography is favourable for hydrogen storage due to an abundance of salt caverns, which have the potential to store 9TWh of hydrogen for long duration storage.[267] Long duration energy storage could provide between £13 billion and £24 billion in savings to the electricity system between 2030 and 2050, with the largest possible savings deriving from hydrogen storage and power.[268] This is explored further in the final section of this Pillar.

336. Regarding flexible generation, BEIS has commissioned external analysis to evidence the need and case for market intervention to support hydrogen to power applications. Electrolysers can ramp production up and down quickly, and so can be placed in areas of potential constraints to soak up excess generation, avoiding lost power and curtailment costs whilst producing a versatile and low-carbon fuel.[xiv]

337. **Given these co-benefits of grid flexibility and balancing the future power system, we recommend that the Government takes a system-wide approach to developing hydrogen as a strategic storage asset.**

338. We recommend the Future System Operator (FSO) take forward a role in setting out a system plan for hydrogen, considering the interactions between hydrogen storage and balancing renewables for the decarbonised grid. In doing so, the FSO must consider hydrogen in parallel with the electricity and gas networks.

339. **We also recommend that government, with support from the FSO, takes decisive leadership on naming priority areas for minimum viable pipeline and storage infrastructure, providing strategic direction that shows how we will link up demand and supply**. We need early identification of strategic assets that are critical enablers of other infrastructure and therefore require at risk investment.

Do not stand still on demand

Government should **continue the hydrogen heating community trials**, to inform decisions on the role hydrogen can play in heating. Additionally, by the end of 2023, **government should update its analysis of the whole system costs of the mass roll out of hydrogen for heating**, in order to ensure that the case for economic optimality and feasibility still holds.

340. A recent report by McKinsey and Hydrogen Council stressed that demand visibility was of vital importance for government in scaling up hydrogen deployment.[269] They recommend that policy makers should "enable demand visibility and regulatory certainty by adopting legally binding measures…such as targets or quotas for hydrogen consumption across end-use sectors". These can create 'ripple effects' through the value chain, stimulating investment in supply, manufacturing, and infrastructure.

[xiv] Dynamic Dispatch Model (DDM) reference case analysis suggests economically curtailed electricity could increase from 50-100 TWh in 2035 to 110-220 TWh in 2050. Although dependent on the scale of electrolytic hydrogen production, operating models of individual plants and policy design, some electrolytic projects are likely to also make use of new build renewables (and potentially nuclear) for hydrogen production.

341. It is also possible to give visibility to demand and catalyse investment without adopting legally binding targets. For example, by testing and evidencing the licensing, consenting, and regulating regime. Developing the evidence to determine the end uses that achieve highest carbon savings and cost efficiencies can also help drive investment.

342. **The Review therefore recommends that government deliver a comprehensive programme of trials and projects across different end use technologies and sectors to expand the evidence base for determining most suitable end uses of hydrogen.**

343. **Wherever possible, these trials and projects should be locally-led and place-based**, focusing on areas where the use case is strongest, and a hydrogen eco-system can be supported by co-locating supply and demand.

344. For example, more hydrogen transport hubs should be considered,[270] supporting areas such as the South West, where leading organisations have formed a hydrogen consortium to create an infrastructure ecosystem to bring the benefits of hydrogen and drive growth and jobs in the region. The collaboration creates links between supply and demand centres in the region, enabling partnerships across sectors that will drive the development of hydrogen infrastructure and technology.[271] Expanding into more hubs will help grow the evidence base and give local areas more options for decarbonising.

345. As has been done with production through the clusters, **we recommend Government provides early certainty where possible on likely locations/hubs for demand.** This will provide investors with greater confidence and encourage greater anticipatory investment into infrastructure in certain areas.

346. Government should continue the hydrogen heating community trials, to inform decisions on the role hydrogen can play in heating. Additionally, in light of recent high energy prices and projections for this continuing, government should, by the end of 2023, update its analysis of the whole system costs of the mass roll out of hydrogen for heating, in order to ensure that the case for economic optimality and feasibility still holds. This analysis should also consider any relevant evidence emerging from the preparations for the hydrogen heating community trials.

Sustainable biomass-based and other low carbon fuels – a key component of the future energy system

Sustainable biomass and other low carbon fuels play an important role in the net zero transition as a flexible resource to replace fossil fuels. Biomass technologies also have the **potential to generate negative emissions**. However, stringent sustainability criteria are needed to guard against adverse impacts on a finite global supply and government will need to identify priority uses to provide investment certainty. More should also be done to encourage sustainable UK biomass production.

Government should publish its Biomass Strategy as soon as possible

347. **Sustainable biomass plays a key role in the net zero transition of the energy sector,** as a resource for the production of low carbon fuels, renewable electricity and hydrogen. As an input for deployment of bioenergy with carbon capture and storage it could also generate negative emissions in the future. In 2021, biomass provided the energy for about 13% of power,[272] 5% of road transport fuels[273] and 7% of heating.[274] Bioenergy Carbon Capture and Storage (BECCS) is an integral part of the *Net Zero Strategy* scenarios, providing the single largest source of negative emissions[xv] required to offset residual emissions in 2050.[xvi][275] Biomass use in the power sector and BECCS are also covered in the sections on renewable electricity and CCS.

348. Sustainable biomass is considered a renewable low carbon energy source because the carbon it contains has only recently been removed from the atmosphere and can be regrown, in contrast to fossil fuels, where the carbon was sequestered millions of years ago. Key types of biomass currently in use include wastes and residues from food, agriculture, forestry and other processing operations as well as virgin food and feed crops.

349. Different types of biomass can be processed into a wide range of fuels (e.g. biofuels, biomethane, pellets) used across different parts of the economy, often as a direct replacement for fossil fuels. This also includes electricity production capacity – contributing a baseload complementing intermittent renewables – and hydrogen production, both possible with carbon capture and storage. The production of the different fuels may yield wider co-benefits and co-products. However, the production may also carry certain environmental risks.

350. Therefore, it is critical that any biomass adheres to a stringent set of sustainability criteria, to guard against unintended adverse impacts like land use change leading to deforestation, particularly as part of global supply chains. Availability of sustainable biomass is finite and the global transition to low carbon electricity and fuels will increase pressure on supply. Biomass is also expected to play a role in the decarbonisation of other sectors (such as in construction and chemicals) where it can be used as a raw material to displace fossil fuel inputs, for example bioplastics and biochemicals. Use of this resource will therefore need to be prioritised where limited alternatives are available. In some sectors this use will only be transitional.

351. The UK has an established industry, using both domestic and imported biomass, though the UK's use of bioenergy is growing faster than its supply from domestic sources,[276] pointing to possible future increased dependence on other countries for this energy source. Domestic production of certain types of biomass (fast-growing trees and perennial grasses) will need to be significantly increased to secure the scale of land-based carbon sequestration necessary by 2050.[xvii] Done sustainably, this can potentially bring wider environmental benefits, but to manage competing demands on land and achieve domestic increases with multiple benefits, careful spatial planning is required.

352. **To provide clarity as soon as possible, the Government should publish a Land Use Framework, alongside an analysis of incentives for land managers to grow biomass and a plan for how to improve those incentives.** This needs to clearly set out how the public, private and local decision-makers can achieve the multiple goals for land use set out in the *Net*

[xv] Various Whole System Energy models reviewed here (UK TIMES, ESME, CCC modelling) show the need for BECCS technologies to deliver well over half (and often close to 70%) of negative emissions from engineered greenhouse gas removals, as well as at least a third of all sequestered emissions (including nature-based removals).

[xvi] Mostly from agriculture, aviation and industry.

[xvii] According to all scenarios modelled in the Net Zero Strategy and other reviewed Whole Energy System models.

Zero Strategy, including increased biomass production *(see **Pillar 3*** for a longer discussion of the Land Use Framework). There may also still be the potential to increase collection and use of wastes and residues, provided these are in line with the waste hierarchy and waste reduction targets. Land use implications and the fact that some biomass may be provided at lower prices by other countries will also need to be considered.

353. **Apart from biomass, other waste sources such as the fossil fraction of mixed waste streams** (for example unrecyclable plastics) **or waste fossil gas as well as electricity (power-to-liquids)** can be used in the production of low carbon fuels other than hydrogen. In particular in the aviation industry, there are currently several projects looking at so-called recycled carbon fuels. To ensure these fuels deliver carbon savings, it will be important to ensure that these adhere to waste hierarchy principles and potential reduction in waste streams is considered.

354. The Review heard from industry representatives that there are significant growth opportunities for biomass and other low carbon fuels across different sectors, including BECCS, industrial applications including biorefineries and biochemicals, hydrogen, heat and transport fuels. In regards to the latter, many respondents highlighted the economic opportunity sustainable aviation fuels (SAF) could play for the UK, provided the UK can establish production sites early (see also transport section in ***Pillar 3***).

355. Respondents to the Review highlighted that many of the production sites are dispersed across the country and, for example in case of liquid fuels, often in areas in need of regeneration close to former and existing refineries. Many respondents also highlighted that the UK's leading role in establishing the regulatory framework and rigorous sustainability criteria also provides a competitive edge in terms of influencing international regulation and economic opportunities for services and goods.

356. However, businesses also highlighted the **need for clear policies, including an understanding of the priority use order for different biomass uses**. They also urged for the Government to **deliver on related reforms on waste** (ensuring for example a separate collection of different waste streams) as well as on **sector-specific policies**, for example a SAF mandate (see ***Pillar 3***). **In particular in the heat sector, businesses highlighted the need for a clearer** vision from government what role different technologies may play in the transition to net zero.

357. Stakeholders also commented on the need to receive **early indication on what is to follow on from support schemes coming to an end**, such as the Green Gas Schemes in 2025. Given competition across sectors, some stakeholders also pointed out the need to avoid competition between support schemes.

2.6.2 Reducing emissions from current oil and gas production

It is clear that **we need to transition away from oil and gas**. However, demand will remain as we transition towards net zero. We therefore need to **decarbonise the upstream oil and gas process as quickly as possible**.

To reduce emissions from oil and gas production, government should:

- Accelerate the end to routine flaring from 2030 to 2025.
- Ensure all new oil or gas fields have abatement built in now to avoid backwards engineering when they are electrified
- Ensure the Climate Compatibility Checkpoint is an effective tool now to shape policymaking
- Consider setting fossil fuel producers operating domestically a 10% storage obligation target to restore carbon dioxide to the geosphere by at least 2035, separate to any investment on nature-based solutions.
- Recognise the importance of geological net zero and work to align international ambitions toward geo zero by 2050, in line with net zero.
- The 2023 consultation on the long-term tax treatment of the North Sea must include an option to create a hypothecated net zero fund
- Dependent on the response to the consultation, by the end of 2026, HMT should set out a long-term plan for replacing the Energy Profits Levy with a 'Net Zero Fund' that clearly ringfences revenue for investment into clean offshore technologies and/or energy efficiency improvements
- Ensure greater transparency and data from industry on the carbon intensity of oil & gas (O&G) imports, and also from the North Sea Transition Authority (NSTA) and industry on O&G that is produced.
- Publish an offshore industries integrated strategy by the end of 2024.

358. **We need to reduce our reliance on hydrocarbons as quickly as possible**. The shift away from oil and gas will reduce our susceptibility to volatile energy prices and increase our energy security, save consumers money on their energy bills, and play a crucial role in meeting carbon budgets and the net zero target.

359. However, as set out in the previous section, **this cannot happen overnight because of the need to meet present demand for hydrocarbons and protect our energy security.** The domestic oil and gas industry is an important industry for the UK economy, both historically, and for the future. It supports hundreds of thousands of jobs and is expected to invest £100 billion by 2030.[277] It has a world class supply chain, skills base and infrastructure stock that will be crucial for decarbonising the UK Continental Shelf (UKCS) and creating an offshore energy system as we transition towards offshore wind, CCUS and hydrogen. Given its importance to the economy, the transition to decarbonise the UKCS must be equitable. We must do it in a way that protects British jobs, industry, and consumers.

360. **Government, industry and the regulator (the North Sea Transition Authority, NSTA) have a plan to reduce emissions.** Greenhouse gas emissions from upstream oil and gas activity accounted for 4% of net UK territorial greenhouse gas emissions in 2020 according to data from the National Atmospheric Emissions Inventory.[278] Around 70% of emissions from oil and gas

production come from powering oil and gas platforms by combustion of either natural gas or diesel, with the next largest cause being flaring at 22%.[279]

361. As part of the North Sea Transition Deal (NSTD), a 50% emissions reduction target for 2030 was agreed for the upstream industry. The North Sea Transition Authority (NSTA) also produced the Net Zero Stewardship Expectation, which mandates that new field developments demonstrate initiatives to reduce emissions.

362. **Industry has played a role as well.** In 2021, the UK offshore oil and gas industry published its *Methane Action Plan*[280] to reduce emissions and flaring. The Plan commits to a 50% methane emission reduction by 2030 (against a 2018 baseline). Furthermore, the sector will: through individual assets, seek to accelerate compliance with the World Bank 'Zero Routine Flaring' Initiative ahead of 2030; and commit to the Oil and Gas Climate Initiative (OGCI) 2025 methane intensity commitment.

Barriers to decarbonising upstream oil and gas

363. **There is a significant capital cost of building new offshore transmission infrastructure and/or investment needed to retrofit existing infrastructure so that it can run on electricity**. The financial incentive to electrify is not present as businesses often do not account for wider societal benefits that their spending will bring. Similarly, **operational costs** act as a barrier to electrification, making schemes unattractive or uneconomical.

364. **Lack of regulatory clarity is another challenge**. Clarity on consenting pathways is needed to facilitate electrification of offshore infrastructure. Industry has said that the regulatory regime for platform electrification is currently too complex, with developers requiring different approvals from a range of regulators, slowing down deployment and making it hard to get electrification off the ground. For example, electrification projects in the Central North Sea wanting to use a single offshore wind turbine to supply renewable power to Floating Production and Storage Offshore (FPSO), face a lack of clarity in two areas. Firstly, on consent for the wind turbines, it falls across the Marine Scotland and Crown Estate Scotland jurisdictions, and outside of Innovation for Targeted Oil and Gas leasing areas. Secondly, there are questions over how CfD rules will apply to the floating offshore wind, for example whether the proportion of wind power fed to shore can remain eligible for CfDs with proportion to oil and gas.

365. **Access to grid connections is a huge challenge for the sector**, given potential grid reinforcement requirements and/or competition from other industries to access the onshore grid. Generation connections improve the economics of otherwise significantly negative net present value of electrification projects by allowing power from a windfarm (typically over-sized beyond oil and gas operators' needs) to be exported to the grid.

Accelerate efforts to decarbonise upstream production

Accelerate the end to routine flaring from 2030 to 2025.

Government should ensure **all new oil or gas fields must have abatement built in now** to avoid backwards engineering when they are electrified.

Government should ensure the **Climate Compatibility Checkpoint is an effective tool** to shape policymaking.

366. According to the NSTA, *"The UKCS has enormous potential to reduce emissions from offshore oil and gas installations and support the decarbonisation of the wider UK economy."*[281]

367. The Climate Change Committee's (CCC) optimal pathway for reduction in upstream oil and gas emissions by 2030 is 68%, from 2018 levels.[282] This is significantly more ambitious than the 50% for 2030 target that was agreed by industry, government and the NSTA in the NSTD.

368. The easiest way to achieve these emissions reductions in upstream production is by reducing supply. Forcing this in the short term will present risks for our energy security, and could lead to the UK importing higher carbon intensity liquefied natural gas (LNG). Plus, production is already declining and will continue to do so because of maturity of the UKCS. By the NSTA's own estimates, the basin's emissions would decline by 44% in a business-as-usual scenario.[283]

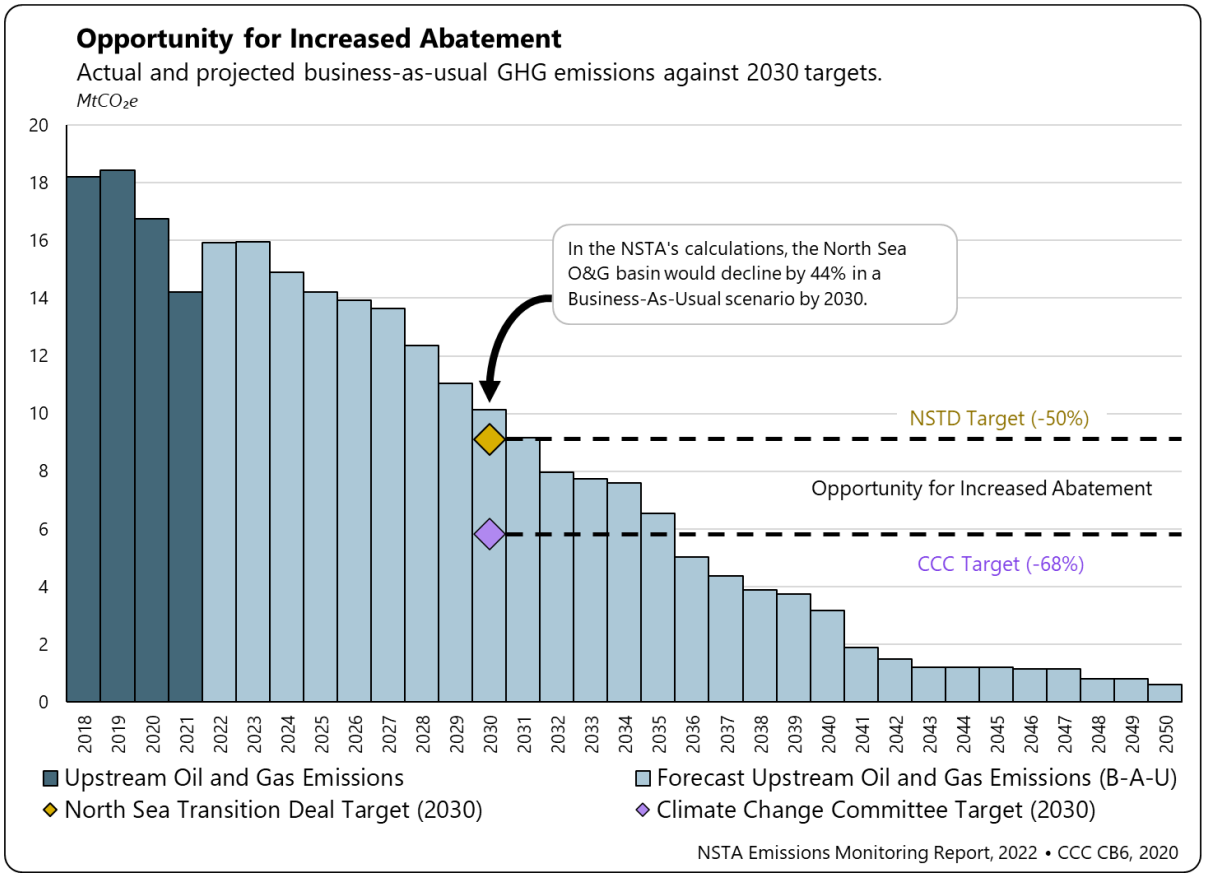


Figure 2.14 – *NSTA emissions reduction target against CCC pathway*

369. Therefore, instead of looking to suppress production, **the oil and gas industry must accelerate efforts to reduce carbon intensity of production to meet the 50% NSTD target and go some way towards meeting the CCC's 68% pathway.** This report recommends vital steps which must be taken to achieve this.

370. **Accelerate the end to routine flaring from 2030 to 2025** - the NSTA have issued guidance saying the ban on flaring should be implemented by 2030 at the very latest. Shell have committed to zero routine flaring by 2025. **We recommend that industry follows suit.**

371. **All new oil or gas fields must have abatement built in now to avoid backwards engineering when they are electrified**. It should be noted that there are safeguards in the NSTA's strategy around satisfactory commercial returns that mean they cannot force an operator into an investment decision that would be uneconomic, such as on platform electrification.

372. **Ensure, as soon as possible, that the Climate Compatibility Checkpoint**, which is to check the compatibility of future oil and gas licensing rounds with UK's climate objectives, **is an effective tool to shape policymaking** as opposed to just a hurdle to new North Sea licences.[284]

Geological net zero

Government should **consider setting fossil fuel producers operating domestically a 10% storage obligation target to restore carbon dioxide to the geosphere by at least 2035**, separate to any investment on nature-based solutions.

Government should **recognise the importance of geological net zero and work to align international ambitions toward geo zero by 2050**, in line with net zero.

373. Sections on CCUS and engineered greenhouse gas removals in this Pillar explain the technology, investment and funding mechanisms needed to remove and store carbon in line with the UK's net zero pathway.

374. **Stopping fossil fuel use from causing further global warming, where use cannot be completely eliminated, will require atmospheric removals**. One strategy to achieve this is by mandating the current high emitters to ensure that for every tonne of carbon dioxide still generated from geological sources, one tonne is safely and permanently restored to the geosphere.[285] This can be coined as 'geological net zero' or 'geo zero' and used to support existing efforts in the areas of CCUS and GGR, both with business and internationally. In order to support these efforts with investment, government should consider how investment can drive development of engineered removals separate from any investment in nature-based removals.

375. At present, approximately 0.1% of carbon dioxide generated from geological sources is restored to the geosphere. Achieving geological net zero means, very simply, increasing this re-stored fraction to 100%. In scenarios that meet Paris goals, this fraction reaches 10% in the early 2030s,[286] a challenging but achievable goal for the fossil fuel industry if accompanied by reducing inefficient uses of fossil fuels and clear policy direction.

376. **This report therefore recommends that government considers setting fossil fuel producers operating domestically a 10% storage obligation target to restore carbon dioxide to the geosphere by at least 2035, separate to any investment on nature-based solutions.**

377. **Government should also recognise the importance of geological net zero and work to align international ambitions toward geo zero by 2050, in line with net zero**.

Establish a Net Zero Fund

The 2023 consultation on the **long-term tax treatment of the North Sea must include an option to create a hypothecated net zero fund**.

Dependent on the response to the consultation, by the end of 2026, HMT should set out a **long-term plan for replacing the Energy Profits Levy with a 'Net Zero Fund'** that clearly **ringfences revenue for investment into clean offshore technologies and/or energy efficiency improvements**.

378. The Review welcomes the Energy Profits Levy curbing excessive profits from oil and gas companies over the past year in light of the high prices caused by Russia's invasion of Ukraine.

The revenue from the levy supports British households to heat their homes, which in the current cost of living crisis, helps maintain the social license of oil and gas companies to operate. However, the Levy model can be improved, likely with stakeholder support, to better develop clean offshore industries as growth opportunities for the UK economy.

> *"When carbon revenues go towards the general government budget, some studies have found that public acceptability is lower. If instead carbon revenues are earmarked for a specific purpose—notably as targeted green investments or transfers to particularly affected groups—citizens report greater acceptability of carbon pricing."*[287]

379. The Government is set to consult stakeholders in 2023 as part of a review of the UK's long-term tax treatment of the North Sea after the Energy Profits Levy ceases.

380. This **Review therefore recommends that the 2023 consultation on the long-term tax treatment of the North Sea must include an option to create a hypothecated 'Net Zero Fund'.**

381. **Dependent on the response to the consultation, by the end of 2026, HMT should set out a long-term plan for replacing the Energy Profits Levy with a 'Net Zero Fund' that clearly ringfences revenue for investment into clean offshore technologies and/or energy efficiency improvements.**

382. Doing this well in advance of 2028 is important for providing long term certainty and stability to investors in the UKCS. [288] [289]

Improve transparency from Oil and Gas companies and regulators

Greater transparency and data from industry on the carbon intensity of **oil and gas** (O&G) **imports**, and also from the North Sea Transition Authority (NSTA) and industry on **O&G that is produced**.

383. While the NSTA publishes an annual Emissions Monitoring Report which tracks industry performance against emissions reduction targets, we do not have comprehensive data of how companies or their assets are performing and therefore accountability is low.

384. Similarly, we have heard from industry that domestic gas produced is cleaner than imported alternatives due to its lower carbon intensity. However, this data is relatively patchy and is often from third parties and therefore not always impartial.

385. Finally, we also have a relatively poor understanding of whether changes in production displace production in other regions.

386. NSTA must therefore improve transparency on progress against the 2030 emissions and flaring targets at a company or asset level by the end of 2023. This should be delivered through their Emissions Monitoring Report.

387. Furthermore, in order to improve the evidence base and achieve meaningful reductions in emissions from the import and production of oil and gas, by the end of 2023 we recommend greater transparency and data from industry on the carbon intensity of oil and gas imports and from NSTA and industry on oil and gas that is produced. We believe this will support the social license to operate that oil and gas companies have in the UK. The NSTA and industry could for example provide greater clarity on the emission factors they include in their system calculations,

in particular the method for estimating fugitive emissions. Given growing third-party measurements of international oil and gas field emissions, we ask the NSTA to ensure official reports are not undercounting and to explain any discrepancies. For example, S&P Global found considerable variation with the GHG intensity of hubs/fields in the North Sea ranging from less than 1 $kgCO_2e$/boe to nearly 150 $kgCO_2e$/boe.[290]

Publish an offshore industries integrated strategy by end of 2024

Government should **publish an offshore industries integrated strategy** by the end of 2024 which should include **roles and responsibilities for electrification of oil and gas infrastructure**, how the **planning and consenting regime** will operate, a plan for how the system will be **regulated**, **timetables and sequencing for the growth and construction** of infrastructure, and a **skills and supply chain plan** for growth of the integrated industries.

388. The oil and gas sector has built infrastructure and supply chains across the UK to support UKCS operations and is well placed to seize growth opportunities presented by low carbon developments such as floating offshore wind, CCUS, and hydrogen. We are already seeing operators come forward with proposals to use oil and gas platforms and onshore terminals to create a base for bringing in CO_2 by ship, reinjecting CO_2, partnering with nearby wind farms, and installing power and hydrogen infrastructure.

389. The UK oil and gas industry should provide the skills, capabilities and expertise needed to deliver the decarbonisation of the sector, as well as developing low carbon hydrogen, and CCUS industries.

390. However, we risk not realising these opportunities. Stakeholders from across the offshore industries have requested a more holistic approach; it was raised at the oil and gas roundtable and further supported by the NSTA calling for a long-term vision for an integrated energy basin responding to the call for evidence.[291] With different authorities for different industries, there is no single agreed approach to spatial planning or prioritisation, and shared data availability and access could be improved through coordination.

> *"Currently there is no clear strategy to the offshore, which can provide regulatory certainty, spatial planning direction or co-location guidance to industries which may be looking to developing in similar regions"* – Carbon Capture and Storage Association (CCSA)[292]

391. We have heard that we need to do more to support the growth of the right skills and supply chains, allowing workers with the right skills to move between oil and gas work and renewable energy projects.[293] For example, stakeholders at the oil and gas evidence roundtable called urgently for a single accreditation or 'offshore passport' for skilled workers to move between offshore sub-sectors.

392. Government should therefore publish an Offshore Industries Integrated Strategy by the end of 2024 to remedy this. This should include roles and responsibilities for electrification of oil and gas infrastructure, how the planning and consenting regime will operate, a plan for how the system will be regulated, timetables and sequencing for the growth and construction of infrastructure, and a skills and supply chain plan for growth of the integrated industries.

2.7 Reducing emissions through carbon capture and removal

The UK is uniquely placed to be a **global leader in Carbon Capture Usage and Storage** (CCUS), which will play a critical role in the transition to net zero. We **must act quickly to foster certainty and attract the investment** that we need.

Key recommendations:

- In 2023, government must act quickly to re-envisage and implement a clear CCUS roadmap, showing the plan beyond 2030. As part of the roadmap, government should take a pragmatic approach to cluster selection. This means allowing the most advanced clusters to progress more quickly.
- By 2024, government must develop a strategy for the plan for non-pipeline transport and how dispersed sites and mini clusters can connect to the CCS network and what support should be offered for doing so.
- As soon as legislation allows, government must finalise the business models and regulatory frameworks across the value chain, including for industrial CCS, Energy from Waste with CCS and CO2 transport and storage.
- In 2023 HMT should set out the funding envelope available to support Track-1 CCUS clusters.

393. **Net zero must involve capturing emissions from processes which still use fossil fuels and storing this carbon,** with net anthropogenic flows between geosphere and atmosphere eventually equalling zero.[294] Not everything can be electrified or replaced by an alternative fuel immediately, and therefore we need to look towards capturing or removing greenhouse gases from the atmosphere to meet our target. Carbon capture, usage, and storage (CCUS) is perhaps the best-known method for this, whilst other methods of engineered removals, such as direct air carbon capture and storage (DACCS) and bioenergy with carbon capture and storage (BECCS) will also play a role. All modelled pathways to net zero envisage a key role for CCUS and the UK should see this as an opportunity.[295]

394. **Industry is responsible for around 16% of the UK's greenhouse gas emissions,** with industrial clusters accounting for around 50% of all industrial greenhouse gas emissions.[296]

395. While the continued use of fossil fuels is necessary to maintain our security of energy supply, CCUS can be deployed to help decarbonise the energy system. Its importance is supported by the Climate Change Committee, who have described CCUS as "*a necessity, not an option*."[297]

396. The CCUS industry represents a unique opportunity for the UK, given our unique geological storage opportunities under the North and Celtic Sea – totalling an estimated 78 gigatonnes of storage potential around UK shores, enough to support the UK's demand for hundreds of years.[298] With limited EU storage capacity, we could provide storage services for other countries, if regulatory barriers can be addressed.[299] We also have significant industrial infrastructure in place through the gas network, and extensive experience from oil and gas sectors in the right places.

397. In their recent report *Carbon Capture and Storage*, Offshore Energies UK found that the UK has the technological experience and skilled workforce to develop an agile CCS industry. This industry could attract £100 billion of investment into the UK by 2050 and could be crucial in

retaining jobs in energy-intensive industries and preserving the profitability of hard to abate industries such as steel and cement.[300] The sector could also have an exportable value of £2.1 billion per annum by 2050.[301] Analysis suggests that global turnover from power CCUS tradable goods and services could reach £53 billion annually by 2040.[302]

CASE STUDY: Tata Chemicals Europe

Exemplifying the UK's early progress in the sector, in June 2022 Tata Chemicals Europe (TCE) opened the UK's first industrial scale carbon capture and usage plant which was supported with a £4.2 million grant from BEIS' Energy Innovation Programme.

The CCU facility captures 40,000 tCO_2 each year from TCE's gas-fired combined heat and power facility, and is used in the production of 130,000 tonnes of pharmaceutical grade sodium bicarbonate. Approximately 60% of the sodium bicarbonate is exported to over 60 countries around the world.[303]

398. CCUS will also help deliver sustainable growth by creating net zero aligned jobs and unlocking new export opportunities. Many of these jobs will be high skilled and concentrated in our industrial heartlands which will go through significant economic restructuring in the transition to net zero. In terms of exports, according to the Government's *CCUS Investor Roadmap*, CCUS could create £4.3 billion in GVA.[304]

399. Government has recognised this potential and taken a number of steps to grow and enable the industry, including: committing to capturing 20-30MtCO_2 per year by 2030, bringing forward the first UK CCUS projects in the mid-2020s as part of the CCUS Cluster Sequencing process,[305] developing a series of business models resulting in strong competition for Track-1 (first projects on the cluster sequencing process) confirming deployment of four clusters by 2030, and developing the licence conditions and business model arrangements so that non-piped sources of CO_2 can be accommodated by the transport and storage business model.

400. Current demonstrator projects as part of the UK Net Zero Industrial Clusters programme have shown the potential and ambition for industry to go further, faster than has been envisaged as part of the Track-1 and Track-2 process.

401. **In spite of this progress, the first-mover opportunity is fading. We must act now to ensure timely decarbonisation whilst maximising investment and export opportunities for the UK**. We already know the UK will be required to decarbonise all large industrial sites, so we should not wait for an artificial process to be concluded. If a decision needs to be taken, it should be taken now, to bring certainty to investment whilst helping to lower the learning costs of technology.

402. In light of the recent US Inflation Reduction Act and similar measures from Canada, the UK must move quickly to take advantage of the opportunities presented by CCUS and our comparative advantage in the sector. Whilst CCUS is a globally proven technology, commercial deployment has been limited and further technology developments and cost reductions are required. It has suffered from a stop-start approach in the UK, including most recently with the temporary pause of the Energy Bill. **If we do not accelerate in key areas, the cost of this inaction could be far greater than the cost of action**.

2.7.1 Provide long term certainty and visibility of funding for CCUS projects

As soon as legislation allows, **government must finalise the business models and regulatory frameworks across the value chain**, including for industrial CCS, Energy from Waste with CCS and CO_2 transport and storage.

In 2023, HMT should **set out the funding envelope available to support Track-1 clusters**.

403. There is currently limited clarity on the commercial viability of CCUS projects. Stakeholders have been vocal in asking for government to finalise business models across the value chain, including for transportation, storage and greenhouse gas removals. They have asked for clear timelines for support and clarity on what opportunities also exist outside of the cluster allocation.

404. The likes of Shell and SSE have said that **delivering the business models through primary legislation is *"a matter of urgency"* to deliver on our CCS ambitions**.[306] On power CCUS there is a particular "lack of clarity on market design" according to BP, with uncertainty as to how the Dispatchable Power Agreement (DPA) will fit into future electricity markets being developed under government's Review of Electricity Market arrangements (REMA).[307] Similarly, Storegga, a leading UK-based carbon capture developer, told the Review:

> *"Any delay in the legislation risks stalling the excellent progress to date on these business models. Delays will create uncertainty for developers and investors, increasing the cost of investment."*[308]

405. Furthermore, as set out in the hydrogen section, US and Canadian policy has changed the funding landscape for CCUS, with the US providing long term tax credits for CCUS operators. With investment already being drawn to the US, this has sharpened focus on the need for governments to provide long term funding certainty to attract investment.[309]

406. As soon as legislation allows, government must finalise the business models and regulatory frameworks across the value chain, including for industrial CCS, Energy from Waste with CCS and CO_2 transport and storage. This will enable the UK to start awarding contracts and building capacity as soon as possible.

407. More specifically, in 2023 HMT should set out the funding envelope available to support Track-1 clusters.

408. At the same time as establishing the CCUS business models, the UK should continue to innovate by focusing on the opportunity for business to utilise CO_2 and by-products created.

2.7.2 Re-envisage the CCUS programme across a ten-year investment cycle

In 2023, government must act quickly to **re-envisage and implement a clear CCUS roadmap, showing the plan beyond 2030**. As part of the roadmap, government should take a **pragmatic approach to cluster selection**. This means allowing the most advanced clusters to progress more quickly.

409. **Timely cluster delivery is a crucial building block for a successful CCUS industry.**[310] We heard at the CCUS evidence roundtable that the allocation of contracts has been overly constrained, with industry keen to have a more streamlined process for cluster selection and subsequent phases. This is in part because the process prioritises robustness, value for money

and sequencing, over pace and progression. A lack of pace however risks missing the capture targets set out in the *British Energy Security Strategy*.

> *"Government […] needs to align the delivery timing of multiple business models: low carbon hydrogen, transport and storage, and CCS, as often a combination of these are required for investment decisions. In addition, certainty in the timing of future government allocation rounds will be critical. Providing timely visibility of how and when future clusters will be sequenced is necessary in providing the certainty required for investments to progress in what is rapidly becoming an increasingly competitive global landscape."* – ExxonMobil[311]

410. Leading CCUS stakeholders such as the CCSA and Shell have told us that the lack of a clear route for deployment beyond Track 1 clusters, and phase 1 projects within these clusters, could damage the UK's progress.[312] They have also said that the lack of clarity around clusters beyond Track 1, and a plan beyond 2030, is supressing investor action due to significant uncertainty on future demand.

411. There is also specific uncertainty around the growth of CO_2 storage. The capacity for transport and storage networks to accept CO_2 from dispersed sites and international sources will be vital for our long-term objectives of achieving our Carbon Budgets and net zero. There is currently very little regulatory clarity around cross-border CO_2 transport and storage activities[313], and there is *"material uncertainty over the process [transport and storage] will follow to develop new storage capacity".*[314]

412. Attracting investment into storage sites, which have a six-to-ten-year lead time, requires government signals and a clear route to market. However, stakeholders have voiced concern that there was little market incentive for storage investment, in part because cluster selection is so slow such that there isn't clear visibility of demand.[315]

413. **In 2023, government must therefore work rapidly to re-envisage and implement a clear CCUS roadmap, showing the plan beyond 2030.** This should take the form of ten-year investment cycles and be used to inform the overall R&D roadmap that is covered in ***Pillar 6***.

414. We have seen that speed of deployment is a key value driver in ensuring CCUS is realised in the UK. **As part of the roadmap, government should take a pragmatic approach to cluster selection. This means allowing the most advanced clusters to progress more quickly**, recognising that the roll out of 'first of a kind' projects will carry a degree of risk.

415. Publishing a longer-term delivery plan will send clearer signals to attract investment. The roadmap should include:

- Approach to confirming the pipeline of capture projects, at least up to 2030, that will receive future funding, not limited to Track 1 cluster locations. In doing so, it should set out the process and timeline for Track 2 cluster selection.
- Greater clarity on planned investment for CO_2 transport and storage, including a streamlined route to market for future CO_2 storage sites and a plan for making economic licenses more readily available to those that have safety licenses for CCUS acreage already.
- The plan for ensuring our supply chains and skills can meet demand

416. The roadmap should also explore **how the UK can utilise its natural CO_2 storage facilities for export**. This will require further work on regulations and standards for international carbon pricing and markets (as detailed in ***Pillar 6***).

2.7.3 Develop a Strategy for dispersed and remote sites

By 2024, government must **develop a strategy for the plan for non-pipeline transport and how dispersed sites and mini clusters can connect to the CCS network** and what support should be offered for doing so.

417. Half of industrial activity takes place at dispersed sites. Like the rest of industry, these sites will need access to the full range of technological solutions to decarbonise fully, including fuel switching and CCUS. However, because of their distance from the clusters where hydrogen and CCUS infrastructure will first be deployed in the UK, dispersed sites face barriers to accessing these technologies, including uncertainty about access in the future, which is stifling their ability to plan for deep decarbonisation.

418. As a result, many are at an early stage in their decarbonisation journey and require support to plan and upskill to overcome knowledge barriers.

419. Current approaches to decarbonising such places are sector-led, which is not always optimal. Different areas face different barriers and opportunities – we cannot for example electrify or fuel switch all dispersed sites or the entirety of a single industry. Instead, it is beneficial to take a place-based approach to supporting dispersed sites that reflects the needs and capacity of the industry and the local area.

420. Exemplifying the challenge are five cement production sites in the Peak District, which output around 2MT of greenhouse gas emissions annually. There is a huge decarbonisation opportunity, but given they sit outside of the HyNet cluster, it is unclear how this will be realised.

421. At an evidence roundtable for the Review, we heard that it was, and will continue to be, very challenging for dispersed sites to connect into the CCUS network, exacerbated by a lack of non-pipeline transport options such as shipping of CO_2.

422. This Review therefore recommends that, by 2024, government must develop a strategy for how dispersed sites and mini clusters can connect to the CCS network and what support should be offered for doing so.

423. Encouraging mini-cluster development is a low-regrets option. Co-located dispersed sites can share costs, risks and expertise, overcoming information barriers and benefit from economies of scale. Non-pipeline transport such as shipping should be included, to facilitate links between dispersed sites and more advanced clusters.

424. Government should also ensure that the Local Net Zero Hubs continue to have capacity to support local solutions at dispersed sites, so that every industrial energy intensive location can reap the benefits of CCUS.

Mission: Setting a clear plan for industry decarbonisation built around long-term investment in CCUS and hydrogen networks and technologies. **Energy intensive industries such as steel and cement will need to use emerging technologies like CCUS and hydrogen in order to** decarbonise (See ***Pillar 3***). **CCUS will also play a role in balancing remaining emissions from the use of oil and gas as transition fuels.**	
Issue heard by the Review	**Action recommended**
Lack of clarity on the plan for cluster selection beyond Track 1; industry needs greater certainty on the process and timeline for cluster selection to incentivise investment and kick start deployment.	**In 2023, government must act quickly to re-envisage and implement a clear CCUS roadmap, showing the plan beyond 2030**. As part of the roadmap, government should take a pragmatic approach to cluster selection. This means allowing the most advanced clusters to progress more quickly. The roadmap should include: a. **Approach to confirming the pipeline of capture projects, at least up to 2030**, that will receive future funding, not limited to Track-1 cluster locations. In doing so, it should set out **the process and timeline for Track-2 cluster selection** b. **Greater clarity on planned investment for CO2 transport and storage**, including a streamlined route to market for future CO2 storage sites and a plan for making economic licenses more readily available to those that have safety licenses for CCUS acreage already. c. The plan for **ensuring our supply chains and skills can meet demand.**
Lack of long-term funding certainty for CCUS and hydrogen projects, exacerbated by the recent temporary pause of the Energy Bill, which will be essential for the delivery of business models.	As soon as legislation allows, **government must finalise and legislate for hydrogen and CCUS business models** and regulatory frameworks across the value chain. This will enable the UK to start awarding contracts and building capacity as soon as possible. **In 2023 HMT should set out the funding envelope available to support Track-1 clusters.**
Dispersed sites face specific barriers to decarbonisation, and risk being left behind due to their lack of access to established industrial clusters which are being prioritised for early deployment of CCUS and hydrogen.	By 2024, government must **develop a strategy for dispersed sites** and mini clusters to connect to the CCS network and set out what support should be offered for doing so. This should include non-pipeline transport. For hydrogen, we recommend that government delivers the **transport and storage business models** as soon as feasibly possible.

In the short-term**, we will still need oil and gas as transition fuels towards 2050**. Where their use cannot be eliminated, CCUS and other greenhouse gas removal methods will be needed.	Government should consider setting a **10% storage obligation target to fossil fuel producers** operating domestically, to restore carbon dioxide to the geosphere by at least 2035, separate to any investment on nature-based solutions. Government should also recognise the importance of 'geological net zero' and **work to align international ambitions toward geo zero by 2050**, in line with net zero.

2.7.4 Developing engineered Greenhouse Gas Removals

Engineered and nature-based greenhouse gas removals (GGRs) are essential for capturing residual emissions to enable the net zero transition. Engineered GGRs include direct air carbon capture and storage (DACCS) and bioenergy with carbon capture and storage (BECCS). Nature-based GGRs are discussed further in ***Pillars 3*** and ***6***.

The UK must create a market and incentivise investment into engineered GGRs and get them to scale. Doing so will support negative emission efforts and create new economic markets supporting growth and creation of jobs.

Key recommendations

- Government should announce, as soon as is possible, its intentions for engineered GGR business models including timings and eligibility. This announcement must clearly outline what standards these business models are expected to require.

425. For some sectors like aviation and agriculture, residual emissions remain where emissions can't be captured at source of release as they would be with CCUS, or where no further feasible action can be taken to reduce emissions. **It is therefore essential that the UK normalises the use of engineered greenhouse gas removal methods (GGRs) which capture emissions directly from the atmosphere if we are to meet our Net Zero 2050 target (see Figure 2.15 below).**[316]

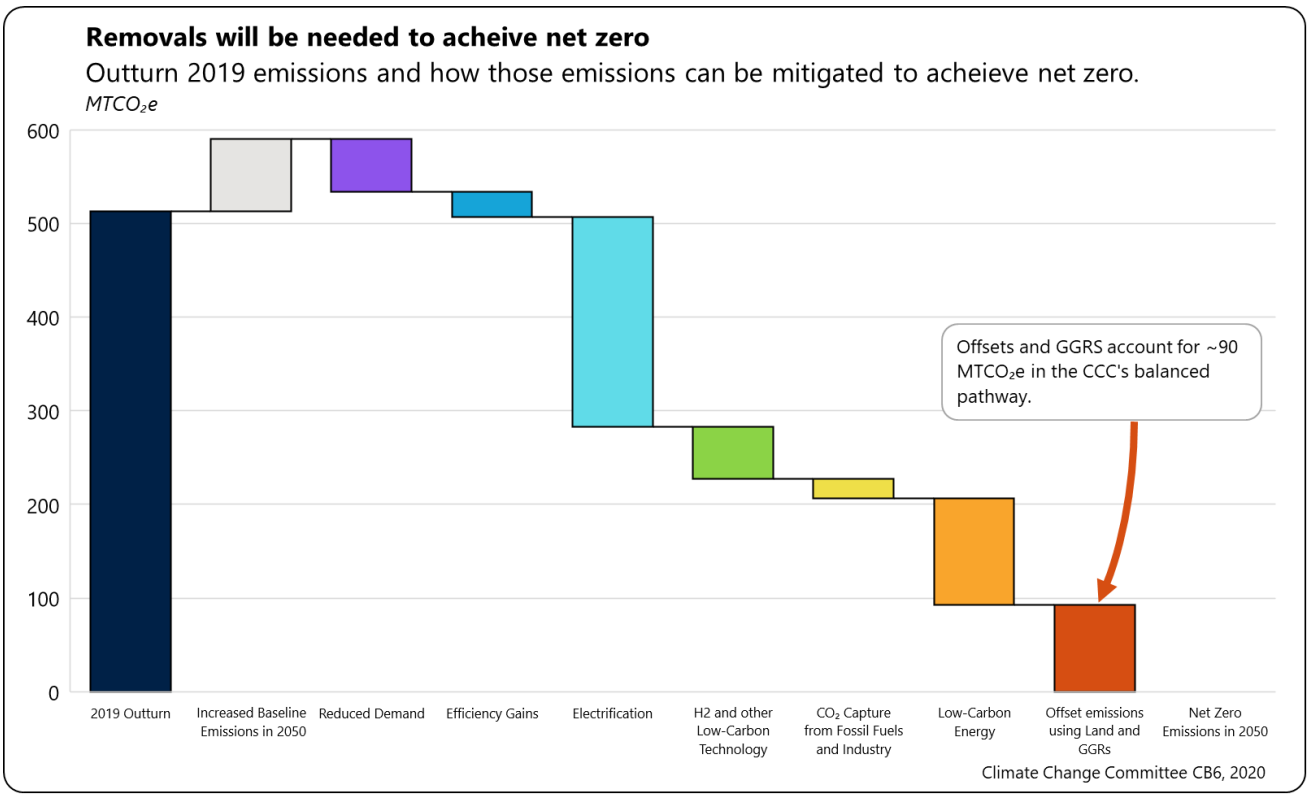


Figure 2.15 – *Requirement of removals in the CCC's balanced net zero pathway*

426. Direct air carbon capture and storage (DACCS) and bioenergy with carbon capture and storage (BECCS) are key engineered greenhouse gas removal methods (GGRs) that remove emissions directly from the atmosphere. These GGRs are in the early stages of development.

427. **GGRs are vital to the delivery of the *Net Zero Strategy*.** The Strategy committed to deploying at least 5MtCO_2 per year of engineered removals by 2030, with modelling suggesting this could need to rise to 23MtCO_2 per by 2035. However, the UK needs to accelerate development of the GGR industry if it is to capture the 40 to 100 MtCO_2 p/a of residual emissions expected to remain in 2050.

428. **Stakeholders such as *CO2RE* have been clear that it is vital we act now to ensure we have infrastructure in place to ensure a thriving GGR sector by 2050.**

> *"It is generally accepted that to meet the UK's net zero obligation, the GGR sector will by 2050 need to be the size of the current power generation sector. That is an unprecedented rate of growth for a new sector which currently scarcely exists."* – CO2RE[317]

429. **Government is progressing this work.** As outlined in the *Net Zero Strategy*, the long-term ambition is to have a competitive market for GGRs. To kick-start the integration of engineered GGRs into a market, government has consulted on (and is now analysing) a technology-neutral business model for a broad portfolio of early GGR projects.[318]

430. **It is vitally important that, whilst engineered GGRs are essential to delivering on net zero, they should not be seen as a 'silver bullet' for decarbonisation, nor a substitute for reductions where they can reasonably be made.** The UK Government is clear in this messaging when engaging on GGRs and must remain so.

2.7.5 Engineered GGRs provide new opportunities for the UK

431. **With our world-class research institutions and technological and engineering expertise, the UK is well-placed to become a global leader in engineered GGRs**. At an evidence roundtable attended by stakeholders across the GGR industry, many remarked that the UK's CCUS cluster ambitions provide the ideal opportunity for engineered GGR production, given they provide the infrastructure needed for CO_2 transportation and storage for the initial development stages of GGRs.

432. **Engineered GGRs have significant potential to create a carbon negative economic sector with novel export potential and could create swathes of green jobs.** Stakeholders at the roundtable were confident of this. For example, a *Vivid Economics* report for Drax calculated that developing BECCS at Drax alone would support on average 8,100 jobs per year during construction between 2024 to 2028, peaking at 10,300 jobs in 2027.[319]

2.7.6 Engineered GGRs are a developing market

433. **Other nations are already making moves that provide more favourable conditions for GGR investment than the UK.** The US, for example, recently updated their 45Q tax credit scheme to include direct air carbon projects which will pay \$130/tCO_2 for usage and \$180/tCO_2 for DACCS. Stakeholders at the evidence roundtable advised that without an equally clear market signal for UK businesses, investors and consumers, the UK may struggle to retain a leading role in GGRs in the face of international competition.

434. **Moreover, the UK has little in the way of a negative emissions market or predictable revenue stream, and engineered GGRs are not recognised within the UK Emissions Trading Systems (ETS).** Engineered GGRs are only accounted for through voluntary carbon markets (VCMs), which can be difficult to navigate given the lack of standardised verification and methodologies. This means developers often face significant and confusing barriers. The integration of GGRs within Carbon Markets is discussed further in ***Pillar 6***.

435. **Engineered GGRs are still in development.** It is worth noting that, as with any technology in early-stage development, there are elements of engineered GGR efficiency that can be improved upon. BEIS is undertaking work with a range of stakeholders to understand and address these areas. This includes analyses to validate net-negativity of power BECCS and the sustainability of biomass fuel, and the commissioning of external research to build evidence around Direct Air Carbon (DAC) technologies.

436. **Additionally, the UK lacks GGR-specific regulations or legislative framework, particularly in relation to Monitoring, Reporting, and Verification (MRV).** Instead, current general regulatory regimes are applied which can cause uncertainty in their application or complications from their overlapping. Stakeholders at the roundtable spoke to the importance of robust MRV for successful deployment of engineered GGRs, as well as better facilitating transparency of risk so investors better understand the market.

2.7.7 Develop business models for engineered GGRs

Government should announce, as soon as is possible, **its intentions for engineered GGR business models including timings and eligibility**. This announcement must clearly outline what **standards these business models are expected to require**.

437. Stakeholder evidence provided through the roundtable and the Call for Evidence has been clear that **greater clarity from government policy and finance commitments is needed to gain the confidence of investors and consumers.**

> *"…the government must provide the emerging GGR sector with clear market signals, as well as a regulatory regime to ensure that legitimate carbon removals are socially and environmentally robust."* – CO_2RE[320]

438. **A lack of funding, combined with the high costs of early-stage GGR methods, creates barriers to the sector's growth to commercial viability. This does little to bridge the 'valley of death' often experienced by early-stage businesses.** Stakeholders attending the evidence roundtable stressed that to help address this gap Government should provide early indications of business model eligibility.

439. **It is vital that the UK Government provides clear signals demonstrating a commitment to getting to scale the first engineered GGRs by 2030.** This must be done now if the industry is to garner the investment required to scale it up to the levels needed by 2030 and 2050, and establish a market in doing so.

440. **This Review recommends that the Government announces, as soon as is possible, its intentions for engineered GGR business models including timings and eligibility. Moreover, this announcement must clearly outline what standards these business models are expected to require.**

441. These measures are vital in removing emissions that are difficult to extract from the atmosphere, and therefore are an aid in decarbonising our atmosphere. However, these cannot replace the move to reduced emissions. The priority is to reduce the production of CO2 and the use of fossil fuels by driving down demand, defossilising the use of carbon, and moving towards new ways of working in our economy that achieve lower emissions and net zero- therefore we now turn to addressing demand in our economy.

Pillar 3: Net Zero and the Economy

The private sector is key to the net zero transition. Their **investment and innovation will bring low carbon technology to the mass market**. They will drive many of the benefits we will all experience from net zero, not least economic growth.

The UK economy is transitioning towards net zero – with businesses decarbonising and capturing new opportunities. But the Review has heard from the hundreds of businesses consulted that more is needed. In many cases, **cross-cutting actions are required – on skills, energy efficiency, support for small and medium businesses, and providing a tax environment that stimulates investment**. In others, we have heard of specific sectors offering great opportunity – but needing the right support to flourish.

Key recommendations

1. Review how policy incentivises investment in decarbonisation, including via the tax system and capital allowances, by Autumn 2023.
2. Drive forward delivery of the Green Jobs Taskforce recommendations and the commitments from the *Net Zero Strategy*, reporting regularly on progress starting by mid-2023.
3. Building on the UK Business Climate Hub, BEIS to launch a 'Help to Grow Green' campaign, offering information resources and vouchers for SMEs to plan and invest in the transition by 2024.
4. Through their update to the Green Finance Strategy, set out a clear, robust and ambitious approach to disclosure, standard setting, and scaling up green finance.Support specific sectors through a new long-term national mission on the circular economy.

3.1 The prize on offer to UK industry

442. **Net zero is a driver of economic growth: it has already delivered growth for the UK and will continue to do so.** There are already around **430,000 jobs in low carbon businesses and their supply chains** across the country with **turnover estimated at £41.2 billion in 2020.**[321] Government analysis suggests that nearly 68,000 green jobs have been created or supported since November 2020.[322]

443. In 2022, **the economic context changed which means the opportunities from net zero have never been greater**. High fossil fuel prices are expected to remain high in the short-term and there is uncertainty over their long-term future. As a result, markets are moving to capitalise on this.[xviii]

444. It is essential that the UK acts quickly and decisively. There is a new global race to maximise the growth potential from net zero at a time of wider geopolitical uncertainty. We are now at a crunch point where the UK could get left behind.

445. We are operating in an international environment in which foreign enterprises are being offered incentives to invest elsewhere in the world.[xix] In 2019, there were 2.5 million businesses operating in the UK non-financial business economy; only a small percentage of these (1.3%) were foreign owned, yet they contributed 28.5% of approximate gross value added (GVA).[323]

446. **The UK can take a share of the global economic prize from the transition, but it must act now.** The UN's Net Zero Asset Managers initiative recently announced that nearly a third of the $66 trillion of assets managed by their members globally are committed to net zero with tangible decarbonisation goals. Additionally, McKinsey have estimated that supplying the goods and services to enable the global net zero transition could be worth over £1 trillion to UK businesses between 2021 and 2030.[324]

447. If the UK wants to be part of this race and reap the benefits, it must act now to seize this opportunity. We know that first-mover advantage means a greater opportunity to secure growth opportunities and expand on the potential co-benefits from the transition.

448. **The UK can seize this opportunity by focussing on the enablers of growth** to build a resource efficient economy that utilises its areas of comparative advantage, creates an open investment environment, delivers projects via a highly skilled workforce, using reliable and well-connected infrastructure and empowers participation throughout supply chains and small businesses.

449. Given the global momentum, driven by industry, to reach net zero and reap benefits from the economic opportunities, the risk is that the UK does not capitalise on this via poor planning and a lack of policy certainty.

450. The evidence seen by the Review has shown that significant action is required to ensure the UK economy grasps the opportunity on offer. The UK needs to:

[xviii] There are different estimates on the future of fossil fuel prices. Estimates, based on BEIS modelled scenarios predict the return of prices to near previous levels are different years in the future. While the OBR's assessment anticipates prices persisting at three-to-fourfold the average price observed from 2018-2021. Early view of the BEIS 2022 Fossil Fuel Price Projections

[xix] Firms are also seeking regulatory alignment to enabler cross-border investment.

- Tackle the enablers of economic growth that will affect success for all sectors of the economy: business tax incentives, a highly skilled workforce, energy efficient non-domestic buildings and an informed and active small business base.
- Provide targeted support to individual sectors.

3.1.1 Policy enablers for business growth and decarbonisation

451. Businesses need bespoke support to breach the tipping point of barriers to growth and decarbonisation. Policy enablers of business growth and decarbonisation allow businesses big and small to meet their net zero targets and directly financially benefit from the transition.

452. **Businesses want to grow and decarbonise.** The Review has encountered hundreds of businesses who want to support the UK's journey to net zero, regardless of whether they are in a green sector.

453. Globally, we are seeing a huge uptick in major corporations pledging to reach net zero.

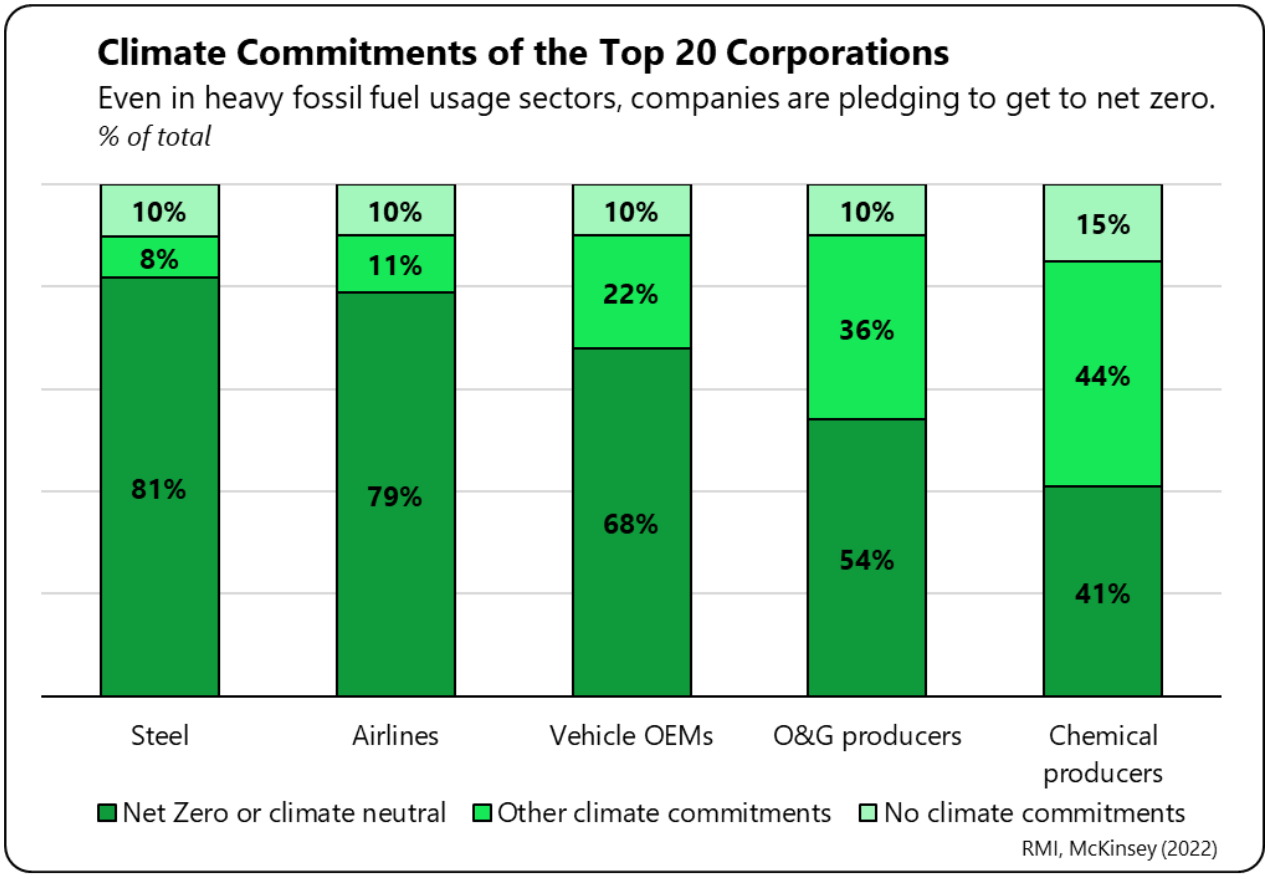


Figure 3.1 – *Climate commitments of top 20 corporations*[325]

454. **Bold business leadership supports bold policy action**. The right policy action can in turn accelerate further business action and trigger the 'ambition loop' for businesses big and small.[326] Evidence submitted to the Review has demonstrated that the UK Government can act to enable economic growth from net zero – with clear opportunities and challenges emerging, particularly around existing business tax incentives, building a skilled workforce fit for the transition, greater business resilience via energy efficient buildings and by providing direct support to SMEs.

3.2 Business tax incentives

455. The Review heard from a variety of businesses, SMEs and representative organisations who stressed that to fully seize the opportunities of a sustainable future, the UK needs to accelerate the development of new and emerging green markets and low carbon technologies.

456. The Government has a range of fiscal levers to drive this change and it needs to consider the merits of utilising various options to achieve its Net Zero ambition. This includes business model development, financial incentives such as grant funding, taxation, co-investment, and loans to support businesses and mobilise the investment required to achieve our net zero targets.

457. Ideas for best use of these policy levers have been received through our call for evidence. These cut across direct tax relief via tax credits or capital allowances, rebalancing energy levies, and business rates.

458. Businesses asked for this range of levers to be used to incentivise tech adoption and innovation as well as reward those who have already adopted or are decarbonising:

> *"[We] operate in a range of sectors... and would highlight the following broader priorities: i) Incentivise investment in decarbonisation technologies through capital allowances and tax reliefs and ii) shifting the tax burden away from (green) electricity to natural gas". – Large manufacturer*[327]

459. The Review also heard that tax relief may not be the one-size-fits all solution for all businesses:

> *"Capital equipment costs to replace or upgrade existing equipment to more energy efficient ones are a barrier and fiscal reliefs can work. While tax reliefs are appreciated, the current situation is that companies are very tight on cash (and keeping it to pay their energy bills rather than investing), so loans, grants and funds are preferred at this moment."*
> – The Lighting Industry Association[328]

3.2.1 Tax credits

460. **A tax policy to incentivise growth and decarbonisation is needed.** The Government should use a balanced approach of tax incentives and disincentives to encourage economic activity that meets the dual objective of growth and decarbonisation.

461. In the UK, some tax measures are already in place to support the decarbonisation journey to net zero by influencing business and consumer decisions. These currently target the power sector via Carbon Price Support, broader business energy efficiency via the Climate Change Levy and Climate Change Agreement Joint Incentives and the waste sector via the Plastic Packaging Tax, Landfill Tax and Aggregates Levy. A net zero tax audit would help to ensure that the taxes not defined as 'environmental' also support the transition.

462. We know that other countries have been utilising tax incentives to drive growth and decarbonisation. Most recently the USA has developed a moon-shot tax credit policy offer for businesses in the 2022 Inflation Reduction Act,[329] while the Canadian Government has offered a similar policy but in the form of a tax credit (tax rebate in USA) to lower the cost of capital in clean technologies and hydrogen production.[330] This aims to encourage businesses to more actively participate in, and seek to directly financially benefit from, the transition to net zero and provide greater energy security.

CASE STUDY: The USA Inflation Reduction Act Offer for Businesses

Cutting energy costs for businesses…

- *Small businesses can receive a tax credit that covers 30% of the cost of switching over to low-cost solar power.*
- *There is a tax credit for up to $5 per square foot to support energy efficiency improvements that deliver lower utility bills.*
- *Small businesses that use large vehicles like trucks and vans will benefit from a tax credit to cover 30% of the purchase costs for clean commercial vehicles, like electric and fuel cell models.*

...and expanding their economic opportunities

- *Creating a level playing field via an increase in the refundable R&D tax credit for small businesses from $250,000 to $500,000. This can be used to reduce payroll taxes and other business expenses via investment in innovation and commercialisation of those new solutions.*
- *Targeted tax incentives for the manufacturing of materials for batteries, solar and wind energy but also for deep decarbonisation technologies such as carbon capture systems and electrolysers for hydrogen[331].*

463. Evidence from OECD countries suggests that corporate taxes reduce investment in tangible assets and R&D and in theory, lowering the cost of capita via tax relief should make business investment more attractive.[332] Furthermore, we know that increases in business investment tend to be driven by several firms undertaking a new investment, rather than increases in the size of existing projects, with investment risk at a firm level being an important factor.[333]

464. **Businesses want to be part of the transition and government should empower them to do so**. There are some businesses who consider tax relief to be a useful incentive for investment:

> *"Provide specific investment tax relief for businesses who can demonstrate a clear contribution to the UK net zero objectives (along the lines of the R&D tax credit)."* – Abundance Investment[334]

> *"[The Government should] target easy to access, high leverage financial incentives: For example, tax relief for businesses using low carbon technologies in operations. Unlike R&D tax reliefs, the focus would be on the application of low carbon technologies that advance the net zero transition."* – University of Derby Business School[335]

465. However, while tax credits are planned in other competitor countries as discussed above (and in ***Pillar 2***), evidence on effectiveness of tax credits to influence investment decisions to grow and decarbonise is limited. Given current cost pressures on UK businesses, more research is needed to understand the likely impact on business investment today, for example in the uptake of energy efficiency technologies.

466. Furthermore, the UK Government should be mindful of the policy choices made by other countries, as they are made within a political context. Alternative interventions may be better suited for the UK given our own policy landscape.

467. As part of a wider review into the tax system to incentivise investment in decarbonisation, HMT should explore the effectiveness of tax reliefs for businesses in encouraging investment, when energy costs are so high.

3.2.2 Capital allowances

By Autumn 2023 HMT should **review how policy incentivises investment in decarbonisation, including via the tax system and capital allowances**.

468. Capital allowance policy in the UK is focused on boosting business investment and economic growth. The right tax incentives can change the narrative for all businesses from risk mitigation to opportunity capture from net zero.

469. The UK has recently taken steps to help incentivise businesses to make new plant and machinery investment for the period 1 April 2021 to 31 March 2023 via:

- a **super-deduction tax** providing allowances of 130% of the qualifying cost on investments that ordinarily qualify for the usual 18% main rate writing down allowances
- a **first-year allowance of 50%** on other asset investments that usually only qualify for 6% special rate on writing down allowances

470. While more broadly, the Government's allowances policy is fairly competitive when accounting for measures such as the annual investment allowance, HMT should be monitoring the competitiveness impacts of its capital allowances regime during the next year.

471. Businesses have welcomed the super-deduction, with more than half of firms (53%) planning to claim the super-deduction; 20% of the qualifying capital spend is seen as truly additional by firms.[336]

472. In the short term, there is a strong financial case for business investment to take advantage of the super-deduction policy window before the impact of inflation further adds to the cost of that investment. However, longer term support for investment decisions is necessary to create a sustainable investment environment (see ***Pillar 1***). The Government should be considering how best to use the tax system, for example via a super-deduction policy or similar, and other capital allowances, to achieve growth and decarbonisation. We have heard example tax measures from businesses to support this:

> *"[We] would recommend an extension of the targeted system of First Year Allowances (FYAs), to include enhanced benefits for investments which would additionally support the government's policy objectives relating to net zero and productivity. For example, this could include plant and machinery which contributes to industrial energy efficiency/energy management and productivity enhancing investments in industrial digitalisation."* – ABB Ltd[337]

473. We recommend HMT, as part of a wider review, consider a successor to the super-deduction tax relief with a focus on increasing investment in low-carbon technologies as the super-deduction is due to end in March 2023.

3.2.3 Business rates

474. Business rates are taxes designed to fund services within a local authority. They are levied on business properties. Business groups have long called for business rates reform and cited business rates as a barrier and distortion that constrain business investment.[338]

475. Business rates policy matters for business investment:

> *"The proposal to increase the Small Business Rates Relief threshold was ranked as a top three investment incentive by 24 per cent of small businesses in FSB's 2021 tax survey."*
> – Federation of Small Businesses (FSB)[339]

476. HMT's *Business Rates Review*, which focused on English business rates, recognised that extra relief was required to support investment in property improvements. This was to enable occupying businesses to invest in expanding their properties and making them work better for their customers and employees.

477. Additionally, it highlighted the need for exemptions for eligible green plant and machinery such as solar panels, wind turbines and battery storage used with renewables and electric vehicle charging points, as well as a 100% relief for low carbon heat networks that have their own rates bill.

478. **The Government should continually assess the existing business rates incentives to ensure there are no further inadvertent disincentives for businesses to invest in net zero technologies.** For example, up to 50% of business investment is potentially subject to business rates.[340] HMT should consider the balance between increasing business rates and the use of business rates in supporting business growth and decarbonisation.

3.3 A skilled workforce for the transition

Government to **publish an action plan for Net Zero skills that includes a comprehensive roadmap of when, where, and in which sectors there will be skills needs specific to net zero.**

479. Successful decarbonisation of key industrial sectors could bring many new green jobs and support workers to transition to jobs of the future. **To ensure that these jobs are created here in the UK, provide opportunities across the country, and underpin a just transition for workers in industries with changing skills needs, the Review has identified some key actions that government and industry should take.**

3.3.1 The opportunity and the challenge

480. The Government estimates that the policies underpinning the *Net Zero Strategy* and the British Energy Security Strategy could support **480,000 green jobs by 2030**, and the Energy Innovation Needs Assessment published by BEIS found that business opportunities identified from decarbonisation could support approximately **500,000 jobs in the UK by 2050**[341].

481. There is evidence that suggests that green jobs tend to offer higher wages.[342] However, novel analysis by LSE Grantham Institute (forthcoming) on green jobs in the UK and the US suggests that, while green jobs tend to be created in better paid occupations, they are not necessarily better paid because of their greenness. More specifically, while for a given occupation (e.g. engineers) green jobs were generally better paid in the early 2010s than their non-green counterpart, wage premia have become more modest in recent years and vary considerably across occupations. Higher wages may reflect a mismatch in the supply and demand of certain skills, as well as productivity levels in different sectors. For example, gross value added (GVA) per worker for industries such as offshore wind and CCUS remain higher than the UK average.[343]

482. **The UK can seize opportunities for levelling up** as part of place-based impacts of the transition. For example, there are growth opportunities in CCUS and low carbon hydrogen which can create jobs in Merseyside, Humberside, Scotland and South Wales. Similarly, opportunities in environmental development (tree planting, peatland and seagrass restoration and urban green infrastructure) exist in the 20% of British constituencies facing the most significant employment challenges.[344] [345] Job returns on investments in nature-based solutions (like tree planting or peat restoration projects) are high in comparison to other sectors in the economy; on average, investments in nature-based solutions have around ten times the job creation rate of investments in fossil fuels.[346]

483. The LSE analysis of UK vacancy data mentioned above shows that low-carbon jobs are more spatially dispersed than high-carbon ones. This is promising in that the net zero transition could bring about economic opportunities across the UK.

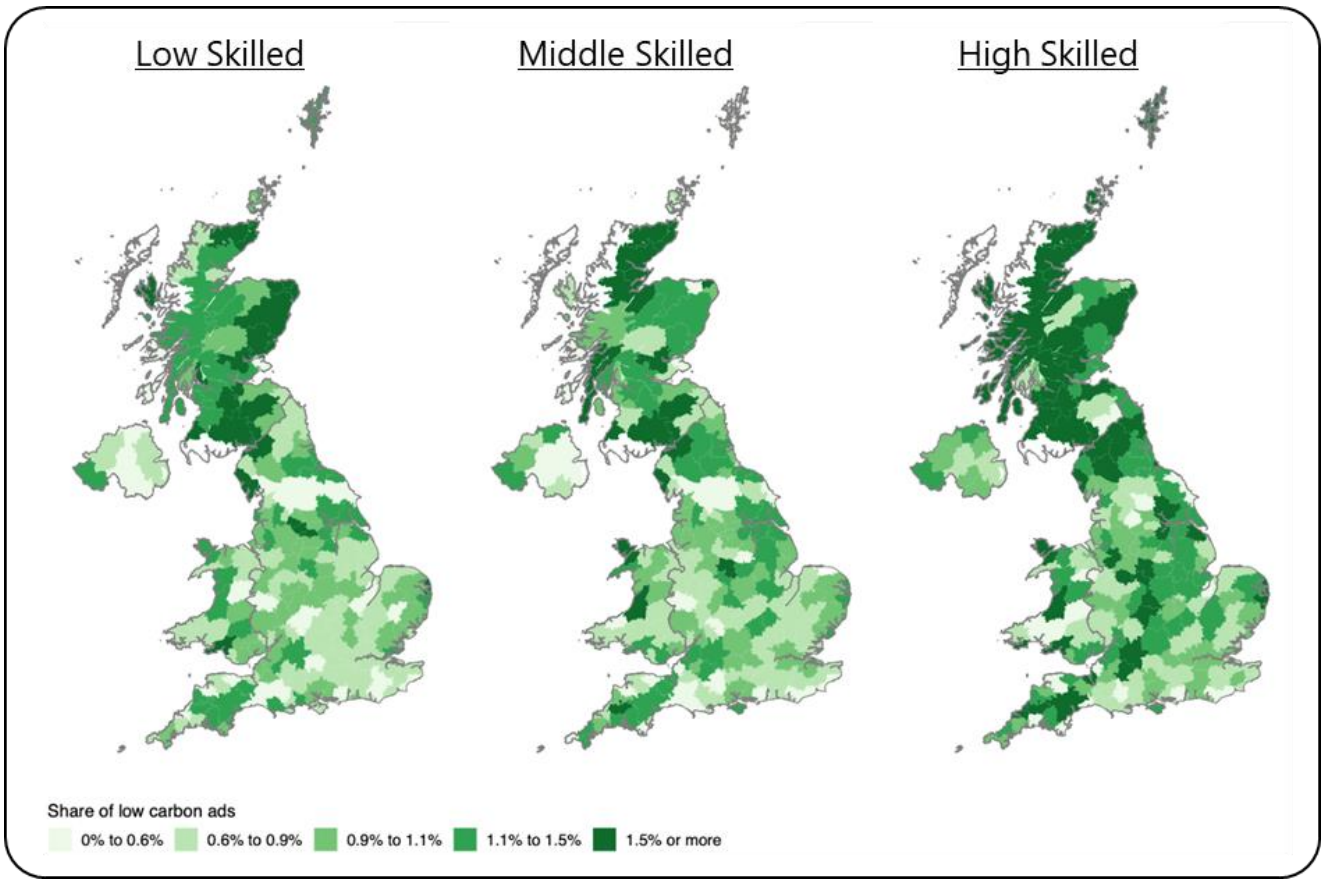


Figure 3.2 – ***Spatial distribution of low-carbon vacancies at different skill levels***[347]

484. **However, disparities are already emerging**. Regional analysis in PwC's Green Jobs Barometer[348] found that the lowest-scoring regions on the overall Barometer Index were Northern Ireland, the North East, and the East Midlands. "Although every region of the UK is experiencing significant green job creation, the rapid increase is disproportionately concentrated in London and the South East".[349] On gender, Onward found that "in net zero industries, approximately 82% of employees are male and just 18% are female".[350] While gender balance is marginally better than in incumbent industries, policies are required to tackle this for the future.

485. **To ensure that future green jobs are created here, we must ensure that the UK has the right pipeline and mix of skills to deliver the transition.** Industry has been clear that having the right skills in the economy is critical for achieving net zero, capitalising on growth opportunities available to the UK, and ensuring that the transition brings these high-quality jobs across the country.

486. **Skills challenges were raised in engagement with almost all sectors.** To capture the jobs growth opportunities from net zero**, the UK needs a shift in mindset about the mix of skills we need in the economy across all sectors.**

487. **This challenge is exacerbated by an existing decline in skills** in some sectors of the economy that are critical to the transition. Some crucial areas show concerning existing skills gaps, including tradespeople, where depending on the sector, we have seen a 5-30% decline over the past three years,[351] undermining the UK's ability to undertake retrofitting and install heat pumps, and construction, where 50% of Federation of Master Builders members report challenges recruiting for key trades including bricklaying and carpentry.[352]

"To build, renovate and retrofit the good homes of the future, the UK will need to reverse its recent decline in the numbers of tradespeople ready to work." – Kingfisher[353]

"On the ground there is a lack of confidence that the skills are there to deliver retrofit projects, which is holding back our investment when we can see the return." – Venture capital firm[354]

488. **The UK Government set out to tackle this challenge by establishing the Green Jobs Taskforce in 2020** to "set the direction for the job market as we transition to a high-skill, low carbon economy."[355] The Taskforce, comprising of a diverse group from industry, academia, unions and the education and skills community, produced an advisory report to Government, recommendations of which are yet to be fully implemented.

489. The **Green Jobs Taskforce Report** made a thorough assessment of the opportunities and impacts of the transition and received broad cross-sector support for its recommendations.[356] It categorised sectors into three groups that will experience emerging skills demands in different ways:

- Well-established green sectors which will experience significant growth – for example, offshore wind, electricity networks, smart systems technologies, buildings retrofit and construction of new builds.
- Green sectors that are predicted to grow ahead of the transition – for example, hydrogen, CCUS, climate resilience, nature conservation and restoration.
- Sectors experiencing significant transformation – e.g., automotive, heating and cooling, circular economy and resource efficiency, and oil and gas.

490. The Report emphasised the importance of cross-cutting skills: Science, Technology, Engineering and Mathematics (STEM) skills, but also digital and data, project management, education communication and change management, and leadership, management and communication.

491. Industry views heard by the Review reinforced many of the challenges raised by the Green Jobs Taskforce and reiterated ongoing and future concerns about having the right skills in the economy, **suggesting insufficient confidence that progress is being made.**

492. Challenges we have heard from industry through this Review include:

- confidence in existence and longevity of jobs
- access to and affordability of skills provision
- training and retraining skills pipeline
- parity of esteem for entrants into trade vocations
- rate of movement of workers between jobs

493. The solution relies on clear long-term policy (see ***Pillar 1***) support to help people access training and re-training (and know where the opportunities lie), clear and coherent training pathways – including the role of the education sector in building STEM skills from school age to higher education – and building capacity in local areas where the jobs of the future will be created.

494. Stakeholders also pointed out that long-term policy certainty could benefit net zero skills development. Long-term commitment to support for priority net zero technologies will give

employers the confidence to invest in skills development. Moreover, a significant gap exists between the scale of the skills challenge at national level and local plans for skills development.

495. **Government should drive forward delivery of the recommendations of the Green Jobs Taskforce and the commitments from the *Net Zero Strategy*. Publish an action plan for Net Zero skills that includes a comprehensive roadmap of when, where, and in which sectors there will be skills needs specific to net zero.** This should include clear public targets for green skills action and governance to regularly track and report against these. Government should look to report on progress made by the Green Jobs Delivery Group on a regular basis, starting by **mid-2023**.

3.3.2 Publicly measure progress on green skills and jobs – however imperfectly

To monitor progress against the just transition, Government should swiftly **develop robust regional green jobs statistics** (ideally at local authority level, at least for England), breakdowns of green jobs considering protected characteristics, and publish information about salary levels.

496. Onward's 'Qualifying for the race to net zero' discusses the challenge of predicting and accurately measuring green jobs of the future:

> *"It is not possible to precisely predict which jobs will be created in the pursuit of decarbonisation, or what skills will be needed among the workers who fill them"*[357]

497. The Review heard this challenge reinforced from a variety of players tasked with estimating, measuring, and reporting against the future skills requirement in net zero sectors. For example, the ONS set out the issues with defining a 'green job' in its 2021 article,[358] which discussed the challenges of reaching an agreed definition of 'green' and evaluating how 'green' a specific job is in practice. In the second half of 2022, the ONS also ran a stakeholder engagement exercise on defining green jobs, the Review notes that the ONS will publish an official green jobs definition by early 2023, with experimental green jobs statistics to follow.

498. Alongside updated backward-looking green jobs statistics to reflect an improved definition, this Review recommends the ONS work with other organisations to deepen monitoring of the labour market impacts of net zero, particularly with regards to the just transition.

499. Industry made it clear to the Review that to invest confidently in the UK, clarity is required on both the pipeline of technology and the status of the skills pipeline. Options provided to the Review include:

- Government providing opensource regular national labour forecasts that recognise the interdependencies between different industries.
- Setting targets for future numbers of students in priority industries to provide early warnings on skills shortages.
- Government providing a forward plan for transitioning skilled workforces in large carbon intensive projects to green jobs.

500. In its Green Jobs report of 2021-2022, the House of Commons Environmental Audit Committee (EAC) recommended that by the end of 2021:

> *"The Government sets out how it will set out how it will measure progress towards its green jobs targets; this should include its definition of 'green jobs', and how it will measure the number, type and location of these over the 2020s, for the purpose of monitoring and evaluating the impact of its policies."*[359]

501. While the Review recognises the limitations with anticipating the jobs and skills of the future economy, there is an ongoing need to continue to develop and publish data – which, even if imperfect, can support with the dialogue and further evidence development in this area.

502. Government should swiftly develop robust regional green jobs statistics (ideally at local authority level, at least for England), breakdowns of green jobs considering protected characteristics, and publish information about salary levels, to monitor progress against the just transition – reports on these through the climate data portal recommended in ***Pillar 1.***

3.3.3 Enabling an equitable transition and developing talent

Government and the Green Jobs Delivery Group should explore a range of targeted options, including:

- Increasing the flexibility of the Apprenticeship Levy, and assessing whether the Levy aligns with Government net zero and growth priorities, and whether shorter, more intensive courses should be available alongside exploring the role of T levels.
- Options for retaining talent within businesses and access to international labour.

503. The Confederation of British Industry (CBI), speaking on behalf of some 190,000 businesses, said that in the transition to net zero:

> *"What is often lost in the projected numbers of green jobs is there will be very few direct skills transfers, and not all of these will be permanent. We (the UK) need(s) a more flexible and agile approach to addressing skills training throughout the economy, that facilitates re-training"*[360]

504. The Review heard that **without a significant supportive decarbonisation policy mix in partnership with industry the UK will not have an appropriately skilled workforce at the scale and pace required to deliver the transition.** For example, pre-pandemic Engineering UK analysis projected shortfalls of between 37,000 to 59,000 in meeting an annual demand for 124,000 core engineering roles requiring Level 3+ skills, including an expected graduate-level shortfall of at least 22,000 per year.[361]

505. The Review heard that to bolster the workforce**, the Government and the Green Jobs Delivery Group should explore a variety of targeted options:**

- **Increasing the flexibility of the Apprenticeship Levy** in partnership with industry. The Review heard from many in industry that the Levy could be improved, including from Kingfisher, who advised that "each year, over £1 billion is returned to the exchequer in unspent Apprenticeship Levy funds." In monitoring the effectiveness of the Apprenticeship Levy programme, the **Government should assess whether the Levy aligns with Government net zero and growth priorities.**

- The Review has also heard from industry that some skills, for example installing heat pumps, could benefit from a shorter training programme than standard apprenticeships. The Government should also consider how the Levy could be applied to shorter, more intensive courses to rapidly upskill and retrain the existing workforce, alongside the extensive apprenticeship training programme.
- On **retaining talent**, we heard in our Call for Evidence that making it easier for companies to move their people around the business will ensure the best talent is available in the UK. Industry should consider **a net zero skills passport to simplify and streamline retraining needed to move into new green jobs**.
- Industry raised that easier access to high-skilled international labour may help reduce the skills gap, in particular in coming years when it will become more pronounced given the rapid increase in net zero skills demand and loss of existing talent – one in five energy and utilities workers are due to retire before 2030.

3.4 Energy efficiency

Government should legislate by 2025 for **the minimum energy efficiency rating for all non-domestic buildings, both rented and owned, to be EPC B by 2030**.

Government should legislate for **all new non-domestic buildings from 2025 to have an EPC B rating.**

Government to **drive the creation of sustainable material supply chains and influence market development through public procurement standards** by 2027 (see Construction sector).

UK to continue to show leadership through a**mbitious public sector decarbonisation by conducting its own trials to ensure alignment with the targets** in the *Heat and Buildings* and *Net Zero Strategies*.

506. The broader energy efficiency mission is not a complete package unless non-domestic buildings are considered. Energy efficiency measures have the potential to reduce business energy use by up to a third, and demand reduction is a crucial piece of the puzzle.

507. **It is paramount that businesses save money on energy bills**. The most vulnerable sectors during a period of high energy prices are energy-intensive manufacturing (for example paper mills and chemicals manufacturing), hospitality, and entertainment and recreation – all of which are large employers in the UK.

508. **Government can offer support via a comprehensive and integrated communications campaign and energy advice service.** Rolled out iteratively as and when material is ready from 2023, it can expand on the planned Industrial Energy Advice Service and include advice on low/no-cost measures, sources of funding or incentives, a payback calculator and sector specific guidance.

509. **High energy costs significantly impact profit margins.** Untapped measures are costing UK businesses £6 billion per year and 51% of industry surveyed saying that access to finance to make upgrades is a key barrier.[362] In 2022, businesses' (industry and other non-domestic buildings) gas and electricity expenditure totalled around 12% or £46 billion of profits, up from around 6% or £23 billion in 2019.[363]

510. **Direct funding is required.** The Review recommends that there are direct funding measures for both SMEs and large companies or those in large buildings (and their landlords where applicable) or projects that are innovative in the short term. This could also involve extending the existing Industrial Energy Transformation Fund (to £185 million, in line with the Conservative Manifesto[364]) and new support for SMEs and in commercial sectors/buildings.

511. **Government action can give businesses the capacity to invest**. Businesses paying less on energy bills means more money to support other investments, directly supporting growth and UK competitiveness. HMG can maximise this further by supporting technological innovation and new markets through green finance, as well as by developing new regulatory levers by the late 2020s.

512. Government should legislate by 2025 for the minimum energy efficiency rating for all non-domestic buildings, both rented and owned, to be EPC B, to be implemented by 2030. Government should also legislate for all new non-domestic buildings from 2025 to have an EPC B rating.

513. **This can have positive impacts on competitiveness**. Improving operational energy and reducing embodied carbon in corporate buildings can also become a competitive advantage for the UK. For example, the University of Birmingham partnered with Siemens to deliver Internet of Things (IoT) technology at scale. This technology is in place across the campus and helps to better consider the use of space and avoid building structures with a huge, embodied carbon impact. This innovative technology not only helps buildings and companies to be more productive and competitive, but also offers Intellectual Property (IP) export opportunities. ***Pillars 2 and 5*** will cover further export opportunities, including in the smart energy system space.

514. **Putting standards in place can help build the market.** By putting commercial minimum energy efficiency product standards in place by 2028, this will ensure that our market is seen as serious about energy efficiency, attracting more investment. This could be bolstered by new Enhanced Capital Allowances (ECAs) or super-deductions for energy efficiency products, including heat pumps and manufacturing equipment.

515. **Further regulatory reform and increased advice can help grow this market**. In 2019 the non-domestic building UK supply chain turnover was £2.4 billion - £5.7 billion, which could be expanded if there was better understanding around technology use, increased access to independent advice and clearer long-term regulation to enable businesses to evolve their business models. BEIS estimates that around £20 billion (CAPEX) is required to achieve all energy efficiency potential in non-domestic buildings.[365] The Government should use the existing *Energy Savings Opportunity Scheme (ESOS)* to increase uptake of energy efficiency measures using powers, including extending coverage and requiring firms to take up recommendations.

3.4.1 Public sector decarbonisation

516. Government can lead by example by investing in the energy efficiency of the public estate, galvanising local and national government efforts, and reducing energy demand. National government has a role in supporting the development of business cases that maximise value for money and provide demonstrable examples for local government and industry to progress.

517. For example, a public sector pilot carried out in schools and homes in New York, Milan and Copenhagen introduced a methodology and toolkit to enable cities to quantify the benefits from deep retrofit projects. Trials and examples such as this will support Government in motivating people to change their thinking and support regional Governments in making the case for funding or to crowd in private investment.

CASE STUDY: Benefits of Deep Retrofits

C40cities, Burohappold Engineering and Rockwool undertook a study to provide cities with a unique toolkit to estimate the multiple benefits of retrofitting a portfolio of buildings as well as an entire city-wide programme[366].

This toolkit was piloted on specific retrofit projects in three C40 cities:

	New York Pilot	Milan Pilot	Copenhagen Pilot
Building type	23 schools	5 residential	5 schools
GHG reduction	42%	34%	18%
FTE	1967 -1601		34
Net Present Value	$21.6m over 29 years	$790k over 15 years	$19.5m/7 years
Reduction in energy costs	42% /year	23%	18%
Productivity value		2.5% Asthma reduction	$840k/year

3.5 SMEs as active participants in net zero

518. SMEs face specific barriers to participating fully in the net zero transition – targeted support offers from government can amplify a growing will to 'take action' on net zero and allow SMEs to share in the benefits alongside larger businesses.

519. We know from the Federation of Small Businesses (FSB) that there is a clear and growing appetite among small businesses and others to do more.

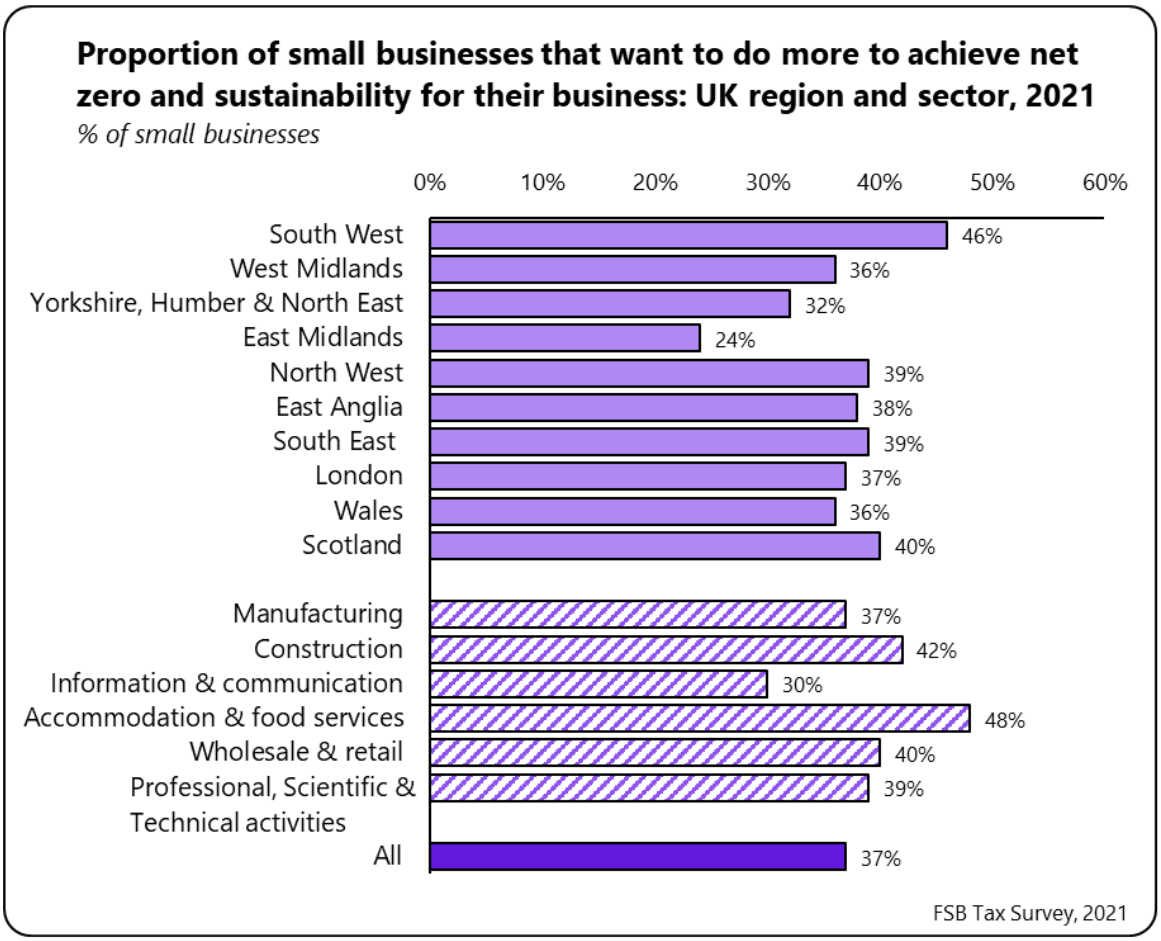


Figure 3.3 – ***Proportion of small businesses who want to do more to achieve net zero and sustainability for their business***[367]

520. **SMEs are a core target for growth and the future of net zero**. Analysis by the British Business Bank found that SMEs account for almost one third of all UK emissions and around half of total UK business emissions.[368] However, big businesses can more easily participate in net zero, and can better minimise costs and maximise financial benefits.

521. Government needs to act to enable SMEs to actively participate and benefit from the net zero transition. Evidence from the British Business Bank suggests most small businesses are at an early stage in their transition to net zero, with the most commonly perceived barriers to action around cost and feasibility.[369] Access to finance is part of the solution to drive more action.

522. Small businesses could play a more active role in the net zero transition, but they are often constrained by time and cost. Information needs to be easily accessible and simplified for SMEs to digest given the resources they have if they are to identify decarbonisation opportunities and measure their own emissions.

"Create simpler engagement mechanisms for SMEs to engage with NetZero (and the broader sustainable issues across social value frameworks). Barriers of time and cost should be addressed to encourage businesses to begin their transformational journey. Less than 10% of UK SMEs currently attempt to measure their carbon emissions, progress needs to be made quickly to deliver Net Zero." – Scope Zero[370]

523. Additionally, SMEs often do not have the capital to pay the upfront costs and if they do the payback period for net zero initiative can be uncomfortably long.

524. SMEs need to be empowered to take actions to improve the greenhouse gas emissions impact of their business and capitalise on the financial benefits from the transition.

- **Utilise role models**. In the construction sector, as part of the *CO_2nstruct Zero* programme, the Construction Leadership Council has recognised the importance of promoting role models for other businesses and the self-employed with action on net zero.[371] This looks to provide evidence on the steps taken to decarbonise, provide case study material and work with their trade association to signpost other businesses within their sector on action to take.
- **Better signposting**. The Government has had limited success in signposting smaller businesses to the type of support currently offered.

  "There is mixed awareness of the support and technologies available, which could be addressed through schemes like Help to Grow and Made Smarter." – Industrial manufacturer[372]

  "The majority of UK SMEs tend to turn to government website and support schemes. This speaks to the importance of improving the quantity and the quality of information available on the platforms to accelerate decarbonisation." – Zero Emissions Enterprise (ZEE) Network[373]

- **Reducing the 'prisoner effect'**. Too often green actions by small businesses are constrained due to their tenant status in a building. SMEs and landlords should be working in collaboration to change the built environment.

  "One of the key barriers faced by small businesses, for example, wishing to become more energy efficient, are the restrictions found within their tenancy and lease agreements, which may restrict if and what they can install in terms of energy-efficiency measures." – Federation of Small Businesses (FSB)[374]

- **Impacting SMEs via policies aimed at larger firms:** small businesses are often subcontractors to larger businesses and so policy aimed at larger businesses should also be considering the impact on small businesses**.**

  "This needs to be done with sensitivity, as direct requirements of certain standards from subcontractors might disadvantage smaller firms and disturb balance of competition on the market" – Zero Emissions Enterprise (ZEE) Network[375]

525. **Tax incentives matter for SMEs too**. Evidence from the OECD suggests there is greater additionality – that is, direct funding being effective in stimulating additional investment – from R&D tax credits for smaller firms than larger firms,[376] Smaller firms have a lower tendency to make investments in research and development. We have heard these incentives could be used via similar model to deliver greater investment more broadly.

"…changes in a number of areas could help facilitate investment and deliver of transition to net zero: Develop stronger tax incentives to enable businesses and consortia to deliver and

develop NZC services - examples of this include a similar model to the R&D tax credit" – University of York, BioYorkshire[377]

"[The UK] should have a version of the R&D tax credit system [for] net zero as a means to incentivise. Alleviates the cost burden and we could mirror existing models thus should be swift to establish and implement" – Engineering company[378]

526. This matters for both the business as a whole and for incentivising their employees:

"Government should create tax-efficient schemes for organisations to encourage their employees to become NetZero; how they heat, and light, their homes, travel to work and work-based activities, take their holidays and invest for the future via pension schemes." – Scope Zero[379]

527. Energy use by businesses is a major source of their emissions,[380] and there is evidence that SMEs are aware of the benefits of energy efficiency.[381] In 2020, the Carbon Trust found that over 80% of SMEs surveyed were acting on energy efficiency and 51% saying they want to do more, but a lack of time and money is the most cited barrier to further action.[382]

528. However, this year the ability of small businesses to invest has faltered:

"By January 2022, evidence from the FSB found that only 22% of small businesses had plans to invest in net zero over the following 24 months. Since the beginning of the year, inflationary pressures have further diminished small businesses' ability to invest, while successful applications for credit are at an all-time low (46.2%).

"We believe that without further fiscal intervention, many small businesses will be forced to focus on business survival instead of investing in microgeneration or energy efficiency measures." – FSB[383]

529. The Review therefore recommends that part of the wider review of the tax system to incentivise investment in decarbonisation should include SMEs and consider incentives to improve their uptake of energy efficiency technologies.

Building on the UK Business Climate Hub, Government should launch a **'Help to Grow Green' campaign, offering information, resources and vouchers for SMEs** to plan and invest in the transition by 2024.

Government should develop an **SME role models programme**, which provides mentoring for micro businesses and the self-employed by 2023.

Government should establish a **taskforce of suppliers, small business landlords and business groups to agree on how to cut energy use in rented premises** by 2023.

3.6 Turbocharging growth and decarbonisation across UK sectors

530. The Review has spoken to hundreds of sectors to understand the specific barriers they face to decarbonising and capturing the economic opportunities from the net zero transition. Central to this were over 50 roundtables with sectors, which took place around the country. This section sets out specific recommendations for[xx]:

- Financial Services
- Manufacturing
- Energy Intensive Industries (EIIs)
- Construction
- Circular economy, resources, and waste
- Retail
- Food, agriculture, nature, and land use
- Technology and digitalisation

3.6.1 Financial Services

531. Financial Services are small in terms of their own emissions, but own, lend money for and invest in assets and activities in the economy that produce greenhouse gas emissions. The financial sector therefore has a crucial role to play in the transition – both as an enabler of the transition across all parts of the economy, and as a growth opportunity in itself.

532. Significant investment is needed for the transition to net zero to happen. *The Net Zero Strategy* estimated that we need additional investment of £50-60 billion per year in the late-2020s and 2030s to reach net zero. This is considerably more than seen to date, leaving a significant investment gap, which will largely rely on private finance to plug.

533. Green finance is growing rapidly – globally the issuance of green bonds increased 11-fold over the five years to 2021 (see Figure 3.4 below), creating unique opportunities for the UK as a global financial centre. A recent report by McKinsey estimated that the global revenue potential for banks from debt investment in climate finance will average around $100bn annually through 2030,[384] suggesting it would be even larger for the wider financial system. This could create significant export opportunities for the UK. And the financial services sector is increasingly recognising the investment opportunities associated with the transition to net zero:

> *"According to our research, the global green economy has recorded a compound annual growth rate of approximately 14% over the last 12 years, increasing its market capitalisation from $2 trillion in 2009 to more than $7 trillion in 2021. Despite the current geopolitical and economic environment, investors are increasingly looking to allocate capital more sustainably. In a recent survey, we found that 86% of asset owners globally are implementing sustainable investment in their strategies – this is up from 76% in 2021."* – London Stock Exchange[385]

[xx] The Review has attempted to consider the sectors of the economy with either the largest carbon footprints or greatest economic opportunities – but in the short period allocated to the work, we acknowledge that some sectors are missing.

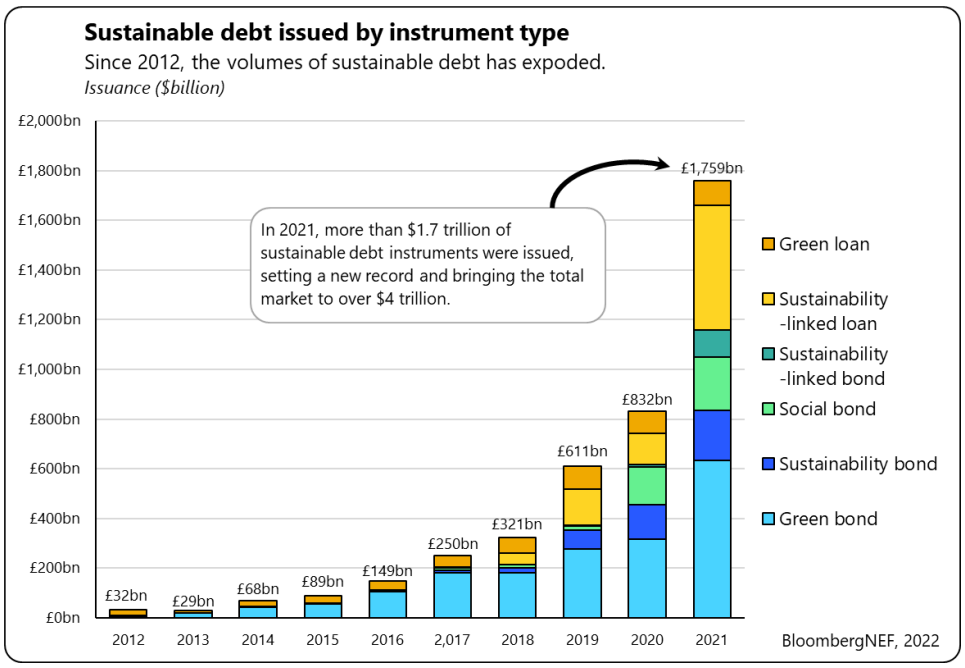


Figure 3.4 – *Annual issuance of green labelled debt globally*[386]

534. Mobilising finance – including the nearly £10 trillion of assets managed by UK institutional investors – is therefore key to funding the transition, as well as an economic opportunity for the UK financial services sector in establishing itself as a leading green and sustainable finance hub.[387]

UK as a global centre for green finance

Review how the UK can become the **most competitive financial centre for green and transition listings, capital raising and project financing**. This should include reviewing prospectus and listing regimes to encourage integrity and growth in the market for green finance instruments, as well as exploring the new opportunities arising for professional services, climate and nature data and analytics and innovative product development.

Through its update to the Green Finance Strategy, Government should set out a **clear, robust and ambitious approach to disclosure, standard setting, and scaling up green finance** – including how it will meet existing commitments to implement Sustainable Disclosure Requirements across the economy; how it will provide a **clear, long-term plan for attracting capital to meet net zero ambitions, how to maintain the UK's position as the leading green finance hub internationally** and metrics for success.

535. The financial sector is not only crucial in making the transition to net zero happen, and in an efficient way, but the shift to green finance creates a growth opportunity that the UK is uniquely placed to take advantage of. London is already considered a leading hub globally for green finance – ranked first in the world, overtaking Amsterdam, according to a recent index.[388]

536. At COP26 the UK government committed to the UK becoming the world's first net zero aligned financial centre. Government needs to set out a clear plan for how it will reach that target. The UK must build on its leadership in terms of setting clear standards, internationally aligned, to ensure robustness and trust in the system, and build confidence with investors (see also ***Pillar 1***).

537. **To meet its aspiration of becoming the world's first net zero aligned financial centre, government should review how the UK can become more competitive in terms of green finance** – akin to the recent Hill Review on competitiveness of listing rules but going beyond the stock exchange. This review should consider how the UK can become the most competitive financial centre for green and transition listings, capital raising and project financing. To facilitate this, the review should recommend how the UK can become a global hub for professional services (such as legal, accountancy and consultancy services); climate and nature data and analytics (building on the UK Centre for Greening Finance and Investment) and innovative product development (for example, sustainability linked products)

538. This review should also capture the role of the London Stock Exchange – a key pillar of the UK's financial system, enabling companies to raise capital and investors to build their portfolios across a range of global markets. In order to encourage green securities issuance at the London Stock Exchange, **the Government and Financial Conduct Authority should take the opportunity of the ongoing reform of the prospectus and listing regimes to review the rules to encourage integrity and growth in the market for green finance instruments**, with the aim of supporting the net zero transition. To do this effectively, they will need to work with issuers, their advisors and other market participants including exchange and venues.

539. This would support, and sit alongside, the comprehensive financing strategy (see ***Pillar 1***) that looks at how the UK Government can leverage government investment, policies, and regulation to scale up private finance to deliver the UK's net zero enabled growth.

540. Government has committed to an update to its Green Finance Strategy (GFS). It needs to deliver on this commitment and use that opportunity to bring together the numerous aspects of green finance and set out a clear, robust and ambitious approach to disclosure, standard setting, and scaling up green finance – including how it will meet the existing commitments to implement Sustainable Disclosure Requirements across the economy. The GFS should provide a clear, long-term plan for attracting capital to meet net zero ambitions, and how to maintain the UK's position as the leading green finance hub internationally and metrics for success.

3.6.2 Manufacturing

541. Industrial emissions, which include manufacturing and refining, are a major source of greenhouse gas emissions, producing 17% ($MtCO_2e$) of the UK's total greenhouse gas emissions. The *Industrial Decarbonisation Strategy* set out ambitions for the industry to reduce carbon emissions by at least 67% in 2035 and by at least 90% by 2050.

542. The abatement opportunities in manufacturing are driven through greater energy and resource efficiency, fuel switching to low carbon fuels and via the adoption in deep decarbonisation technologies such as hydrogen and CCUS.

543. **There are economic opportunities** to demonstrate and deploy new green technologies which the UK can manufacture and export, such as electrolysers for green hydrogen.

> *"[…] two in five (42%) manufacturers agree that they have already identified opportunities and are already taking advantage of them. Some have gone even further and changed their research and development strategies to take full advantage of the net zero economy."*
> – Make UK[389]

544. Additionally, there is also an opportunity to support the growth of a market for low carbon products. As set out in the *Industrial Decarbonisation Strategy,* the Government set out plans to

develop proposals for ‘demand-side policies’ including product standards (both voluntary and mandatory), product labelling and procurement (both public and private).

545. These policies are intended to address the lack of information about the climate impact of industrial products, enabling consumers to identify low carbon products and empowering them to make green choices. This may enable manufacturers to attract green premiums for low carbon products, increasing the profitability of decarbonisation further.

546. **However, there are broad sectoral challenges for manufacturers to grow and decarbonise.** Firstly**,** both clustered and dispersed sites need access to CCUS, hydrogen and electricity networks in order to decarbonise, but access to developing or upgraded networks is uncertain beyond those clusters included in phase 1 (of cluster sequencing) for CCUS deployment, particularly for transport of carbon dioxide. for CCUS deployment, particularly for transport of carbon dioxide.

> *“Other technologies e.g., CCUS are still in their infancy e.g., CCUS and there are concerns on how this would work in dispersed sites (especially for cement) as locations in natural beauty and the distance from clusters makes deployment challenging.”* – Make UK[390]

547. When the Review visited the West Midlands for an industry focused roundtable it learned of further barriers, such as how some sites also have multiple technological options and are unclear on which technology they should invest in.

548. Finally, there are knowledge and capacity barriers for firms. This is a particular challenge for small sites, as they can lack the expertise or capacity to act.

> *“Manufacturers are still facing the barriers to digital adoption, such as access to finance, lack of digital skills and knowledge of where to start and how to apply different and very often expensive and complex technologies.”* – Make UK[391]

549. **For smaller dispersed sites there are more specific challenges, due to the high costs of decarbonisation, the lack of tailored policy given the heterogeneity of sites and the lack of specific funding for these sites**. There are high costs of decarbonising dispersed sites due to the need to expand networks and high operational costs of technology, particularly electrification. The sites are highly diverse in terms of location, sectors, and industrial processes, which means there is no single technical or policy solution. Finally, other than the Industrial Energy Transformation Fund (IETF), there is a lack of dedicated policy towards these sites.

Priority areas

Energy efficiency

550. Manufacturers see energy efficiency and the installation of new or upgraded equipment as the main pathways to effectively reduce emissions within their businesses.

551. In non-domestic buildings, the highest 6% of electricity consumers are responsible for 80% of electricity consumption, while the highest 4% of gas consumers are responsible for 80% of gas consumption.[392] We should seek to prioritise action where we can make the biggest impact on emissions via energy consumption.

552. Almost half (47%) of businesses had adjusted their business practices to reduce energy consumption in response to heightened energy prices in 2022. This was consistent across manufacturers of all sizes, sectors and regions.[393]

553. Optimising industrial processes is a continuous improvement process and energy efficiency is never ‘done in the first go.’ Emission and cost savings can be made over again, even for those who have already started with some measures.

> *"While energy efficiency is largely straightforward, the transformation of industrial processes is less so, yet this will be critical within the next decade. Therefore, Government must take bolder action. It must hold itself to account on its Industrial Decarbonisation strategy by providing regular updates on progress in order to help business understand the Government’s overall intentions and make investment decisions accordingly."* – Make UK[394]

554. Manufacturers are replacing old equipment that is no longer energy efficient with more modern equipment. It is often the case that when equipment has not reached the end of its life, an upgrade is sufficient to improve efficiency or reduce carbon emissions. Manufacturers may also want to replace machines or vehicles running on fossil fuels with electric ones, for example, enabling them to electrify their processes and operations.

555. The *Industrial Decarbonisation Strategy* set out how the Government will support sites, including dispersed sites, and focus on installing energy management systems, improving heat recovery and reuse across sites, developing a communications plan on existing available policy support and finally, increasing resource efficiency and material substitution within industry.

556. **The Government must accelerate and unlock the potential of energy efficiency to decarbonise the manufacturing sector by delivering on the plans set out in the *Industrial Decarbonisation Strategy* by 2024.**

On-site generation

Government should develop a **policy proposal to incentivise on-site generation in Manufacturing** by Q2 2024, with options to consult on the funding formula required by the public and private sector to reach the tipping point of adoption.

557. On-site renewable electricity or heat generation is seen by manufacturers as the second main pathway for decarbonising their businesses, with 39% of manufacturers.

> *“In the last few months, the demand for it has soared as many see this as a means to insulate themselves from electricity grid prices which are linked with the unsustainable and volatile wholesale price of gas and other fossil fuels.”*[395] – Make UK

558. The need to reduce dependence on grid-supplied energy is growing because of very high prices and the uncertainty about energy supply. Where possible, manufacturers will opt to produce their own energy, which may or not cover all their needs. Moreover, currently selling self-generated power back into the National Grid is very attractive for manufacturers, with the income sometimes surpassing the savings from the generation itself.

559. However, the Review has heard there are a variety of barriers for manufacturers adopting on site generation:

> *"Easing and accelerating local planning permission and adding local infrastructure to allow feedback into the power grid. In addition, it is more complicated for manufacturers leasing buildings than owning them and this would warrant official recommendations (or obligations) for landlords to respond within a set timeframe to installation requests from their tenants and would warrant streamlined and harmonised agreements/contract templates between*

landlords and tenants to facilitate the process……For many businesses, finding the upfront cash is difficult (cash is being put aside to pay energy bills). Getting credit is still subject to blanket criteria which will penalise those who already have other (covid-related) loans, without the consideration of the overall low risk and benefits of such projects." – Make UK[396]

560. The Review recommends Government should develop a policy proposal to incentivise on-site generation in Manufacturing over the next two years, with options to consult on the funding formula required by the public and private sector to reach the tipping point of adoption. This needs to be joined up with policy on the future of the National Grid and on broader planning policy.

UK Carbon price policy

Government should **progress its consultation on carbon leakage measures, including a carbon border adjustment mechanism (CBAM) and mandatory product standards by 2023** (See ***Pillar 6*** for more discussion). This will enable Government to implement effective carbon leakage mitigations from 2026.

561. It is positive that the Government is looking to consult on carbon leakage measures in relation to trade, including the option to establish a carbon border adjustment mechanism (CBAM). At the same time, we have heard concerns from stakeholders about the domestic carbon price. The Government should also consider how to minimise the upward pressure on carbon prices, such as when it sets a net zero consistent cap for the Emissions Trading Scheme or on the long-term role played by Carbon Price Support.

3.6.3 Energy intensive industries (EIIs)

562. **UK EIIs are facing uniquely difficult challenges to decarbonise, especially as they generally compete in international markets**. They are comprised of manufacturers in aluminium, cement, chemicals, glass, steel, paper, and other manufacturer who require a lot of energy to produce their products.

563. The opportunities from the transition cannot be realised without competitive energy prices, measures to mitigate the risk of carbon leakage and Government financial support in innovation and large-scale decarbonisation demonstrations.

"Higher energy prices are one of the main challenges and obstacles to the industrial decarbonisation…Security of energy supply is an absolute condition to decarbonise. Without security of energy supply, energy intensive industries are unlikely to have to confidence to make the investment necessary to reach the net zero target.

"…The main challenge of carbon pricing is its impact on competitiveness. High UK carbon prices and reduced allocation of free ETS allowances, will increase the risk of carbon leakage and reduce availability of capital to invest in decarbonisation.

"…commercialising these opportunities depend on Government putting a stable and regulatory framework in place, providing finance to de-risk large demonstration projects and facilitating knowledge sharing of new technologies and financial products."
– Energy Intensive Users' Group and Manufacturers' Climate Change Group[397]

564. **These sectors are facing higher energy prices and higher prices than their competitors.** EIIs are particularly susceptible to currently high energy prices; in industrial processes where fuel is consumed for energy, such as boilers and furnaces, fuel costs contribute over ten times as much to the total cost over the lifetime of the equipment as the capital investment costs.[398]

565. Due to the UK's relatively high reliance on gas for electricity generation and the higher cost of generation from gas (as compared to generation from coal, nuclear or renewables), wholesale electricity prices in the UK have been higher than in key EU competitors such as Germany, France, and the Netherlands. The UK offers relief for some energy intensive businesses; however, the support offered in EU countries is greater, hindering UK EII businesses' international competitiveness.

566. **The technologies to decarbonise manufacturers already exists**. McKinsey finds that about half of industrial fuel consumption can be electrified with technologies and processes available today. Despite electricity prices doubling since 2020 while gas prices increased fivefold, electricity prices remain significantly higher than gas prices.[399]

567. **International solutions will likely be important for these sectors**: a small number of economies import a large proportion of global steel, and fewer than ten countries dominate the world's steel and cement production.[400] Taking an active role in establishing the future global market for clean steel in the long run should be one of the UK's ambitions.

568. The Review has heard from EIIs and their concerns over the impact of the carbon price support mechanism, the renewable levies, network charge arrangements and uncertainty over the future of ETS and carbon leakage policy. This is about remaining competitive internationally.

569. Any development of the UK ETS carbon pricing regime should consider the risk of carbon leakage and ensure that sufficient mitigation measures are in place. As set out in ***Pillar 6***, Government should work within the UK ETS Authority to develop a pathway for the UK ETS until 2040. As part of this, the Government should be engaging with EIIs to help alleviate the concerns listed above.

Sectoral support internationally

570. Germany is leading Europe's international response to the high energy prices environment with a large €200 billion 'protective shield' to run until 2024 for households' and businesses' soaring energy costs.

571. The EU has previously announced plans to raise around €140 billion by imposing windfall taxes high profits produced by energy corporations and redistributing the proceeds to consumers and businesses facing rising bills.

572. The European Commission offered a new package of emergency measures to reduce energy prices in October, through joint gas purchasing, price limiting mechanisms on the Title Transfer Facility (TTF) gas exchange and new measures on transparent infrastructure use.[401]

573. The UK Government launched a consultation into support schemes for EIIs, including steel, paper, glass, ceramics, and cement. Targeted proposals could mean further relief for EIIs on their electricity bills. This follows the announcement earlier this year that the EII Compensation Scheme has been extended for a further three years.

3.6.4 Construction

574. **Scale of decarbonisation.** The built environment and construction activity are significant contributors to carbon emissions in the UK. It is estimated that around 43% of UK emissions are from the built environment (both buildings and infrastructure), mostly from the heat and energy that buildings consume, but also from the production of energy-intensive products and materials that are widely used within the industry, such as concrete.[402]

575. At the same time, the sector is crucial for delivering net zero, through retrofitting existing buildings, improving building design to increase energy and heat efficiency, more sustainable product selection and improving manufacturing processes to reduce energy consumption and eliminate waste.

576. **Size of the economic opportunity.** Evidence suggests that an additional 350,000 workers would be needed by 2028, mainly to be involved in delivering improvements to existing buildings to reduce energy demand. These workers will be largely working in small construction firms, tasked with carrying out vital retrofit works in households.[403]

577. To meet this demand for net zero engineering services skills, the UK needs to recruit around 11,500 electrical apprentices (currently 7,000), and almost double the number of plumbing and building services engineering apprentices. From 2023 to 2030 this creates an additional 64,000 new net zero engineering services apprentices, bringing the total to 156,000.[404]

578. There are new business opportunities from the transition, such as in the engineering services sector to facilitate electric vehicle (EV) charging, heat pumps, smart energy and building management and battery storage. For builders' merchants, the beneficial opportunity is in supplying the materials and products needed to improve the energy and thermal performance of homes and workplaces.

579. The use of new, sustainable building materials presents opportunities for greater resource efficiency. For example, the reuse of structural steel could see a 95% carbon saving kilogram for kilogram, with a 10-40% cost saving depending on how the steel is sourced and procured.[405]

580. **Barriers to action.** The sector is being constrained by three key areas in its attempts to grow and decarbonise.

- Continued changes to government net zero policy and measures to undermine business confidence:

  "We believe that clear policy would encourage sustained business investment, increase consumer confidence, enable the skills system to train the workers required to deliver retrofit, and for the supply chains to develop across the UK. […]

  "Businesses need to know about, and be able to rely on, any rules and financial implications affecting net zero investment. The current planning, fiscal and other rules around the procurement of net zero technologies can be too complex, particularly for smaller business." – Construction Leadership Council[406]

- The availability of skills to complete the retrofits and other work required:

  "The skills issue is a huge challenge. With retrofitting [buildings], if a customer is spending a lot of money to airtight a house but the person delivering the job isn't delivering the job correctly, the house won't be airtight." – Construction firm[407]

- Questions over the availability of zero carbon materials, products, and vehicles:

  "Essential material, product, and component shortages are currently affecting the speed of some key technology delivery in the short term (e.g., electronic components)." – Construction Leadership Council[408]

- As well as these three specific areas, the overall business environment for construction impacts on the ability for industry to change and adapt.

  "…cash-flow issues due to payment delays and unfair contractual arrangements, which impact on the ability of the SMEs to train and innovate." – Construction Leadership Council[409]

Priorities

Maintaining and implementing existing policy proposals

581. A key message the Review has heard is the need to implement the planned policy that has been announced. In the construction sector this includes:

- Maintaining the Future Homes Standards and the Future Buildings standards
- Fully implementing the Government's Construction Playbook, which includes a requirement to do whole life carbon assessments of every project. Local authorities and other public bodies should also be encouraged to adopt the approach set out in the Construction Playbook.

Public procurement plan for low-carbon construction

Government to **develop a public procurement plan for low-carbon construction and the use of low-carbon materials, by the end of 2023.**

582. The Government can set standards and build new markets for low-carbon construction through its own public procurement standards. Given the scale of the Crown Estate and public buildings, standards for how construction should be carried out would send strong signals to the sector and enable firms to test innovations and start to scale them up.

583. It should also specify the need for greater use of low carbon materials within their public procurement guidance for bids.

"Government-backed best practices in Public Procurement can set a new standard for sustainable development. By entrenching the use of low carbon materials, construction methods and operations. In doing so, it has the potential to set the baseline against which development must strive to exceed, address industry's aversion to risk and support small and medium-sized businesses in moving towards sustainable building design and operations." – Landec[410]

584. The Review recommends a public procurement plan for low carbon construction and the use of low-carbon materials, to be developed by the end of 2023.

Non-road mobile machinery (NRMM) decarbonisation

BEIS, DfT and Defra to **develop a strategy on the decarbonisation of non-road mobile machinery** by the end of 2023.

585. There appears to be an absence of a policy plan by government departments for decarbonising non-road mobile machinery. The decarbonisation of non-road mobile machinery (NRMM) is a component of both the construction and agricultural sectors decarbonisation by 2050. Examples of NRMM include excavators, bulldozers, forklifts, tractors etc.

586. As suggested by the Climate Change Committee (CCC), the Government should set out a clear plan to develop a near-zero emission NRMM for applications in the agricultural, aviation, construction, and industrial sectors.

587. The UK has an opportunity to lead on the transition of low-carbon NRMM technologies. The UK remained a net exporter of construction and earthmoving equipment in the first half of 2022, with exports (£1,879 million) 41% higher than imports (£1,330 million).[411]

588. The Review recommends that BEIS, DfT and Defra develop a strategy on the decarbonisation of non-road mobile machinery.

Net Zero retrofit hubs

589. Over the next decade, warmer homes have the potential to grow the economy by £174.4 billion and create 500,000 new jobs distributed in every region and community across the country.[412]

590. The sector, via the Construction Leadership Council, has developed a long-term plan to retrofit the UK's existing housing stock calling for a partnership between government and industry. This would take the form of a national programme for a 'Net Zero Retrofit Hub' or localised hubs, run by industry with government support, to act as a co-ordinating body to help facilitate local retrofit delivery. The policy framework should be structured in a similar way to the Future Homes Hub.

591. The Hub should bring together all relevant stakeholders to enable locally driven retrofit programmes. It should aim to build trust across the retrofit sector by: identifying and supporting clear and necessary strategic links across industries; holding the evidence base for what works and providing a safe space for innovation; delivering communications to establish household demand; and signposting and creating resources for delivering the vital interaction between information, incentives, and installers.

> *"We support the current proposal for the creation of a Retrofit Hub to be supported by industry and government and Innovate UK. Perhaps this can provide the technical, scientific and business focus that government struggles with."* – Construction Products Association[413]

592. See ***Pillar 5*** for more information on the recommendation for localised retrofit hubs.

3.6.5 Circular economy, resources, and waste

593. **A more ambitious approach to managing waste and encouraging re-use and recycling could decrease emissions and provide significant economic opportunity. UK policy on this issue has been too slow and is failing to grasp these opportunities.**

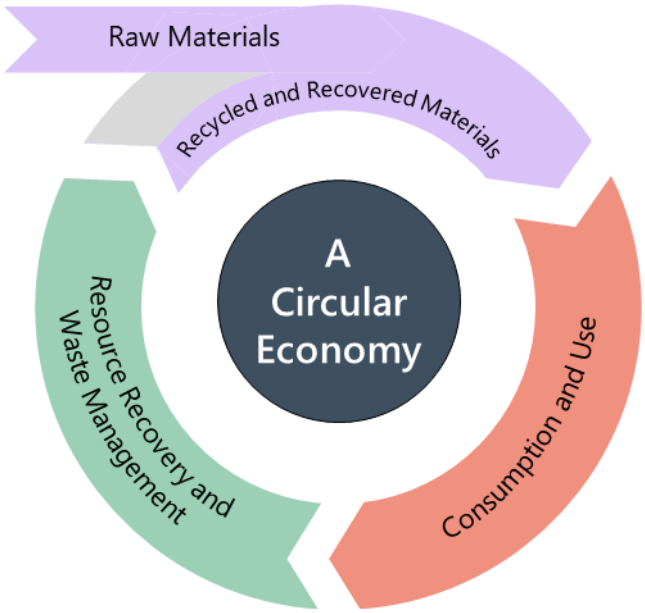


Figure 3.5 – *Flow of resources in a circular economy*[414]

594. **How the UK handles things we no longer need is a crucial issue for achieving net zero.** Waste and wastewater together accounted for 4.2% of UK greenhouse gas emissions in 2019;[415] much of these come from methane emitted by biodegradable waste breaking down either in landfill or during wastewater treatment.

595. The Government set out its ranking of waste management options according to what is best for the environment in the *Waste Hierarchy*. This states that we should prioritise in the following order: waste should first be prevented at source; where this is not possible it should be prepared for re-use (repaired or refurbished); if not possible it should be recycled into a new product or material; if that is not possible then it should be recovered in some other way (disposed of in some way that recovers energy, for example via anaerobic digestion); then finally, if none of the above options are available, it should be disposed of via landfill or incineration.[416] These rankings form the underlying principles for a resource-efficient and circular economy.

596. Climate Change Committee (CCC) analysis suggests that greater resource efficiency can drive up to half of the industrial abatement in the early 2020s and will play a significant role out to 2050.

> *"Research from the Centre for Industrial Energy, Materials and Products (CIEMAP) reveals that improving material use could reduce emissions by nearly 200 $MtCO_2e$ by 2032. The modelled savings all fall in the scope of domestic targets, and would mainly come during the fourth and fifth carbon budgets from five key sectors: construction, vehicles, food and drink, electronics and appliances, and clothing and textiles. Construction alone accounts for over half of the reduction."*[417]

Economic and strategic opportunities to the UK of moving to a more circular economy

597. **Building and expanding industries in the UK:** The UK currently exports a significant amount of its waste to be processed overseas. In 2019, an estimated 61% of UK plastic packaging was exported – because of a lack of capacity within the UK to recycle.[418] There are concerns that some of this is not actually being recycled.[419] The UK must work with global partners on international approaches to this.

598. Responses to the Call for Evidence suggest there is an economic opportunity for the UK in doing more of our waste processing here.

> *"By increasing the amount of materials recycled and increasing the proportion of these recycled in the UK, greater carbon reductions can be achieved. Recycling has been a UK success story for the last two decades, delivering significant environmental and economic benefits. However, too much of what we collect is shipped abroad for recycling. Reprocessing it here in the UK instead could contribute 16 million tonnes of CO_2e to the 6th Carbon Budget, while adding £8 billion to UK Gross Value Added and creating 60,000 jobs."* – WRAP[420]

599. In more complex examples of re-use or recycling, there are emerging sectors which the UK has an opportunity to benefit from. As described in ***Pillar 2***, the availability of critical minerals is likely to be a strategic challenge as the global economy decarbonises. This was the focus of the UK's 2022 *Critical Minerals Strategy*, which describes how "some high potential waste streams, such as electric vehicle motors, electric vehicle batteries, hydrogen fuel cells and wind turbine magnets, are still relatively low volume but will accelerate in the coming decades."[421] Attendees at the Review's roundtables were aware of the economic opportunities these provide.[422]

600. More broadly, evidence provided to the Review suggests that policies to move to a circular economy, maximise resource efficiency and improve waste measures could increase GDP by 0.9% by 2035, creating over 200,000 gross jobs in the UK and reduce unemployment by about 54,000 jobs by 2030.[423]

> *"[The] implementation of ambitious circular economy scenarios could generate a 'win-win-win' scenario where GDP increases, CO_2 emissions decrease, and jobs are created […] Government could help to create over 450,000 jobs in the circular economy by 2035 in reuse, repair, and manufacturing across the UK"* – Green Alliance[424]

601. The circular economy is already providing economic opportunities: almost 90,000 new jobs were created in the circular economy across the UK between 2014 and 2019, taking the sector to almost 560,000 employees.[425]

602. An ambitious circular economy is likely to offer geographically dispersed employment across a range of different occupations – in particular, reuse and open loop recycling activities are likely to be the least concentrated, requiring activity at local and regional levels.[426]

603. **Reducing costs:** Money is being wasted on throwing things away or failing to re-use or refurbish them; more efficient use of resources can also bring immediate direct benefits to businesses.

> *"There is evidence that UK businesses could realise resource efficiency savings of at least £3 billion per year at low or no cost. The move to a more resource efficient economy can have significant positive impacts on the UK economy and could deliver an increase of up to £76 billion in Gross Value Added by 2030, whilst also improving resource security*[427]

"Product lifetimes can be extended through simply making more use of the products we already have or passing them on to others to use. WRAP's 2022 report Seven Steps Towards Net Zero shows that increasing refurbishment of products could add over £70 billion to the UK GVA, and create over 300,000 jobs, whilst increasing repair could create over 30,000 jobs, add £3.3 billion to UK Gross Value Added, and revitalise city centres.

"The hospitality sector food waste costs the industry £3.2 billion a year and 75% of the food waste could have been eaten." – WRAP[428]

604. Helping consumers to reduce waste and make more sustainable purchasing decisions can save them money and ensure the products they buy are more efficient, durable, and cost-effective. ***Pillar 5*** explores how consumers can be supported to engage in the circular economy.

605. **Strategic advantage.** There are clearly strategic advantages to the UK from having the capability to re-use and recycle materials where the supply is limited or subject to global competition.

"The transition to a circular economy offers a solution to break the link between economic growth and unsustainable resource use that is driving nature degradation. In addition, a set of key resources like metals are usually not recovered and reintegrated into production, instead being downcycled or exported as waste. This has left us more vulnerable to supply chain disruptions and rising commodity prices which are a key driver of inflation – non-energy prices, including agriculture and metals, are projected to increase almost 20% in 2022, remaining well above the most recent five-year average and wheat prices are forecast to increase more than 40%, reaching an all-time high in nominal terms this year".
– Aldersgate Group, The Green Line[429]

606. ***Pillar 2*** refers to some of the potential uses of biogenic and non-biogenic wastes and residues, which offer significant circular economy opportunities. This includes, for example, the use of agricultural slurry in anaerobic digestion, use of forestry residues in wood pellets or different types of wastes and residues in the production of fuels. To ensure we use these resources sustainably and extract maximum value, it is important for government to set clear expectations of priority use order, including as part of the upcoming Biomass Strategy, and ensure compliance with the waste hierarchy.

607. As well as pressure on virgin commodities, other economies are moving to using resources in a more circular way. We should ensure that we are extracting maximum use from domestic waste streams:

"Expedite the delivery of separate collections of food and garden waste for households and businesses, so that the UK can invest in new facilities to deal with the increased volumes and enable the production of renewable energy and renewable fertilisers and soil improvers."
– Association for Renewable Energy & Clean Technology (REA)[430]

608. Stakeholders raised challenges around sharing of commercially sensitive information about supply chains and resource use. There have been a number of initiatives providing an independent service to address this challenge:

CASE STUDY: Invest NI'S Resource Matching Service

Northern Ireland's regional business development agency Invest NI offers a resource matching service to transfer business waste, unwanted materials and by-products from one business or organisation to be reused, recycled, reprocessed and repackaged by another.

The service aims to increase the productivity and competitiveness of participating businesses through the identification and realisation of synergies resulting in more efficient resource use, including commercial exchange of wasted resources, energy, water, materials and logistics. It is free to use for any business in Northern Ireland.

A 2018 evaluation found the following benefits of the scheme:

The Industrial Symbiosis Service identified up to £8.89 million of potential cost savings;

Net additional GVA benefits of the Industrial Symbiosis Service were expected to be £8.72 million;

Overall, 76% of businesses surveyed were satisfied with the Industrial Symbiosis Service support as a whole;

The evaluation recommended the continuation of the Industrial Symbiosis Service, which continues to operate today as the NI Resource Matching Service. It estimated that the Net Additional GVA Benefits delivered by industrial symbiosis from October 2019 to March 2024 would be £4.9 million.[431]

Existing commitments

609. The Government has made a number of commitments in recent years via the *Resources and Waste Strategy for England 2018,*[432] the *Net Zero Strategy 2021,*[433,] with key commitments (*) legislated in the Environment Act 2021[434] which included the following targets:

- Extended producer responsibility for packaging, placing net costs of disposing products on producers*;
- Deposit Return Scheme for single use drinks containers*;
- Greater consistency of separate collections of a core set of materials, including requiring separate food waste collections in all local authorities in England by 2025*;
- Deliver the UN Sustainable Development Goal 12.3 to halve food waste by 2030;
- Explore policies to work towards the near elimination of biodegradable municipal waste to landfill by 2028; and
- Proposed targets to reduce residual waste by 50% by 2042.

610. **The Review heard very clearly that the UK is not moving fast enough on delivering many of its existing commitments** – and that this is undermining efforts to decarbonise and potentially wasting economic opportunity. Policy responsibility for resource efficiency is distributed across government departments including Defra and BEIS, meaning initiatives are not always joined up from industry's perspective. This results in a lack of momentum on moving towards a circular economy.

611. The *Resources and Waste Strategy for England* has been well-received, but the UK is underperforming on i) recycling ii) extended producer responsibility iii) digital waste tracking, consistency of collection iv) minimising the embodied carbon impact of products at the design stage, and v) improving overall policy coherence.

612. Stakeholders told the Review:

> *"[The Environment Act 2021] is almost a year old and we are still waiting for regulations and any significant moves to exploit the system change opportunities to reduce waste and emissions made possible by this legislation."* – Merseyside Recycling and Waste Authority[435]

> *"Government intervention is necessary to create the systematic change required to ensure that the sustainable choice is the easy and favourable choice by introducing appropriate policies and legislation to support this. […] However, policy and regulation in this area is incomplete, and often has a record of inconsistent application and maintenance which undermines both investment in solutions by businesses and individuals and fails to consistently reinforce communications and messages that are required to change behaviour in general."* – Suez R&R UK ltd[436]

613. There were some suggestions that doing more to include **UK consumption emissions** in net zero reporting could help to drive a greater focus on the circular economy:

> *"[Including consumption-based emissions in the measures used to evaluation progress] would also give a clear signal to business that government is also grappling with the issue of scope 3 emissions and make it possible to push for greater action. It would also encourage greater resource efficiency and promote the development of a circular economy by giving incentives to develop new business models focused on reuse, repair and recycling as well as promoting onshoring of manufacturing. As the UK begins to develop trade agreements it has an opportunity to differentiate policy from the EU by proactively including ownership of consumption-based emissions, thus offering an incentive to more favourable deals and setting the standard for other major consumption-based economies."* – Business in the Community[437]

614. Stakeholders have indicated that they are keen to invest in the recycling industry. Environmental Services Association members have committed to invest more than £10 billion over the next ten years as long as the regulatory framework is in place.[438] A comparison was made with the transition to Electric Vehicles, where the UK has provided a much clearer statement of intent through the planned ban on new petrol and diesel cars – which has given industry the confidence to innovate and invest.[439]

Mission: Deliver a Circular Economy

Mission: A clear national mission focused on the circular economy will overcome the uncertainty of the current policy environment and ensure the long-term commitment that stakeholders are asking for. This should be driven by government's **overall ambition of doubling resource productivity by 2050, bolstered by a set of specific metrics to drive action**, including **sector-specific circular economy targets** linked to business models.	
Issue heard by the Review	**Action recommended**
Delivery of existing government waste reforms is too slow; these reforms underpin the UK's ability to move to more efficient and circular resource use. **Industry engagement** in extended producer responsibility work has tailed off.	**Deliver urgently on commitments that the UK has already made on collection and packaging reforms**, including extended producer responsibility, standardised collection, and deposit return schemes. Industry engagement must be central to design and rollout of schemes, which should focus on a strategic approach rather than isolated measures relating to individual products.

Commercially viable circular economy business models are not readily available for key sectors. Collaboration between public and private sector actors is needed to identify these and unblock any barriers.	**Launch a task force to work jointly with industry** to identify barriers and enablers and develop sector-specific **circular economy business models for priority sectors**. This should have representation from BEIS, Defra, DLUHC, HMT and DIT, and include the role of extended producer responsibility in promoting reuse, repair, remanufacturing, and rental alongside recycling, in line with the powers under the Environment Act 2021.
There is an economic opportunity in onshoring the UK's plastic processing – and concerns about whether plastic waste is properly recycled when exported	**End export of UK plastic waste by 2027,** and in parallel set an **end date for the import of recycled plastic chips, subject to the UK's international legal responsibilities. To drive domestic demand for high-quality recycled** materials, **ratchet up minimum percentage recycled content targets** for a range of products in consultation with industry.
Additional UK processing capacity is needed to enable ambitious reuse and recycling targets, particularly for plastics and critical minerals. There is also a need to think ahead to new or additional processing capacity for future green industries.	**Delivering UK recycling infrastructure capacity in key areas.** Areas to consider include: • **plastic** processing capacity (an additional one million tonnes) • domestic capabilities in the circular economy of **critical minerals** • the necessary infrastructure to support **textile collection and fibre recycling**. **In doing this, the Government should consider the expected profile of private sector investment in building UK recycling infrastructure - and explore opportunities to further enable such investment if current expectations fall short of domestic need**.
Moving to a circular economy requires **sharing of commercially sensitive information** about supply chains between private sector actors.	**Task WRAP[440] with developing a report** jointly for BEIS and Defra to understand the right role for Government in **supporting resource matching across the private sector**, learning from, for example, Invest NI and the National Industrial Symbiosis Partnership. This must ensure resource planning to achieve symbiosis rather than just waste exchange.

3.6.6 Transport

615. **The transport sector is the largest source of greenhouse gas emissions in the UK.** In contrast to other sectors in the UK, greenhouse gas emissions in the transport sector have remained stable, with efficiency gains being absorbed by increasing traffic and bigger vehicles.[xxi]

616. In 2021, the Government published its *Transport Decarbonisation Plan*[441] setting out commitments to reduce greenhouse gas emissions in the transport sector by 1,300-1,800 $MtCO_2e$ between 2020 and 2050.[xxii] The Plan also highlighted wider co-benefits in terms of growth, jobs, air quality and health benefits. An update on the *Transport Decarbonisation Plan* was published in summer 2022.[442]

617. The Government has set ambitious targets to phase-out existing vehicles with internal combustion engines and replace them with zero emission vehicles (ZEV), such as electric vehicles.[xxiii] For passenger cars and light vehicles, which accounted for more than half of domestic transport emissions in 2020, electrification is considered the most promising technology.[443] For heavier, long-distance vehicles as well as maritime and aviation, zero emission technologies are still at an earlier stage of development. These sectors will likely need to rely on a mix of different technologies, including electrification, hydrogen, low carbon fuels as well as maximizing operational efficiencies to reduce greenhouse gas emissions. In contrast, rail already has one of the lowest emission profiles, but more still needs to be done to electrify remaining lines, where possible, and employ other decarbonization technologies as well as shift transport from road to rail.

618. Technological changes alone will not be enough to reach net zero, as highlighted by the *Transport Decarbonisation Plan* and the Climate Change Committee (CCC). More will also need to be done to break the link between growth and increased congestion and encourage more journeys to be taken by public transport and active travel such as walking and cycling (see ***Pillar 5***).

619. **The decarbonisation of the transport sector offers significant economic opportunities**, with the potential for thousands of new jobs in manufacturing, infrastructure, and services. Changes in the transport sector also have wider economic impacts as they not only influence how people travel but also how goods and services are delivered. The Review heard that zero emission vehicle manufacturing and infrastructure could create more than 70,000 jobs by 2050.[444] The UK also has the opportunity to capture a first mover advantage on decarbonisation

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[xxi] According to the CCC, efficiency of new cars has been steadily increasing since 1990 but reversed between 2019-19 due to rapid increase in purchases of sport utility vehicles (SUVs) and higher emitting vehicles. Their share increased from 7% in 2007 to 25% in 2019 and more than offset the benefit delivered by the increase in sales of electric vehicles 2017-19. See CCC (2020), 'Sixth Carbon Budget. Surface Transport', https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Surface-transport.pdf

[xxii] The *Transport Decarbonisation Plan* included commitments in 11 areas: increasing cycling and walking, zero emission buses and coaches, decarbonising railways, zero emission fleet of cars, vans, motorcycles and scooters, accelerating maritime as well as aviation decarbonisation, delivering a zero emission freight and logistics sector, delivering decarbonisation through places, maximising the benefits of sustainable low carbon fuels, hydrogen's role in a decarbonised transport system and supporting UK research and development as a decarbonisation enabler.

[xxiii] The Government's plans foresee the end of sale for new petrol and diesel cars by 2030 and all new cars and vans to be zero emission by 2035. New heavy goods vehicles weighing under 26 tonnes need to be zero emission by 2035 and all HGVs by 2040. The government has also consulted on phase-out dates for new, non-zero emission buses and coaches (proposed between 2025 and 2032) and L-category vehicles such as mopeds and motorcycles (with 2030 for some and 2035 for all proposed).

of aviation and maritime, including both the production of zero emission technologies and sustainable, low carbon fuels. Building on the UK's role as a central hub for aviation and maritime services and its leading role in developing international standards, there could be significant opportunities to export UK goods, services, and expertise. In the maritime sector alone, 220,000 jobs could be created by 2050.[445] Furthermore, the UK could be a first mover on road freight decarbonisation and there could be significant growth opportunities for technologies, infrastructure and services that enable more sustainable travel options.[xxiv]

620. However, the market is competitive and competitor countries are taking steps to onshore manufacturing capabilities and supply chains. The USA Inflation Reduction Act for example includes a requirement for the final assembly of the vehicle to occur in North America to benefit from tax credits.

Accelerating the deployment of zero emission vehicles (ZEVs)

Government to swiftly **deliver the ZEV mandate**, to apply from 2024, while maintaining regulations and funding to support the uptake of electric and other zero emission vehicles, and continuing to drive emission reductions from internal combustion engines

621. Policies and funding in place have been successful in supporting the uptake and manufacturing of electric vehicles and charging infrastructure. Respondents to the Review generally welcomed government ambitions and support to date, with participants in the roundtables stressing that the **swift establishment of the ZEV mandate to apply from 2024** would be an important next step.

622. While the price of electric vehicles has fallen significantly, on average they still cost more than petrol or diesel vehicles and charging facilities are not yet evenly available across the country**.** This Review heard at the roundtables that **any cuts to current funding and support would seriously risk undermining the sector** at a critical stage.

623. Organisations like the Society of Motor Manufacturers and Traders (SMMT), representing the major car brands, highlighted that:

> *"Government's ambitious and binding targets for rolling out ZEV cars and vans must be underpinned by equally ambitious and binding targets for EV charging infrastructure. A stable and supportive fiscal environment will also be of critical importance."* – SMMT[446]

624. While stakeholders considered the delivery of the Electric Vehicle Infrastructure Plan to be key, they also pointed to existing inconsistencies and regulatory barriers, such as **different VAT rates for public and private charging** (see ***Pillar 5***). Several respondents referred to smart charging as an opportunity for the UK to lead on and highlighted the need for **increased focus on data and data interoperability to enable smart charging.**

625. While electrification of passenger cars and vans is on its way, some stakeholders also highlighted the need to continue to drive down greenhouse gas emissions from existing vehicles, in line with Climate Change Committee (CCC) advice.

626. Respondents to the Review highlighted the **opportunities for UK manufacturing and supply chain** in terms of growth, jobs, and export opportunities. However, businesses also raised concerns that high energy and carbon costs could discourage manufacturing in the UK.

[xxiv] For example, according to the *Transport Decarbonisation Plan* the manufacturing, distribution and repairs of bikes alone could be associated with 100,000 jobs.

According to SMMT, “a strong domestic automotive sector will lead the net zero transition, supporting high-value, rewarding jobs”. However, they also flagged that *“automotive costs are significantly higher in the UK than in sister plants across the EU, with electricity costs on average twice those in the EU and gas costs 60% higher”.*[447] They called for more investment support and the manufacturing process itself to be decarbonised.

627. The Review considers it therefore important that the Government **maintains support for building domestic supply chains and manufacturing** for electric vehicles and, in the long-term self-driving vehicles that may deliver further efficiencies and carbon reductions, as part of the Automotive Transformation Fund, and the Faraday Battery Challenge.

Delivering on sustainable fuels and zero emission technologies

Government to publish the **Low Carbon Fuels Strategy in 2023 and the necessary legislation for the sustainable aviation fuels (SAF) mandate to apply from 2025**. Recognising that an adequate price stability mechanism is vital for investments in SAF, government to **set out evidence for barriers to SAF investments and options to address** this.

Government to **set out options for further legislative steps by 2024** and take a leading role in International Maritime Organization (IMO) negotiations **to decarbonise the maritime sector.**

628. **Harder to electrify transport modes will rely on a mix of technologies and fuels, offering new opportunities for UK innovation, production, and skills.** Respondents to the Review generally welcomed existing ambitions as set out in the *Transport Decarbonisation Plan* and sector-specific plans such as the *Jet Zero Strategy* and *Clean Maritime Plan* but stressed that delivery of these ambitious plans would be key. They saw specific advantages based on the UK’s expertise in R&D, aviation and maritime as well as the UK’s leading role on waste-derived fuels and sustainability criteria.

629. **The UK is well set up to support innovation but commercialisation of new technologies still faces barriers.** Stakeholders pointed out the important role that for example the Aerospace Technology Institute (ATI) programme plays in supporting R&D in the aerospace sector in the UK, with interest exceeding funding available. However, more would be needed to bring new technologies and fuels to the market. Stakeholders highlighted, for example, that to meet the Government’s ambition to have five sustainable aviation fuel (SAF) plants under construction by 2025 and 10% of all UK jet fuel to be sustainable by 2025, government needs to take further action, most notably *“a mandate for fuel producers and the right incentives to close the price gap with kerosene”.*[448]

630. To continue to support innovation, **the Review recommends that government should provide long-term funding** beyond the current spending review period to **support UK manufacturing and supply chains** (including as part of the Aerospace Technology Institute for demonstration) as well as for **testing and certification of new fuels and technologies** (as part of Zero Emission Road Freight (ZERFT) demonstration programme, UK Shipping Office for Reducing Emissions (UK SHORE), SAF demonstration competitions and clearing house).

631. **In addition, an enabling regulatory framework is needed to support investments.** At the roundtables, the Review heard about the value stakeholders assign to existing support mechanisms such as the Renewable Transport Fuels Obligation (RTFO) as well as the planned mandate for SAF and *Low Carbon Fuels Strategy*, which respondents asked to be delivered as soon as possible. Some also argued for higher RTFO targets and fiscal incentives for fuels with

a higher biocontent. They noted that there would be encouraging signs for other technologies such as direct air capture and the development of business models for greenhouse gas removals. However, changes in fuels and technologies will necessitate wider changes. For example, the use of hydrogen and electrical propulsion in aviation will require new regulations to authorise such aircraft. Maritime UK pointed out that "*although government and industry have both made a substantive start towards decarbonisation, there is a need to increase the scale and pace of this joint effort"*.[449] Several respondents highlighted that more clarity is still needed on the next steps in the maritime sector, including the respective roles of industry and government, with a refresh of the *Clean Maritime Plan* expected for 2023.

632. Some stakeholders also highlighted the need to drive operational efficiencies. Taking aviation as an example, Airlines UK highlighted delays linked to infrastructure and airport capacity that force aircrafts to *"stack, bunch and circle airports waiting for arrival slots"*.[450] The British Airline Pilots Association flagged that 'economic tankering', i.e. the carriage of extra fuel to avoid paying higher fuel costs elsewhere, means "*typically 3-5% of the extra fuel is wasted per hour*".[451] **Alongside technological changes, government and industry should continue to increase operational efficiencies.** As part of this, government should for example identify voluntary and mandatory options to put an end to 'economic tankering' by airlines by 2023.

633. **Continued dialogue between government and industry as well across sectors will be important to deliver on ambitions.** Such dialogue will be needed to address potential skills and supply chain constraints as well as identify required infrastructure investments that enable new technologies and operational changes. Many stakeholders stressed the need for more integrated, system-wide thinking, for example on how to link fuel production with CCUS or interactions with impacts other than CO_2.

634. Many respondents also highlighted the international character of the aviation and maritime sector, and the need for joint action and collaboration across borders. Building on the UK's leading role in International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO), **the Government should drive ambitious policies to decarbonise transport at international level, working with partner countries to effect change.**

Accelerating rail electrification and freight decarbonisation

Government should continue to work with industry to set out a clear programme by 2024 to **accelerate decarbonisation of the wider freight sector through modal shift and deployment of new technologies**, building on the Future of Freight Plan**.**

635. While rail is already one of the greenest modes of transport (contributing just 1.4% of domestic transport emissions),[452] a significant share of UK rail lines are not yet electrified. According to a Transport Committee report from 2021, only 38% of the UK rail network in 2019 was electrified, with 9,855 km still powered by diesel.[453] This compares to an electrification rate of 61% in countries like Germany.[454] Combined with a modal shift from road to rail, further electrifying the railways can make a significant positive impact in decarbonising the transport sector. The Review heard from industry that every tonne of freight transported by rail produces 76% less carbon than the equivalent by road,[455] with nine times more tonne kilometres[xxv] of goods being transported domestically by road than rail.[456]

[xxv] A tonne-kilometre is a measurement of the transport of one tonne of goods over a distance of one kilometre

636. Rail Partners, the trade association representing passenger rail and freight operating companies, told the Review that:

> *"Delivering a decarbonised railway will produce around 6,000 jobs many of which will be high-skilled and outside of London and the South East, it will also deliver cleaner air and generate around £2.2 billion in economic benefits."* – Rail Partners[457]

637. In its *Plan for Rail*, the Government made a strong case for acceleration of rail electrification, setting out that:

> *"Electrification does not merely decarbonise existing rail journeys: it has a clear record of attracting new passengers and freight customers to rail, the so-called 'sparks effect', thereby decarbonising journeys that would otherwise have been by road."* [458]

638. While industry welcomed government's ambition, this Review heard that **further long-term clarity on what the future rail network will look like, both interim and long-term timescales and an investment framework is necessary.** A continuous programme for the electrification of rail lines will provide economies of scale for decarbonisation. Stakeholders referred to the example of Germany where due to a continuous programme electrifying about 125 miles each year, electrification costs are significantly lower than in the UK.[459]

> *"We need a long-term approach to electrification, delivered by Great British Railways, including a programme of works and an outline of how the private and public sectors will work together to deliver government's ambitions for rail reform. This would allow us to develop a long term fleet strategy across our operations, ensuring the best mix of electric, battery, hydrogen, bi and tri mode trains to decarbonise the rail network, with rolling stock matched to the track infrastructure available."* – First[460]

639. Participants at the roundtables were clear that government should consider how to leverage private investments in rail decarbonisation, including electrification of railway lines. To ensure that rail is decarbonised in the most cost-effective way, the Review also takes the view that government and industry should explore different technological solutions such as hybrid locomotives running on electricity and hydrogen. Some stakeholders also highlighted the need to bring forward the planned industry reform and include incentives to rail operators to increase demand or make low carbon investments as well as a rail freight target.

640. **In terms of decarbonisation of the wider freight sector – as well as heavier vehicles including buses and coaches** – respondents to the review highlighted multiple challenges given that zero emission vehicles and vessels are not yet available for all uses and the range of these vehicles is still more limited. Decarbonisation therefore requires a mix of different technologies and solutions as well as coordination across different technologies and transport modes. Logistics UK also highlighted that "*uncertainty around the right technology to invest in remains a barrier for members operating road vehicles"*.[461]

641. Other challenges include limited fuelling options, lack of fuelling infrastructure for commercial use or additional costs related to vehicles and low carbon fuels. This Review heard that the low cost margins which most operators are dealing with make low carbon investments particularly difficult in this sector. Respondents highlighted the value of existing trials, and the need to expand the *Electric Vehicle Infrastructure Plan* to heavier vehicles. Government published in 2022 a Future of Freight Plan, setting out challenges and a set of priorities and actions agreed with the industry. Stakeholders confirmed their commitment to working with government and other stakeholders to achieve progress. The Review heard for example from First, a rail and bus operator, that:

"By working in collaboration, we can reduce the cost of operating, fuelling and maintaining our fleets, deliver economies of scale, and explore the opportunities for industry." – First[462]

642. The Review therefore recommends that the Government should continue to work with industry to set out a clear programme to accelerate decarbonisation of the wider freight sector, building on the *Future of Freight Plan.*

Support wider transport decarbonisation through an enabling regulatory framework

Government to reduce delays to anticipated reforms by **bringing forward the delayed Future of Transport Bill** this Parliament.

643. To increase certainty for investments, respondents to the Review also highlighted some more general points for government to consider when setting out transport policies. This included the need to **reduce delays to anticipated reforms and bring forward the delayed Future of Transport Bill** this Parliament.

644. Many respondents also flagged that changes in the vehicle and fuel mix will require **reforms to fuel duty and road taxation in the future,** and that such reforms should consider how to reward lower carbon options.

645. More generally, stakeholders highlighted the importance for the **regulatory framework to enable,** and set clear rules, **for new innovative services** (for example, mobility as a service and smart charging), the need for the planning system to consider wider transport implications and any **infrastructure investments** to support the deployment of new technologies and sustainable travel options.

646. In regards to trade, many stakeholders also highlighted the need for government to work with international partners to set standards, address trade barriers and incentivise greater inward investment.

3.6.7 Retail sector

647. The UK retail industry contributes more greenhouse gases from goods sold in a year, than all of UK household emissions generated.[463] This places the retail industry among the highest contributors to emissions in the UK (c. 215 $MtCO_2e$, 62% of this is from food, drinks and tobacco)[464].

648. Across the retail business there is a wide variety of activities that contribute to emissions. There is energy required for site and vehicle operations, emissions from farms and production facilities and the energy used by customers to power their purchased devices.

649. This sector has the opportunity to influence emission reductions from customers to the value chain and mobilise action for growth and decarbonisation during the transition.

650. Retail is being pushed by both investors and consumers for greater action. Investors in the retail sector have rising expectations around emissions measurement and disclosures, and concrete strategies for reduction. Whilst customers are seeking change with 79% of customers surveyed by the British Retail Consortium (BRC) are changing their preferences based on the social responsibility, inclusiveness, or environmental impact of their purchases and 88% of customers want brands to help them live sustainably.[465]

651. We learned from our sectoral roundtable that the sector recognises that skills are important and it is taking action internally, including by engaging with further education colleges to build these skills. Additionally, the Government should be working with the sector to help demystify the carbon impact of products. This should consider that clear messaging for consumers is paramount, and there is often a lot of information for consumers to digest when purchasing products.[466]

652. Finally, government support is required on developing ecolabelling for consumers (see more in ***Pillar 5***). This needs to ultimately be integrated with international standards due to the cross-border supply chains for many products sold in the UK.[467]

3.6.8 Food, agriculture, nature, and land use

653. How the UK uses our land is a fundamental question for the transition to net zero. Indeed, net zero will not be possible without recognising the vital importance that nature-based solutions have in achieving the 'net' in 'net zero'. Natural carbon sequestration and sinks need to be protected and preserved, with clear and long-term plans in place not merely to restore natural habitats such as peat and forest land, but to double down on our protection of existing landscapes that contribute to net zero. At the same time, our agricultural sector needs additional support and investment to tackle the twin challenges presented by both natural carbon dioxide and methane emissions from livestock and emissions from agricultural machinery and land use.

654. The transition to net zero and the growing impact of climate change is affecting how we use land:

- **High emissions from land use.** Agriculture and land use sectors together currently account for around 12% of UK greenhouse gas emissions. These emissions are reducing slowly – the Government's independent climate advisors found that its plans for decarbonising agriculture are completely missing or wholly inadequate.[468] As other emissions – such as those from transport – are expected to fall with further measures being taken, agriculture's relative share of UK emissions is expected to grow, and some experts we spoke to said it could account for 30% of UK greenhouse gas emissions by 2030.
- **New uses.** Net zero relies on using land to remove carbon from the atmosphere. For example, the UK is planning to plant 30,000 hectares of woodland a year by the end of this parliament.[469] Nature-based solutions (like tree-planting) are expected to provide around 40% of the greenhouse gas removals required by 2050.[470] At the same time, there is growing pressure on our land for other uses – for example, the UK's housebuilding target of 300,000 new homes per year by the mid-2020s and growing uses linked to net zero, such as biomass, nuclear, solar or wind power.
- **Adapting to climate change.** The way land is used can determine the UK's resilience to the kind of climate risks described in ***Part 1***. For example, certain parts of the country are more vulnerable to flooding; any housing or infrastructure built there needs to take this into account, and healthy coastal wetlands, saltmarshes and woodlands can variously provide natural flood defences.

655. These different pressures create complicated trade-offs – particularly when combined with other environmental priorities such as reversing biodiversity loss or improving water quality (for which Government is due to publish legally-binding targets under the Environment Act 2021).[471] Managing these trade-offs is crucial to have a coherent and sustainable plan for using our land. Decisions taken by different levels of Government, industry, and even individual land managers

all affect how our land is used – with many interlocking systems in place for guiding these decisions (not least the planning system, see ***Pillar 4***).

656. How we use our land has a direct impact on the economy. Land is the UK's most valuable single asset, estimated at £6.3 trillion, accounting for nearly 60% of the country's net worth.[472] In 2021, the UK agricultural sector was worth £11.2 billion (0.51% of GDP).[473] Decarbonising land use can create clear economic opportunities. Many emissions reductions measures in agriculture are productivity enhancing, with the potential to boost growth by saving farm businesses £170 million per year by 2035, rising to more than £1.5billion per year by 2050.[474] There is clear opportunity for innovation in this sector, and government has committed to a £270 million *Farming Innovation Fund*.

657. More fundamentally, as described in ***Part 1***, our economy is embedded within nature – not external to it.[475] Climate change and other environmental pressures like soil degradation, water quality and biodiversity present the biggest medium-term risk to UK food production.[476] Nature can help us manage the risks from climate change, for example planting trees in cities can reduce energy needed to keep people cool and reduce productivity losses from overheating in summer.[477]

658. Individual choices, like what kinds of food we buy, have an impact on decisions made on how the UK uses land. ***Pillar 5*** sets out broad recommendations for giving people more information to help guide their choices. This is designed to help people do things they already want to – not to make them do things they do not want to - and includes a recommendation to pursue 'ecolabelling' on food products.

Land Use framework

Government to publish a **Land Use framework as soon as possible**, and by mid-2023.

659. **The Government lacks a clear plan for how we will manage these competing and interrelated demands on land**, according to submissions to the Review. The *Net Zero Strategy* showed a range of possible 2050 energy systems which deliver the target, but no similar analysis is available on how the UK's land area would need to change to deliver the varied land-based goals described above.

660. The complexity of land use and the trade-offs described above mean it is very difficult for even the most committed land managers to ensure they are making best use of their land. Stakeholders told the Review that opportunities to maximise public investment are lost, and that the current framework does not allow land managers to deliver as many positive outcomes as they could.[478]

> *"The right approach to land management can also deliver a food system that is resilient to future climate change and conflicts, where nature thrives within and outside farmland, and where growers and producers get a fairer share of the market and help to avert the climate and nature crises just by doing their job."* – RSPB[479]

661. The Government made the following commitment in its recent *Food Strategy*:

> *"We will publish a land use framework in 2023 to ensure we meet our net zero and biodiversity targets, and help our farmers adapt to a changing climate, whilst continuing to produce high quality, affordable produce that supports a healthier diet."* – Defra, Government Food Strategy 2022[480]

662. Better data and analysis are needed to help the public and local decision-makers realise these outcomes and achieve the multiple goals set out in the *Net Zero Strategy*. The *Land Use Framework* should include analysis showing different options for how these multiple goals can be met within the land area of the UK, considering biodiversity and agricultural productivity needs, including water quality and flood protection.

663. Land use change at a strongly spatially disaggregated level is currently an important evidence gap. This should be modelled and the principles to manage trade-offs and maximise synergies of each scenario should be clearly stated (for example, maximise land used for production of wood-derived biomass and energy crops, such as miscanthus, near the likely location of future BECCS plants; prioritise food production on high-grade agricultural land, etc.). Requiring collaboration between BEIS, Defra and DLUHC, this is an example of the kind of system thinking which is necessary to deliver net zero.

664. Government also needs to ensure that this analysis considers the land use potential at different levels of global warming. A recent Intergovernmental Panel on Climate Change (IPCC) report showed that a warming of even just two degrees considerably alters the kind of crops that can be grown in different regions and changes the effectiveness of different types of land use solutions for biodiversity and flood protection (for example, wetlands no longer provide the same level of protection at two degrees of global warming).[481] The analysis in the land use framework should directly address this with scenario modelling.

665. Alongside the framework, government also needs to consider the existing incentive structures (see section below on Environmental Land Management schemes) and how aligned they are with bringing about outcomes which fulfil decarbonisation, agricultural production, and biodiversity goals, including those for land managers considering growing biomass. Land use change analysis described above needs to be joined up with an in-depth review of the regulatory and policy structures which determine land-use decision-making at different scales. It is becoming increasingly clear that our capacity to deliver upon multiple objectives will depend on how national policies support local action, and on policy coherence across silos.

666. Stakeholders told the Review that the lack of policy consistency is a huge problem for agriculture and other users of land – affecting long-term planning and investment decisions.[482] This includes issues with the planning system which is focused purely on new development and so does not interact well with decisions made on other outcomes, such as environmental protection.[483]

667. The evidence seen by the Review and described above makes clear that a lack of clarity in decisions on land use is a barrier to growth and decarbonisation. It is crucial that the *Food Strategy*'s commitment is met and that it provides the following:

- A basis for deciding on competing land use opportunities – or a hierarchy of use;
- A design to inform decisions made through the planning system;
- Transparency and usability by other decision-makers, for example local authorities.

Environmental Land Management schemes

Government to **publish full details of all Environmental Land Management Schemes** and future plans by the end of 2023 - with a particular focus on how participants can take advantage of both public and private finance.

668. The Review has heard that the necessary incentives on farmers and land managers to decarbonise are not in place. Particular attention was paid to the Environmental Land Management schemes that are expected to replace EU farming subsidies, where stakeholders were frustrated with the time taken to provide clarity to farmers and land managers.

> *"We recognise that there is no food security without nature, and the UK has an opportunity increase resilience and competitiveness of our industry by transitioning to low impact farming. We are fully supportive of the need for the Environmental Land Management Scheme and its direction of travel and wish to work with Government to accelerate its rollout and ambition."* – Marks & Spencer[484]

> *"Net zero should be given the priority it deserves within Defra's Agricultural Transition Plan (ATP). Net zero needs to be embedded into schemes, given equal weight to other environmental targets. Farmers have seen business benefits from implementing a range of net zero activities including resource efficiency, renewable energy, and the bioeconomy, in addition to nature-based solutions."* – NFU[485]

669. At the same time, incentives to decarbonise farming should be reviewed to ensure they are competitive and sufficient, there is clarity about 'stacking'[xxvi] of payments for achieving multiple outcomes, and to assess the risk of public funding crowding out private finance.

> *"The reforms on agriculture subsidies in each devolved nation towards net zero and regenerative agriculture needs to be results-based in terms of rewarding farmers for achieving environmental outcomes, and to a funding level that is needed to achieve UK net zero and nature positive targets. This action de-risks finance that is available to farmers and provides farmers with a clear business case that can cover the upfront costs involved with buying capital equipment, and changing their agricultural practices to become more regenerative."* – NatWest Group[486]

> *"There is currently significant uncertainty within the land management community around how different public and private payment for environmental outcomes can be combined, or 'stacked'. This has led to hesitation among many landowners to engage in schemes, as they worry that they will inadvertently block themselves from accessing another source of income."* – Palladium[487]

670. Farmers report feeling disengaged with the transition – and do not always see the opportunities that could be available to them through different productive uses of their land.[488] Some stakeholders felt there were missed opportunities for peer-to-peer learning, where farmers learn from those who have already made a success from decarbonising their land and other innovations.[489]

671. Further detail on the Environmental Land Management Schemes should be published as soon as possible and address the issues described above. In particular, it should provide the following:

- A clear plan for engaging farmers in decarbonisation – recognising that there is a serious risk of farmers feeling as if they are being treated as blockers to the transition, rather than partners.

[xxvi] 'Stacking' payments: layering payments for delivering a range of different services and outcomes on the same piece of land.

- Clarity on the anticipated interaction between public and private finance to ensure that land managers can confidently deliver and be rewarded for multiple outcomes on landscapes.

Monitoring emissions from agriculture and food supply chains

By 2025, Government to **ensure that 50% of UK-based food and drink businesses measure and report their scope 3 emissions against a government- and industry-agreed standard**. Defra and UKRI research should prioritise innovations that support on-farm measurement and processes to accurately collect the remainder by 2030.

672. Robust measurement of emissions from agriculture can drive good management practices and create the conditions for new markets to thrive. Enabling practical on-farm measurement of emissions in a consistent way will empower farmers to not only manage those emissions, but to see decarbonisation as an opportunity and consider new business models supplying low carbon produce or taking advantage of carbon management schemes.

> *"Government, farmers, the food supply chain and finance need to agree on a common set of metrics that comprehensively measures the environmental outcomes from the change in farming practices. In doing so, farmers can be rewarded for achieving targets by the government, their supply chain customers, and even other private sector players who would like to support nature-based solutions in the UK. It also avoids unnecessary costs for farmers in learning how to fill data from multiple measurement tools."* NatWest Group[490]

673. Robust measurement of emissions from agriculture can drive good management practices and create the conditions for new markets to thrive. Consistency of emissions data collection and methodology across the food supply chain can also pave the way for more transparent engagement with consumers on carbon impacts of choices (see ***Pillar 5*** on eco-labelling).

> *"A lack of readily-available GHG emissions data in a standardised format from smaller companies upstream and downstream in value chains [in sectors beyond just agriculture] makes even the compilation of an accurate carbon inventory challenging, much less taking measures to decarbonise."* – Business in the Community[491]

> *"A key challenge for Food and Drink businesses is the difficulties in measuring their Scope 3 emissions. For these businesses, scope 3 emissions are typically a substantial proportion of their total organisational footprint, and there is increasing pressure from customers, investors, and other stakeholders to measure, report, and reduce emissions these emissions. Scope 3 emissions encompass the indirect emissions that occur outside of a company's direct control, which arise from the wider value chain."* – WRAP[492]

674. By 2025, Government should ensure that 50% of UK-based food and drink businesses measure and report their scope 3 emissions[xxvii] against a government- and industry-agreed standard. Defra and UKRI research should prioritise innovations that support on-farm measurement and processes to accurately collect the remainder by 2030.

[xxvii] Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly affects in its value chain.

Mission: Embed nature and habitat restoration throughout transition plans, maximising co-benefits for climate and nature wherever possible, setting and delivering ambitious targets for nature-based solutions.

675. As set out in ***Part 1***, achieving net zero and recovering nature are challenges that are inextricably linked, and which we must address if we are to achieve sustained, and sustainable, economic growth. Consideration of impacts on nature and the environment must flow through all net zero transition policymaking, to avoid unintended consequences on natural systems (for example pressure on water availability from hydrogen production or air quality impacts of bioenergy production).

676. Nature-based solutions currently in the Government's net zero plans include woodland creation and peatland restoration, but the Review heard that this approach could be broadened.

677. Natural ecosystems and ecosystems services are now being recognised for the intrinsic and economic value they have:

> *"For too long, natural capital has been off the balance sheet and not valued in policy and the market, even though – as farmers know – the character and quality of soil, water and nature on a farm is essential to run a viable rural business. Recognising and paying for natural capital, even though it demands a change in how land is used, opens up opportunities for new business models and new sources of income for the land-based economy."*
> – Green Alliance[493]

678. The ONS has estimated the stock of the aspects of UK natural capital that could be valued to be worth £1.2 trillion, with the value of carbon sequestration by natural systems to be £2.1 billion.[494]

679. Government should look to maximise the contribution of nature-based solutions given the multiple benefits these can bring for climate, biodiversity, water, protection from adverse weather impacts and job creation.

680. The Dasgupta Review also warns of the risk to ecosystems that are approaching tipping points, after which recovery will be far more costly:

> *"Many ecosystems, from tropical forests to coral reefs, have already been degraded beyond repair, or are at imminent risk of 'tipping points'. These tipping points could have catastrophic consequences for our economies and well-being; and it is costly and difficult, if not impossible, to coax an ecosystem back to health once it has tipped into a new state".*
> – Dasgupta Review[495]

681. The Review has heard that the Government's ambition and delivery in this space could be far greater:

> *"There is a significant opportunity to stimulate and facilitate a mass-scale up of high-quality nature-based solutions as a highly cost-effective part of the pathway to achieving-and sustaining-net zero. Currently the scale of uptake is nowhere near where it needs to be in order for the UK to reach net zero (including for peatland restoration, high quality woodland creation, and saltmarsh creation). The low level of uptake needs to be addressed through a vast increase indirect public investment in nature's recovery, and greater stimulation of private markets."* – The Wildlife Trusts[496]

682. Action must be taken quickly, given the long lead time between habitat creation and restoration efforts and seeing the benefits in terms of carbon storage, if nature-based solutions are to play a significant role in delivering net zero by 2050.

683. In particular, for peatland, a more ambitious programme of implementation is required:

> *"Not only are the UK's peatlands emitting around 20 MtCO2e (4% of UK emissions) per year rather than acting as a sink, they are also at high risk of complete collapse in the hotter, drier conditions we are expecting with further climate change; which would trigger an enormous further loss of carbon to the atmosphere"* – The Wildlife Trusts[497]

Deliver **accurate monitoring of carbon across broader range of ecosystems**, with a view to bringing more habitats into the inventory to drive habitat creation and restoration efforts.

684. Government should build on existing work from Natural England reviewing carbon storage and sequestration by natural habitats in England[498] to increase the evidence base and work with international partners to include a wider range of ecosystems in greenhouse gas inventory reporting. At present, coastal and marine habitats are not covered by this reporting, including saltmarsh and mudflats, seagrass, seabed sediments and others. Deepening our understanding and bringing some of these ecosystems into carbon reporting as soon as possible will drive management efforts and can slow depletion of these habitats.

685. For the land-based habitats, how this plays out in the wider land use context should be managed through the *Land Use Framework* to minimise disruption and achieve multiple outcomes including maintaining food supply.

In line with wider thinking on voluntary carbon and ecosystem markets, ensure a pipeline of **investible nature-based solutions projects is available**

686. ***Pillar 6*** sets out thinking around voluntary carbon and ecosystem markets. The Review heard that industry is keen to invest in and deliver nature-based solutions for climate mitigation (like afforestation projects):

> *"The capacity of nature-based solutions to offer climate mitigation, climate adaptation, nature recovery, environmental services, health and economic benefits from one investment renders them formidably cost-effective."* – Wildlife and Countryside Link[499]

687. Government and its delivery bodies must ensure there is a clear pipeline of investible projects, but also manage the risk of greenwashing. This is where projects do not achieve the desired outcome with sufficient monitoring and verification, or risk stymying this investment.

688. In conjunction with the *Land Use Framework* discussed above, and the need for robust standards as set out in ***Pillar 6***, government should review its processes to ensure that there are no unnecessary barriers impeding nature-based solutions projects that align with wider net zero, nature and growth goals.

3.6.9 Technology and digitalisation

689. **The scale of decarbonisation**. Digital solutions can help to reduce emissions and energy consumption, improve environmental monitoring, and facilitate better policy design.

690. However, there is a large and growing carbon footprint from digital solutions. The energy needed for computation and cooling of data centres is also increasing at an alarming rate as our economies become more digitised.[500] Furthermore, there are risks from the rapid rise in digital technology on the climate, due to its 'rebound effects', where there can be increased consumption of energy due to the efficiencies the technology offers. There is currently a large amount of uncertainty on the scale of these effects, however policy should consider any potential unintended consequences of interventions in this regard.

691. **The economic opportunity**. The adoption of digital technologies can drive resource efficiency, reduce energy demand, and raise aggregate productivity.[501] The TechUK Digital Economy Monitor shows that between 2010 and 2019 the sector's contribution to the UK economy has grown by 26.5%, with the latest DCMS figures showing the digital sector added £150.6 billion to the UK economy, 7.6% of total gross value added (GVA).[502]

692. Beyond the measured GVA impact, it is estimated that adoption of smart grid and smart meters could reduce total consumer energy bills by £354 million in 2030; and a smart, flexible energy system built on clean-digital tech could reduce total costs by up to £50 billion a year by 2050.[503]

693. New innovations in digital and investment to scale emerging tech will be key to delivering the level of decarbonisation required to meet the UK's net zero commitments. Up to 15 per cent of the forecast reduction in the UK's total GHG emission between 2019-govertn2030 is attributed to the expected impact of digital technologies, reducing UK 2030 emissions by 7.2 $MtCO_2e$.[504]

694. The UK has existing comparative strengths in clean and clean-digital technologies and products, but the scale of the economic opportunity needs unlocking by Government. Digital technology adoption and innovation can drive both productivity growth and decarbonisation and will be key to delivering a smart energy system.

695. The Review has heard that Government has a role to play in crowding-in private investment and scaling up emerging sectors and technologies.

696. **Digital technologies are not being harnessed at scale**. However, investment in green (and digital) innovations is slowing down. Only around 20% of patents protecting climate change mitigation technologies have a digital component.[505]

> *"There is hesitancy to embrace digital skills, or digital tech, despite understanding the rationale that such adoption brings greater efficiencies, optimisation, and lower energy consumption."* – TechUK[506]

697. **There needs to be a standardised approach to emissions counting and frameworks to properly evaluate business action.**

> *"Firms and government need robust data to measure progress. However, firms, particularly SMEs, are new to carbon accounting, and therefore require support to adopt standardised approaches to collect and collate data, as well as turning information into intelligence."* – TechUK[507]

698. **We need better integration between digital and green innovations.** This could be achieved via increased support for demonstration projects.

699. **Support to R&D undertaken by business should primarily be direct and technology neutral.** Innovation in breakthrough technologies cannot be incentivised through horizontal support or deployment subsidies.

> *"The opportunities are primarily around long term, stable frameworks that markets can support. The climate-tech/clean-tech community is well funded and growing at a much faster rate than the rest of the sector, however, sectors that need to decarbonise are still not incentivised, or do not have the confidence in long term policy. Measures addressing this include: long term tax reliefs to offset capex needed for adopting digital technologies; 'Green vouchers' for SMEs to help adopt decarbonising technologies; moving away from specific products/machines and towards systems that are eligible for grant reliefs and standardisation of emission data capture and reporting, and ensuring standards are internally aligned."*
> – TechUK[508]

Promote climate technology as a solution to industries

BEIS to work with DCMS and DIT to develop a campaign by Q2 2023 to **promote digital technologies, including AI, robotics, digital twins, and autonomous systems**, as a solution to industry's **energy efficiency needs in the short term** and their role in **wider decarbonisation for the long term**.

700. Manufacturing and heavy industry are also slow to adopt digital technologies, with 94% of UK manufacturers stating that there has been underinvestment from businesses in digitalisation. This has led to the UK falling behind the USA.[509]

701. Industry has voiced their concerns that the Government has yet to fully promote the opportunity from growth and decarbonisation from digital technologies for UK businesses.

> *"[We] feel that the UK government has not fully recognised just how essential digital tech is to net zero, so DCMS should have a champion for climate tech that can work with BEIS and DIT to drive it as a strategic sub sector, and really have a focus on how digital tech can drive decarbonisation."* – TechUK[510]

702. Given the scale of the opportunity, and the prevailing view that this is not yet being grasped – it appears that this issue requires dedicated attention from government.

703. The Review recommends DCMS to work with BEIS and DIT to campaign to promote climate technologies as a solution to industry's energy efficiency needs in the short term and their role in wider decarbonisation for the long term.

704. This requires funding for a national campaign to target specific sectors which can benefit most from these technologies and should be ready by the summer of 2023.

Government carbon accounting

BEIS to include **digitisation and the related energy demand change forecasts** in Energy and Emission Projections by 2023.

705. Continued deepened digitisation will have an impact on the global energy demand. Currently, the Government's Energy and Emission Projections do not take this into account in their forecasts. Since the International Energy Agency (IEA) reports that "data centres and data transmission networks are responsible for nearly 1% of energy-related GHG emissions,"[511] this could become increasingly non-trivial and should be included in energy forecasts and modelling.

Pillar 4: Net Zero and the Community

There is plenty of regional, local and community will to act on net zero, but too often government gets in the way. The UK government must provide **central leadership on net zero, but it must also empower people and places to deliver**. Place-based action on net zero will not only lead to more local support but can deliver better economic outcomes as well.

Key recommendations

1. Government should simplify the net zero funding landscape by the next Spending Review
2. Government should fully back at least one Trailblazer Net Zero City, Local Authority and Community, with the aim for these places to reach net zero by 2030
3. Government should reform local planning and the National Planning Policy Framework now

Unlocking local action

706. Having considered how to deliver net zero in a more pro-growth way at a whole-economy level, this pillar will focus on the growth opportunities at regional, local and community level.

707. **More than 300 local authorities have set a net zero target and/or declared a climate emergency, including 182 with targets of 2030 or sooner.**[xxviii] [512] There is clearly a great deal of opportunity and ambition across the country for achieving net zero, which the Government's *Net Zero Strategy* has begun to encourage. Many mayors and local leaders are already moving quickly, and the devolved administrations all have their own clear strategies and priorities for delivery of net zero.

708. The Local Government Association (LGA), the national membership body for local authorities, told the Review:

> *"Local Government wants to work with Central Government, the regulators and with business to create a deliverable plan for achieving net zero both affordably and inclusively."*[513]

709. UK100, a network of local leaders on climate change, told the Review:

> *"Regional, city and local authorities must be the partners of choice for the government in the development of, and delivering on, Net Zero commitments."*[514]

710. Similarly, the Climate Change Committee (CCC) noted that:

> *"There is considerable momentum at local government level. However, there is currently a lack of shared understanding of where these good intentions would be most effectively directed."*[515]

[xxviii] The Review generally uses the term 'local authority' in a broad sense to refer to all types and tiers of local government.

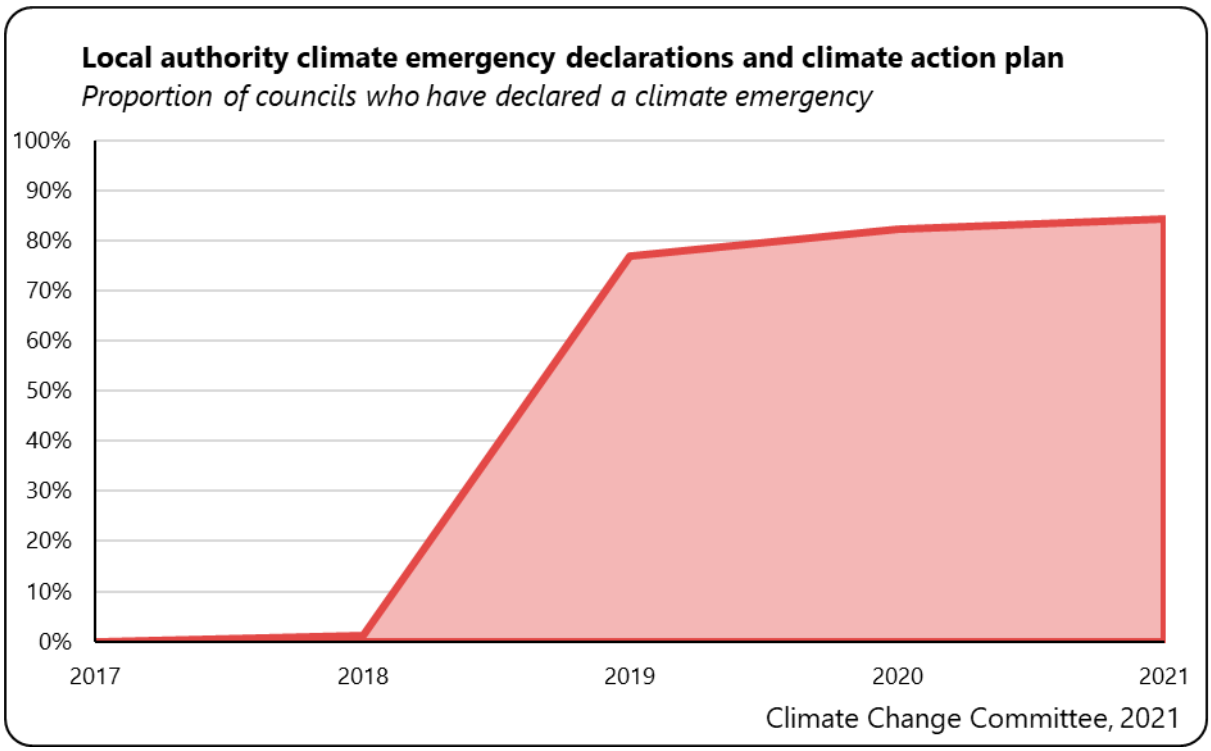


Figure 4.1 – *Local authority climate emergency declarations and climate action plan*[516]

711. The national net zero target has provided a clear mission for the UK, catalysing action across the country and the economy. But at the same time, every region and every community in the UK is different, and each will need different support if they are to thrive through the transition to net zero. For example, rural areas may face more of a skills challenge in their transition compared to cities, but they may also have more opportunity to grow a renewable energy industry.

712. Similarly, more than 50% of UK jobs in carbon-intensive industries are in the Midlands, the North and Scotland.[517] Many of these areas' economies have already suffered from deindustrialisation, and we cannot afford for them to be left behind on the road to net zero. It is particularly crucial that people in these communities feel the economic benefits of net zero, and that green industries contribute positively to their regional identities and their sense of pride in place.

713. **Since 2005, CO_2 emissions have fallen in every region of the UK, both in absolute and per capita terms.** Part of this is due to an increasing move towards a services-based economy in the UK, but it shows that the national trend of decarbonisation and growth is largely replicated across the whole of the UK.

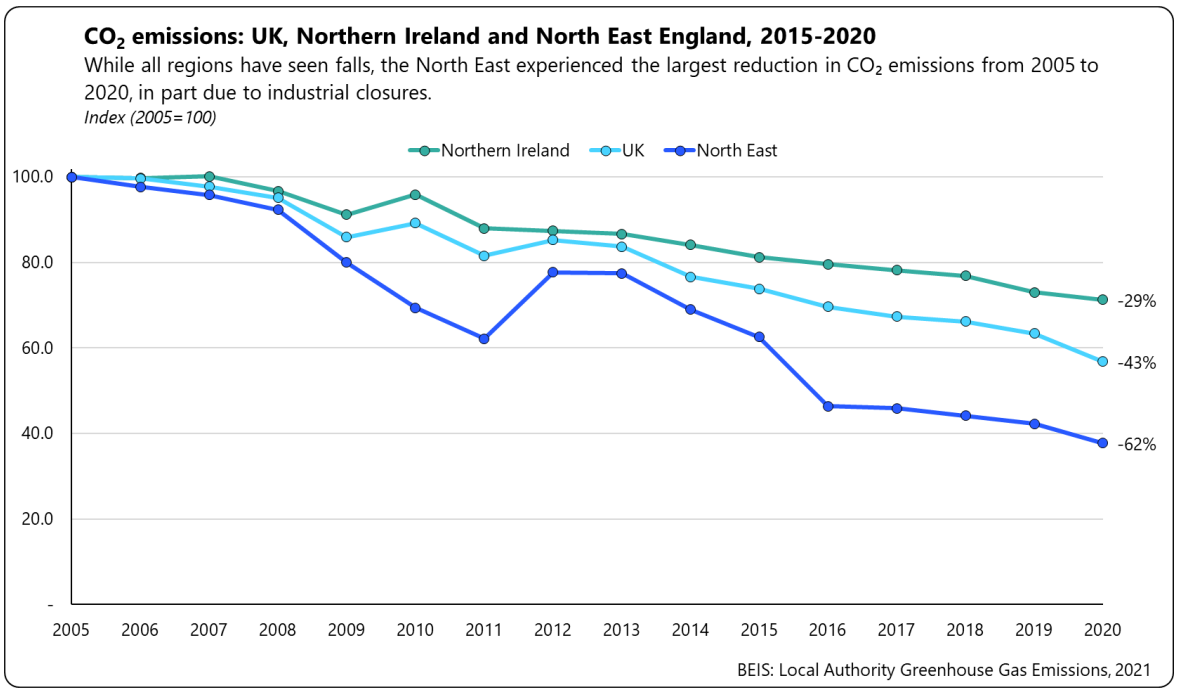


Figure 4.2 – *CO_2 emissions: UK, Northern Ireland and North East England, 2015-2020*[518]

714. Recent government strategies have recognised the importance of place-based and locally-led action. For example, the *Levelling Up White Paper* announced the biggest shift of powers from central government to local leaders in modern times in a bid to improve local and regional economic growth. The *Net Zero Strategy* found that:

> *"Devolved and local government play an essential role in meeting national net zero ambitions [...] Taking a place-based approach to net zero is also vital to ensuring that the opportunities from the transition support the Government's levelling up agenda."*[519]

715. **But the UK Government's current approach to net zero delivery is creating inefficiencies at a local level.** Often, local leaders are better placed to engage with communities and businesses on net zero, better placed to understand the challenges and opportunities their areas face in transitioning to net zero, and better placed to deliver locally-tailored net zero interventions. However, they currently face a lack of clarity over their role, a disjointed and short-term approach to funding, and require further support to build the capacity and capability needed locally to deliver a successful transition.

716. There is clearly a role for national coordination and direction-setting on net zero, as the Review has already shown. But to achieve a place-based, place-sensitive, locally-led transition to net zero, Government must place its trust in local leaders and communities to deliver.

717. If it does this, Government can galvanise the ambition of communities and ensure that every corner of the country feels the economic and social benefits of action on climate change.

718. By driving action from a community level upwards, we can make sure that it is tailored to local situations, responsive to local needs, makes the most of local opportunities, and is more popular and impactful as a result.

719. Polling commissioned by UK100 found that the public think local authorities are well-placed to act on green issues. 40% agreed that local authorities were best placed to take action, compared to 30% believing central government was best placed, and 19% individuals.[520]

720. **Importantly, taking this more locally-led, place-based approach to net zero delivery will not just deliver a better tailored, more supported transition, but it can also deliver greater economic and social benefits.** UKRI's *Accelerating Net Zero Delivery* report found that "a place-specific approach delivers more benefit for less cost".[521] This was the first time a place-based approach to net zero was directly compared to a place-agnostic one.

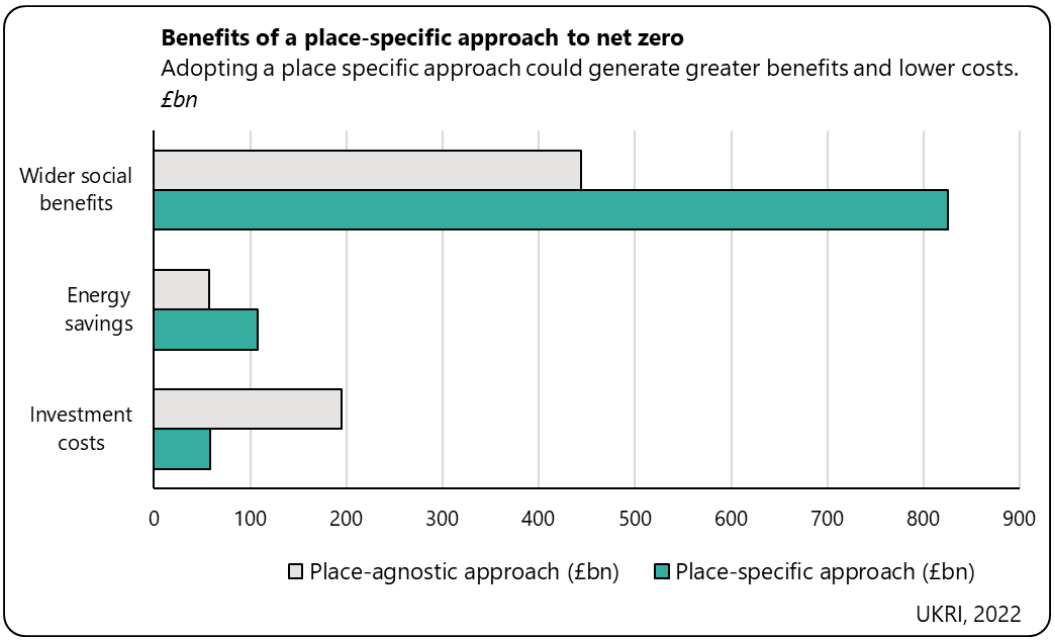


Figure 4.3 – *Benefits of a place-specific approach to net zero*[522]

721. The opportunity for better economic returns is largely because the costs and benefits of the transition to net zero will vary by place. For example, cities with poor air quality may see greater health benefits from investing in active transport solutions. Rural areas may need a greater focus on retrofitting older, less dense housing where residents could see greater savings on their energy bills. A locally-led approach is better placed to identify such challenges and opportunities.

722. **Government funding has already shown that net zero and growth can go hand-in-hand at a local level.** For example, the Levelling Up Fund, Community Renewal Fund, Community Ownership Fund and Towns Fund all included net zero or clean growth principles. £20 million from the Levelling Up Fund will, for example, go towards the development of a new construction skills academy and sustainable housing project in Sunderland, providing green jobs and economic growth for local people.

723. The Review also heard this from stakeholders:

> *"Net zero is pivotal to our growth ambitions – and offers our region's greatest single opportunity to grow our economy and provide well-paid skilled and professional jobs for local people in the coming decades. We estimate [major local stakeholders] are investing £9.1 billion in net zero technologies across the region"* – Tees Valley Combined Authority.[523]

> *"[I]n Greater Manchester the low carbon environmental goods and services private sector already represents over 14% of Greater Manchester's business base (by GVA) and over 3% of total employment. Such activity outperforms many other leading global cities and is a clear example of economic growth potential of the net zero economy"* – Manchester City Council.[524]

CASE STUDY: Bristol City Leap

Bristol City Leap is an innovative new public-private partnership which will attract up to £1 billion of investment in the city's energy system over the next 20 years. Following a procurement process, Bristol City Council selected Ameresco as its strategic partner to form the City Leap Energy Partnership. The partnership is expected to deliver around £424 million of investment over the first five years of the twenty-year partnership, as well as £61.5 million of social value including ca.£50 million of contracts delivered by local supply chains.

Bristol City Leap plans to deliver low carbon energy infrastructure, such as solar PV, heat pumps and building energy efficiency measures at scale on the City Council's land, buildings, and social housing. These investments will enable the Council's operations and council homes to be carbon neutral for heat, power, and fleet. Infrastructure such as the zero carbon heat networks will make a significant contribution to the rapid acceleration of the city's net zero goals. As national net zero policies develop, the partnership will be a powerful delivery route to implement innovative solutions and to multiply the impacts of government funding with private sector investment.

Bristol City Council has invested £7.5 million and over two years of planning in the City Leap procurement. The partnership will now be working to effectively engage with the private sector supply chain and deliver economic growth in a way that provides value for the public sector, grows local business, and supports local communities with jobs and training. [525]

724. While there are inefficiencies in the system, there are already examples of local net zero successes on which to build. Central government has also taken some steps to facilitate local net zero action, such as creation of the Local Net Zero Forum, which has been widely welcomed by local government. However, to make the most of the opportunities outlined above, we need a new relationship between central and local government and a more locally-led approach to net zero.

4.1 Regional and local net zero – making the most of ambition

The most forward-thinking local leaders and mayors are already delivering pro-growth net zero policies. But the relationship between central and local government is not working as well as it could. The relationship needs reform to unlock the potential of local and regional net zero growth.

725. While net zero policy has been developing rapidly at both a central and local level, these developments have not always been in lockstep. The result is a landscape that holds back local areas from delivering on their net zero ambitions. As one local stakeholder put it to the Review, "Net Zero achievements at local government level are in spite of government, not because of it".[526]

726. **Now that our national pathway to net zero has been established, we need a new relationship between central and local government to enable effective local delivery.** Local authorities will be a key delivery partner, whatever the specifics of the strategy we take on decarbonisation and growth. The sooner we address this, the sooner we will see the economic and social benefits of a more place-based approach.

727. The importance of this relationship to our net zero pathway cannot be overstated. **30% of the greenhouse gas emissions reductions needed to deliver the *Net Zero Strategy* rely on local authority involvement, while 82% of emissions are within local authorities' scope of influence**.[527]

728. **We need to allow places to tailor their net zero approach to their own strengths and needs**, informed by the kind of extensive local engagement that central government cannot undertake. We also need to increase local accountability and responsibility for certain aspects of net zero delivery.

729. To do so, we need a reformed relationship between central and local government and a planning system that is fully aligned with net zero.

Mission: Create a Net Zero Local Big Bang. Reforming the relationship between central and local government on net zero will empower local authorities to deliver place-based, place-sensitive action and unlock the high levels of local net zero ambition that we have across the UK. Unblocking the planning system and aligning it more closely with net zero will enable widespread pro-growth, net zero development.	
Issue heard by the Review	**Action recommended**
No clear framework on local net zero action, and no statutory duty. Guidance on some areas but not others. Lack of clarity over the local role, which can prevent action and/or lead to unnecessary bureaucracy between central and local government. Some partnership working. Responsible officers within local authorities sometimes unable to drive internal action due to deprioritisation.	**Government should introduce a statutory duty for local authorities to take account of the UK's net zero targets, based on a clear framework of local roles and responsibilities.**
Complicated net zero funding landscape. Numerous funding pots with different application criteria and restrictions. Actively discourages systems thinking and join-up. Resource intensive funding application processes. Competitions in which smaller authorities struggle. Short-term funding and delays in transfer of funds leads to inefficiency and inability to spend the funds provided.	**Central government should simplify the net zero funding landscape for all local authorities by the next Spending Review. This should include consolidating different funding pots, reducing competitive bidding processes, giving longer lead-in times where bidding remains and providing funding over the medium- rather than the short-term.**
Inconsistent local mission and target setting. Most local authorities have a high-level net zero target date. Underpinning plans vary significantly in terms of detail and development.	**Government should establish local net zero missions in 2023 for a number of key policy areas to encourage places to go further and faster.**
Some devolution of appropriate net zero powers. Varying degrees between nations and regions. Lack of framework and clarity over roles and responsibilities leads to confusion over exact nature of powers.	**Government should fully back at least one Trailblazer Net Zero city, local authority and community, with the aim for these places to reach net zero by 2030.**

Some capacity and capability support; inconsistent monitoring, reporting, and sharing of data. Significant variation between tiers and sizes of local authority. Short-term funding prevents long-term capacity and capability planning. Expensive consultancy often used to fill knowledge gaps, with some coordination between areas to improve costs. **Lack of standard monitoring and reporting presents barriers to progress, including on accountability. Some sharing of best practice.**	**Central government should provide guidance, reporting mechanisms, and additional capacity and capability support to enable local authorities to better monitor and report their net zero progress.**
Planning system presents major barrier to net zero action. View of system on net zero is unclear and does not give sufficient weight to net zero as a national priority. Often slow and difficult to navigate, especially for individuals and communities.	**Central government should reform the local planning system and the NPPF now. Have a clearer vision on net zero with the intention to introduce a net zero test, give clarity on when local areas can exceed national standards, give guidance on LAEP, encourage greater use of spatial planning and the creation of Net Zero Neighbourhood plans, and set out a framework for community benefits.** **Government should undertake a rapid review of the bottlenecks for net zero and energy efficiency projects in the planning system, and ensure that local planning authorities are properly resourced to deliver faster turnaround times**

4.1.1 A local net zero framework – roles, responsibilities, powers, partnership

730. Both the National Audit Office (NAO) and the Climate Change Committee (CCC) have recommended the introduction of a local net zero framework to define local roles and responsibilities. The CCC's latest progress report noted:

> *"It remains unclear how central, devolved and local government will operate coherently towards the net zero goal."*[528]

731. And the NAO has said:

> *"[T]here are serious weaknesses in central government's approach to working with local authorities on decarbonisation, stemming from a lack of clarity over local authorities' overall roles, piecemeal funding, and diffuse accountabilities."*[529]

732. **This lack of clarity is creating blocks in the system for those local authorities that want to be proactive in delivering net zero.** The *Net Zero Strategy* went further than previously in clarifying roles and responsibilities between central and local government, which was welcomed by many local stakeholders. However, more than a year later, local authorities still have gaps and uncertainties about their role.

733. It is impractical for central government to lay out precise roles and responsibilities for all areas of net zero. In some areas these are already well understood, in many these will differ between different tiers of authority, and in others the landscape will change so quickly that a detailed framework may be counter-productive. However, **a high-level framework and an agreement to close future partnership working between central and local government** would help provide clarity, certainty, and accountability for local areas.

734. Such a partnership would allow for quicker and easier identification of problems and areas where there is a lack of clarity. To complement the framework and partnership agreement, **central and local government should work together to create more detailed guidance in areas where it is needed.**

735. For example, many areas want to undertake Local Area Energy Planning (LAEP), an approach that aims to identify the most effective route for an area to decarbonise its energy supply, which can be a foundational building block for net zero plans. This is an area where more precise central government guidance would be helpful:

> *"[LAEP] could underpin a clearer, more evidence-based process to identify key collective investments and strategic choices that could achieve a more cost-effective local balance of energy resources, including opportunities to partner with local industrial clusters."* – Energy Systems Catapult[530]

736. However, there is currently a lack of guidance from central government on who should undertake this planning and how – the CCC recommends that central government needs to provide "clear guidance on who should be responsible for and involved in producing [local area energy] plans."[531] Devolved governments in Scotland and Wales have issued clear guidance on LAEP which has not yet been replicated in England.

737. There may also be areas where the local role in achieving net zero is not yet clear, or where the economic value of a place-based approach has not been determined. In such cases, government should work with local areas to pilot different approaches and test their value for

money, and/or research existing local and international examples of best practice to determine the most effective role for local areas to play.

738. The Local Net Zero Forum – set up recently on the back of the *Net Zero Strategy* to improve communication between local and central government – is well placed to undertake this work, but it needs ministerial buy-in to help solve some of the issues facing local authorities. **Relevant ministers from across government should attend the Forum on a regular basis, with the same focus on action and problem-solving that was seen in the sector through the COVID-19 pandemic.**

739. The Office for Net Zero Delivery (see ***Part 1***) could seek to support the implementation of the framework by encouraging regional coordination and collaboration, working closely with the Local Net Zero Hubs.

4.1.2 A statutory duty to prioritise action

Central government should **introduce a statutory duty for local authorities to take account of the UK's net zero targets,** based on a clear framework of local roles and responsibilities.

740. The Review heard frustration from local authorities about the lack of a statutory duty to deliver or consider net zero. The Climate Change Committee (CCC) found that:

> *"There is a risk that, despite their commitment to climate goals, projects may be delayed in favour of delivering core statutory duties."*[532]

741. In May 2022, the Scottish Government introduced a statutory duty for local authorities to:

> *"[Prepare], publish and update a local heat and energy efficiency strategy, and a local heat and energy efficiency delivery plan."*[533]

742. In Wales, local authorities have a duty under the Well-being of Future Generations (Wales) Act 2015 to consider sustainable development.

743. The Environment Act (2021) also introduced a duty for central government policymaking to have due regard for the impact of policies on the environment, which could provide the basis for a similar local duty. The Health and Care Act (2022) brought in requirements for NHS England to have due regard for climate change, including current and predicted impacts.

744. Evidence provided to the Review by Somerset County Council noted that a statutory duty could have positive knock-on effects in local economies due to the money spent by local authorities on procurement and commissioning, and that the current lack of a duty risks deprioritisation of net zero action.[534]

745. One local authority pointed to local authorities' existing statutory duty to consider and preserve local heritage, making it essentially impossible for them locally to improve the energy efficiency of listed homes and buildings, or those in conservation areas.[535]

> *"The absence of a legal duty or requirement for organisations to act on climate change and the decarbonisation agenda is a significant barrier to delivering on decarbonisation... the lack of any legal duty and associated powers for local authorities to compel organisations to act on climate change means that much of our work is focused on facilitating change with local*

communities and stakeholders, rather than having the powers to require stakeholders to act" – Westminster City Council[536]

746. The *Net Zero Strategy* found that a statutory duty should not be introduced, partly "because of the existing level of local commitment with the sector".[537] This fails to sufficiently recognise the challenge of turning this commitment into action. Given their role as place-makers rather than simply as service delivery partners**, tackling climate change should be an integral purpose of local authorities, and part of their future role and responsibilities**.

747. The *Net Zero Strategy* also argues that "it is difficult to create a uniform requirement that reflects the diversity of barriers and opportunities local places experience."[538] But it is possible for a duty – particularly one supported by appropriate devolution and clarity under a local framework – to allow sufficient flexibility in delivery to reflect local needs. This is already the case with a number of statutory duties – for example, local authorities have a statutory duty to protect residents from climate-related risks such as flooding, but they can still do this in a way most appropriate to their local circumstances.

748. **A statutory duty must be carefully designed to avoid adverse consequences on other areas of local authority delivery, and to drive the action that both local and central government want to see**. Any duty should take careful account of exactly what behaviours it is trying to drive at a local level, and how delivery will materialise locally.

749. **The local net zero framework should therefore be supported with a statutory duty for local authorities to take account of the UK's net zero targets**. The statutory duty should encourage close community engagement on net zero, create clear accountability and responsibility for net zero within local authorities and encourage a whole system view across the breadth of areas for which local authorities are responsible.

750. BEIS, DLUHC and local government should work closely to develop the exact details of this duty and should also consider whether a wide variety of areas within net zero delivery should form part of the broader duty – for example, local authorities could have specific duties to develop local transport plans, local energy efficiency strategies or Local Area Energy Plans.

751. **It is vital that central government provides appropriate additional support for local authorities to deliver this duty** so as not to negatively impact delivery of other important local services.

4.1.3 Making local net zero funding more efficient

Central government should **simplify the net zero funding landscape for all local authorities** by the next Spending Review. This should include consolidating different funding pots, reducing competitive bidding processes, giving longer lead-in times where bidding remains and providing funding over the medium- rather than the short-term.

752. **The net zero funding landscape is extremely complicated and inefficient for local authorities.** The Local Government Association (LGA) highlighted retrofit as an area with particularly diverse funding streams. Local authorities could deliver on retrofit through all of the following eight schemes, many of which had multiple funding rounds: the Local Authority Delivery scheme, the Public Sector Decarbonisation Scheme, the Social Housing Decarbonisation Fund, the Energy Company Obligation, the Home Upgrade Grant, the Warm

Homes Fund, the Boiler Upgrade Scheme, and its predecessor the Renewable Heat Incentive. This list does not include funding streams for related energy efficient power such as heat networks, let alone other areas of net zero delivery.

753. **The need for funding reform featured in virtually every evidence submission to the Review from local government.** One county council told the Review:

> *"Constant last-minute competitions for short term projects results in huge inefficiencies for local government, lots of wasted effort discussing and co-ordinating bids, multiple monitoring methods/criteria for effectively the same outcomes."*[539]

754. The County Councils Network recommended government should "Provide a streamlined funding process that is easier to navigate and less resource intensive." The LGA noted:

> *"One of the biggest obstacles for delivery has been short lead in times for funding schemes, short delivery timescales and a lack of joined up (systems) thinking in the programme design phase."*[540]

755. This is despite welcome commitments in the *Net Zero Strategy* and the *Levelling Up White Paper* to simplify and consolidate funding, which have not yet made an impact on the funding landscape.

756. One local authority told the Review that the rules around use of government funding are so restrictive, and change so frequently between funding rounds and competitions, that a delivery model they had developed through one funding pot was no longer eligible for funding in the next round.[541]

757. Research from the University of Sheffield found that local authorities spent an estimated £63.5 million bidding for the Future High Streets Fund, Towns Deals and the Levelling Up Fund.[542] While these funds are not directly related to net zero, the figures are illustrative of how expensive the current funding system is for local authorities. Research for the LGA found that the average cost of bidding for a competitive grant was around £30,000.[543]

758. The Review heard of similar experiences on net zero funding, with local authorities spending hundreds of thousands of pounds preparing and managing bids across net zero funding competitions. The Review heard that some local authorities see the costs as so prohibitive that they simply choose not to bid for certain funding.[544]

759. **If such a funding landscape continues, it risks creating significant disparities in the ability of local authorities to deliver.** As the Climate Change Committee (CCC) noted:

> *"Funding competitions are problematic, focusing resources into the local authorities with sufficient staffing and capacity to apply for funds, often at short notice."*[545]

760. Authorities that have experience, local expertise and have been able to use previous funds to develop supply chains and skills will continue to receive funding. Others – which often tend to be smaller authorities – will struggle and likely fall behind.

761. **This funding landscape is clearly economically inefficient for local authorities and counter-productive for central government.** Short-term, one year funding competitions are a particular problem and restrict the ability of local authorities to respond and deliver on such short timeframes, making systems-level planning much more difficult.

762. **This funding landscape also holds back growth in local economies.** For example, the CCC notes that:

> ***"****Funds also have to be spent rapidly, which prevents a skilled local supply chain being developed […] Short term, unexpected funding opportunities fail to deliver the best schemes."*[546]

763. **A longer-term, simpler funding landscape would allow local authorities to form a more coherent plan of action** from which they could develop supply chains, build local skills, and coordinate action to benefit from economies of scale and attract private finance.

764. There is value in maintaining a competitive nature to some funding (mainly due to the size of some funding pots), and it is difficult for individual government departments to alter their funding plans within a Spending Review, which defines spending levels for government departments over a certain period. **For the next Spending Review, BEIS, DLUHC and HMT should work closely to deliver local net zero funding reform.** For all local authorities, there should be a simpler and consolidated net zero funding system that provides greater lead-in times and transfers money from central government more quickly. Where possible, funding should be non-competitive to reduce administrative burdens and ensure that allocation of funding is based on need and opportunity rather than bidding capacity. It should be medium- rather than short-term, with multi-year funding arrangements where possible, and additional support should be provided to local authorities with less bidding capacity.

765. For authorities with the greatest devolution and the strongest track record, government should explore how it can provide long-term funding with greater flexibility. This approach is explored in more detail later in this pillar.

766. As a condition of simpler, less competitive, more devolved funding, **central government should require strong economic evaluation of net zero funds.** This will help build a rigorous evidence base on what works locally, which can be used to inform and improve future action.

4.1.4 Local net zero missions – a call to action

Central government should establish **local net zero missions** for a number of key policy areas to encourage places to go further and faster.

767. The UK's net zero target has provided a clear mission and sense of purpose within Government, leading to reforms in how Government delivers. As discussed earlier in this Review, **the act of setting this target has itself catalysed action**.

768. Local areas are already setting their own net zero targets and seeing local benefits from this. Local targets and missions have the ability to create a focal point from which action stems, healthy competition develops, and accountability improves.

> *"The net zero target enables the city to focus on responding to the huge challenge of the climate emergency and how it can mitigate its potential damage and adapt to it, ensuring Manchester is a resilient, climate ready city. Working for a net zero Manchester and Greater Manchester will also ensure the city and the city region are at the cutting edge of new net zero technologies through a transitioned workforce and local economy, ensuring it is internationally competitive within a new green global economy"* – Manchester City Council.[547]

769. Local authorities have a significant amount of local convening power. They can reach and bring together residents, businesses, skills providers, the local energy sector, and others in a way that central government cannot. **A mission-centred approach allows greater opportunity for local authorities to utilise these powers and to focus different actors' energy around a common goal.**

770. However, to date, local authorities have often struggled to act on their ambitions – as already evidenced in this pillar. The reforms outlined above would provide local authorities with a much clearer sense of where and how they can act, but the Review heard from local leaders that greater ability to set local targets and devolution of the powers to deliver and enforce them would also help to mobilise local delivery.[548]

771. While each place's transition to net zero will be different, there will also be many commonalities. **Central government should identify a small number of key policies where a mission could be applicable to all local areas** – for example, buildings retrofit or recycling. These could be linked to responsibilities agreed in the local net zero framework outlined above and should also be centred around positive economic action. Local areas could sign up to these missions, delivering them in a place-based way but with a clear mandate from central government, a common goal on which to share best practice, and a clear message to convey to communities.

772. **Depending on the success of these missions, a more locally specific approach could be developed in future.** Local and central government could work together – including through local consultation with businesses and communities – to formulate local net zero missions with greater community buy-in and a stronger relevance to individual places. Such missions could form the basis for further devolution of powers or funding.

773. Local missions would also help send clear signals to local businesses and communities, supporting their own actions and helping to clarify local priorities.

4.1.5 Deeper devolution and trailblazer net zero deals

Central government should **establish core principles for future net zero devolution and ensure that all devolution deals agreed between now and 2030 have a strong net zero element**.

Central government **should fully back at least one Trailblazer Net Zero City, Local Authority and Community**, with the aim for these places to reach net zero by 2030.

774. Net zero powers are devolved to varying degrees across the UK. The devolved administrations are in many places setting examples for the rest of the UK. For example, Scotland's net zero target is 2045, in Wales the *Well-being of Future Generations Act* encourages sustainable development, and in Northern Ireland the *Green Growth Strategy* is helping to build green industries such as hydrogen.

775. Within England, regions, mayors and different tiers of local authority have varying degrees of power on net zero.

776. The Review visited and heard directly from leaders in all of the devolved administrations and every region of England. It was clear from this engagement that **net zero devolution has been a success to date, and that it has enabled nations and regions to deliver more effectively.**

777. It was also clear that Government can do more through greater devolution of powers and greater consistency in this devolution. For example, Manchester City Council's response to the Review's call for evidence noted that devolution was one factor that would be "essential for future energy security and UK economic growth and productivity."[549] UK100's *Power Shift* report found that:

> *"[L]ocal authorities need more powers and resources, clarity over their role and an investment in skills and jobs to take the next step [on net zero]."*[550]

778. The *Levelling Up White Paper* announced that by 2030 there will be a devolution deal for every part of England that wants one. The first of these deals, for York and North Yorkshire, included a strong net zero element, while Greater Manchester and the West Midlands are currently negotiating deeper devolution deals.

779. **Government should ensure that every devolution deal includes a strong net zero element**, with a focus on the powers needed to achieve greater growth. With more powers, areas will be better able to create systems that drive green growth. For example, the Review heard that greater powers would allow areas to create coordinated local skills plan that meet local net zero needs, undertake LAEP that could form the foundation of future energy projects, or take a neighbourhood approach to retrofit that utilises economies of scale and hyper-local efficiencies such as when transporting materials or erecting scaffolding.

780. Government should work closely with areas to determine where net zero policy can be devolved, learning from other devolved areas such as skills. Based on the framework and statutory duty set out earlier, this could help form a clear framework and future agreement on net zero devolution.

CASE STUDY: Regional Net Zero Action

West Midlands Combined Authority

In 2019 the West Midlands Combined Authority set a net zero target of 2041 and declared a climate emergency. In 2022, it published a five-year plan detailing how the area could start to deliver on this net zero target.

In the West Midlands, the existing low carbon sector already represents a workforce of 94,000 people across more than 5,000 businesses, generating £12 billion of low carbon revenue per year. Three of the four leading sectors in the West Midlands – which are based on existing regional strengths – focus on net zero ambitions. The five-year plan aims to create 21,000 new low carbon jobs by 2026, with associated economic growth expected to create a 7% increase in employment.

The growth potential for the area's leading net zero business clusters has been estimated as:

- *Electric light vehicles and battery storage: £850-950 million growth in output and 11,200-12,400 new jobs;*
- *Modern and low carbon utilities: growth in output of £420-470 million and 4,400-4,900 new jobs;*
- *Manufacturing future housing: £220-320 million growth in output and 3,400-3,700 new jobs.*

The West Midlands is also proactively looking at how its net zero ambitions can directly drive economic growth through initiatives such as its 'SMART hub' (Sustainable Market for Affordable Retrofit Technologies) and its 'Net Zero Neighbourhood' demonstrator, which both seek to catalyse supply chain growth.

Greater Manchester Combined Authority

In 2019 the Greater Manchester Combined Authority (GMCA) launched its five-year environment plan which sets a target for the area to be carbon neutral by 2038.

The plan was launched at its Green Summit, which is now in its fifth year. The summit seeks input from businesses, policymakers, local communities, and industry on how the city region should accelerate action against its five-year plan.

In 2022, Greater Manchester established a new cross-sector taskforce to steer the GMCA commitment to deliver 30,000 operational net zero carbon social rented homes in Greater Manchester by 2038.

In addition, devolution of powers, including the ability to franchise bus services across Greater Manchester, has allowed the city-region to implement price reforms on its bus network. These reforms will support bus users with the cost of living crisis, grow bus patronage and revenues and support the shift to more sustainable travel. Bus fares will cost no more than £2 a journey, or £1 for children, and a weekly cap introduced from the start of 2023 will be £21 for adults and £10.50 for children. This is as part of plans to deliver a fully integrated public transport system across buses, trams, trains and bikes. This has also included investment from the Department for Transport, Stagecoach and GMCA to support the introduction of 170 zero emission buses by 2024.[551]

781. **Other countries and regions are beginning to take a more locally focused approach to net zero.** In September 2021, the EU launched a programme to support 100 climate-neutral cities by 2030. If the UK does not demonstrate ambition on local net zero action, it risks falling behind regional competitors, missing out on first-mover advantage, and having to do more to catch up later.

"Ultimately, the government must provide more funding that is available over a longer-time frame to effectively support decarbonisation. Ideally this would be provided via long-term devolution settlements for net zero at the Combined Authority level. This would provide stability in funding for net-zero while addressing the issues that are caused by short-term funding provision that pits area against area. Local areas in the majority of cases know the interventions that need to be implemented and therefore should be given the freedoms and flexibilities to apply a location specific approach to decarbonisation." – West Yorkshire Combined Authority[552]

782. Alongside net zero devolution for all areas, **Government should fully back at least one city, local authority and community across the UK that want to go further and faster on net zero.**

783. **Government should work with these places to develop 'Trailblazer Net Zero Deals'**, which should have the outcome of helping places to reach net zero by 2030 and should be based on long-term support from central government. As described earlier in the Pillar, short-term funding competitions are a barrier to the long-term, joined-up action needed on net zero. We need to begin planning local net zero delivery across years and decades rather than months.

784. The degree of funding and devolution of powers in Deals should initially be dependent on a track record of delivery, and further flexibility on powers or funding could be based on initial performance to ensure value for money for taxpayers. The Deals should be designed to encourage a whole systems view of net zero.

785. While some funding should come from government, there should also be **a clear focus on attracting private finance**, without which such a quick transition will not be practical. The Deals could also trial a 'Net Zero Sandbox' style approach which allows firms to test innovative propositions and could encourage research, development, and innovation in emerging net zero fields. This could offer an attractive proposition to internationally mobile investments.

786. This approach could be particularly beneficial when combined with other aspects of devolution – for example, combined authorities could put their existing powers on skills to better use if they had long-term funding around which to develop net zero industries and supply chains. Positive results have already been seen from other long-term funding arrangements such as City Deals, through which government committed to providing funding over a 30-year period.

787. Selected 'Trailblazer' places should cover urban, rural, and coastal areas, with strong monitoring and evaluation at every stage to create a strong evidence base that can help determine the best methods for effective local net zero delivery. This knowledge could be shared across all regions to improve net zero delivery, as well as providing a basis from which Government could determine whether and to what extent to continue with projects.

4.1.6 Better capacity and capability support

788. Net zero action is often a complex area, which some local authorities are still developing the specialist skills to successfully navigate. The picture also varies across the UK – while there are many local authorities with ambitious net zero targets, in 2021 there were 84 with no published net zero plan.[553] Published plans vary greatly in quality and ambition.

789. The Review heard that capacity and capability is one area that presents challenges in this regard. For example, West Yorkshire Combined Authority told the Review that a "lack of

dedicated capacity and specialist expertise slows progress, resulting in fewer projects being developed and delivered".[554]

790. When it comes to attracting investment and private finance, the UK Cities Climate Investment Commission found that:

> *"There is a gap in available headcount within Local Authorities to deliver this work [...] Nor are there centralised resources adequate for Local Authorities to draw upon."*[555]

791. This represents a missed opportunity to create areas of competitive advantage for the UK.

CASE STUDY: Local Net Zero Investment

The transition to net zero can be supported by driving innovation in the local private sector to ensure that the opportunities of net zero lead to real benefits for local communities in terms of jobs, skills and pride in place.

Preston in Lancashire is regarded as one of the UK's pioneers of community wealth building, an approach to local economic development focused on using a community's existing assets to create inclusive and local growth. Since 2012 the City Council has worked with other 'anchor institutions' in Preston – such as NHS trusts, universities, housing associations, and large local businesses – to use its influence as an employer, an owner of land and other assets, a major purchaser of goods and services and as a leader of place to reduce the wealth flowing out of the local economy so that it can be retained and shared more widely for the benefit of local people. The figure below shows Preston's success in using community wealth building to retain procurement spend locally. Compared to place-agnostic procurement in 2012/13, prioritising procurement from local and socially responsible businesses led to spend within Preston increasing from 5% to 18% of total procurement spend, and spend within Lancashire increasing from 39% to 79% of total procurement spend.

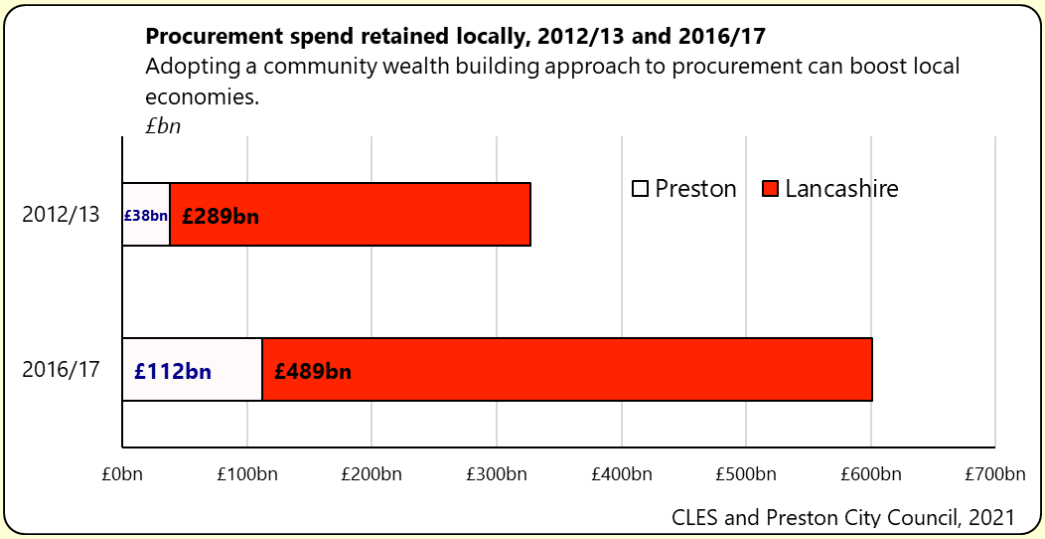


Figure 4.4 – *Benefits of a community wealth building approach*

Following Preston's example, multiple local areas across the UK are pursuing community wealth building approaches, including in their strategies to delivering net zero.

For example, research conducted by the Centre for Local Economic Strategies (CLES) and the Institute for Public Policy Research (IPPR) on behalf of South of Scotland Enterprise has found that a holistic effort will be necessary to develop the retrofit supply chain in the region. The research found that bringing together key anchor institutions in the South of Scotland, including registered social landlords, local authorities, and colleges, would create a combined economic buying power to support innovation and demand for net zero delivery in the local economy. This could see the creation of more than 2,000 jobs and £112 million in direct GVA by 2030.[556]

In North Ayrshire, the Council has pioneered the use of community wealth building to deliver renewable wind and solar energy which is delivering tangible benefits back into local communities. In addition to creating renewable energy and green employment opportunities, new solar PV farms will use council-owned land and assets to support the potential for local suppliers and supply chains to benefit from the investment. [557]

792. Local leaders have already started building net zero clusters that are attracting substantial green investment and jobs. As an illustrative example of the regional economic benefits that the net zero transition can accrue, analysis for the *Net Zero Strategy* suggested that **the North East of England region will likely benefit from the transition to net zero through 27,000 additional jobs and £1.9 billion of gross value added by 2050**.[558]

793. As a practical example of attracting green investment, research from 2020 on two EU programmes providing technical assistance for local net zero projects found that €23 million in grants delivered around €859 million of investment into UK programmes. This included Manchester Combined Authority using €3 million of initial funding to attract over €155 million of capital investment in the city.[559]

794. While this shows what is possible in terms of leveraging private finance, the Review heard that often areas lack the skills to turn opportunities into investible propositions, or to turn one promising project into a coherent net zero programme of growth.

> *"Many places have projects they would like to attract investment into, and many investors are looking for projects, but too frequently the projects are not presented in a truly investable manner [...] In broad terms, places and their leadership know what needs to be done. Again, in broad terms, the local population are behind these plans, and in many cases clamouring for them to happen more quickly"* – 3Ci[560]

795. Despite their local success, Manchester City Council told the Review that:

> *"One of the biggest challenges at the local level is how to finance the climate transition and enable investment that will deliver new jobs and skills, deep decarbonisation and a more climate resilient city."*[561]

796. The Review heard from many in local government that **aggregating projects to an investible size and scale is a challenge**, and that this is exacerbated by the short-term and piecemeal nature of central government funding.

797. **Government must provide additional support to make sure regions can attract green investment and build regional green clusters.** This should include refocusing planned Investment Zones to ensure they encourage net zero investment and development. A community wealth building approach could also be an effective way to develop net zero supply chains locally and ensure that local net zero projects drive economic growth throughout the UK. Central government should work closely with the UK Infrastructure Bank (UKIB) to build on its local pilots and its work providing an advisory function to local authorities.

798. More broadly, research for the Climate Change Committee (CCC) found that:

> *"[I]n most local authorities, capacity to tackle emissions reductions, apply for funding and manage schemes is very limited."*[562]

799. For local authorities, the question of how best to use limited resource has become more challenging due to a reduction in overall funding and pressure on other delivery areas and statutory duties.

800. **There was concern through the Review's engagement that smaller local authorities face particular challenges on net zero capacity and capability**, and that too often this results in individual local authorities procuring expensive consultancy services to help with their plans.

801. The Review heard that the Government's Local Net Zero Hubs have been helpful in this regard, as they have been able to organise a consortium approach to drive down costs and use scale to mobilise regional supply chains. **Government should continue to support the Hubs.**

802. While the reforms laid out earlier in this Pillar will go some way to improving local capacity and capability – for example, by reducing the administrative burden of securing funding, and providing longer-term certainty around which local authorities can plan future action – **central government must do more to support local government's capacity and capability on net zero**.

803. **The 'Office for Net Zero Delivery'** (see ***Part 1***) **should provide central support to enable local net zero delivery**, working with local authorities and the Local Net Zero Hubs to identify particular areas of need and ensuring effective join-up across regions to minimise costs on measures such as training or consultancy.

804. All councils should be required to have a Cabinet lead for net zero, and councils should be encouraged to give regular progress updates at public meetings on their net zero plans.

805. The Department for Transport's Local Authority Toolkit on transport decarbonisation provides one model through which local capability can be supported. The Toolkit highlights the benefits of different interventions, sets out the actions local authorities can take, helps share best practice and signposts to other guidance and methodologies. Net Zero Go, part of Energy Systems Catapult, is another example, which brings together tools and features to support local authorities in progressing energy projects and building businesses cases.

4.1.7 Monitoring, reporting, sharing and accountability

Central government should **provide guidance, reporting mechanisms and additional capacity and capability support** to enable local authorities to better monitor and report their net zero progress.

Central and local government should work together to **convene an annual Local Climate Summit** that helps to share best practice, attract green investment, and provide an opportunity for areas to update on their Locally Determined Contributions.

806. The Review also heard that monitoring, reporting, and sharing of data could be improved at the local level.

807. With a clear framework, statutory duty, missions and devolution, there will be greater value in a standard approach to monitoring and reporting of progress, and a wider range of approaches from which best practice can be taken.

808. If central government is to increase local responsibility for net zero delivery, there will also need to be clear local accountability. Government should look to learn lessons from what has already worked with regards to local monitoring and reporting of other services such as recycling, where transparency and targets have driven greater accountability.

809. Government should also take care to ensure that reporting processes are not burdensome for local authorities and have value, including in how they drive better information sharing, increase public awareness and scrutiny, and are used to help solve delivery problems. Reporting mechanisms must have a clear focus on reducing emissions and economic outcomes.

810. **BEIS, the Office for Net Zero Delivery, and the Office for Local Government should work with local authorities to improve monitoring, reporting and accountability for local net zero delivery.** Measuring and accounting for emissions directly within the control of local authorities – such as those from their own estate – could help provide a basis from which local capability can develop. Government recognised this in the *Net Zero Strategy* and should expedite delivery of this work.

811. One approach that the Review heard to delivering net zero locally is through a Locally Determined Contribution, currently being trialled in Cambridgeshire.[563] As part of the Paris Agreement, the UK is required to establish and regularly update a Nationally Determined Contribution which sets out how we plan to cut emissions and adapt to climate impacts. Locally Determined Contributions would follow the same approach at a smaller scale. Setting a Locally Determined Contribution could help to quantify the opportunities and actions for a local area while giving a clearer sense of how local actions support the UK's broader net zero target.

CASE STUDY: US Embassy Air Pollution Data[564]

A recent study has found that US embassies helped to measurably improve air quality in developing countries by tweeting real-time local pollution data.

In 2008, the U.S. Embassy in Beijing began tweeting air quality readings from a new pollution monitor. By 2020, US embassies had installed over 50 monitors in 38 low- and middle-income countries and were live-tweeting air quality readings on pollution levels in cities across the world, improving the information available to local residents.

Researchers examined 50 of these embassy sites located across 36 countries, gathering satellite data on pollution from before and after US embassies began sharing air quality readings. They then compared the results with data from similar cities without embassy monitors.

The study found that monitoring and sharing information led to a measurable reduction in airborne particulate matter. Researchers estimated that, in the median city, improvements in air quality saved 303 lives in 2019, with a related monetary benefit of $127 million.

812. The Review also heard that central government should be doing more to promote best practice, and that there are sometimes difficulties sharing information between different tiers of local authority.

813. While each local area is different, each will also share many challenges and opportunities – such as on buildings retrofit. For example, instead of every local authority mapping property archetypes around which they should build their local retrofit strategy, central government could reduce this inefficiency by identifying and sharing best practice.

814. **Central and local government should work together to convene an annual Local Climate Summit** to share best practice, inviting community groups, social enterprises, businesses, and international leaders to highlight their own successes and share learning. This summit should have a strong focus on private finance, acting as a local green investment forum. It could also serve as a forum to update on the progress of Locally Determined Contributions.

4.1.8 Local planning reform – simpler, quicker, clearer

Central government should **reform the local planning system and the *National Planning Policy Framework* (NPFF) now**. The reformed system should have a clearer vision on net zero with the intention to introduce a net zero test, give clarity on when local areas can exceed national standards, give guidance on LAEP, encourage greater use of spatial planning and the creation of 'Net Zero Neighbourhood' plans, and set out a framework for community benefits.

Government should **undertake a rapid review of the bottlenecks for net zero and energy efficiency projects in the planning system** and ensure that local planning authorities are properly resourced to deliver faster turnaround times.

815. ***Pillar 2*** highlighted the need for government to work with local authorities, devolved administrations and relevant stakeholders to streamline planning processes to ensure the transition to net zero at pace. There are a number of other reforms that should be taken at a more local level to ensure that the planning system properly facilitates net zero.

816. The Town and Country Planning Association told the Review that "changes are essential for the planning system to facilitate progress towards net zero", and that "further legislative change is needed to enable planning to play the critical role necessary to achieve net zero targets."[565] They also told the Review that stronger national direction and clarity on net zero in the planning system would "give confidence and the clarity needed to encourage growth in the green building sector, bring forward investment and support the development of skills."[566]

817. While the *National Planning Policy Framework* (NPPF) references climate change, it does not reference net zero specifically and the Review heard that **the vision of the planning system on net zero is not clear**. Too often there are conflicting or unclear messages, with important points relegated to footnotes.

818. The planning system should be an essential tool in delivering the changes needed for net zero. A system that appears ambivalent to net zero will not be capable of delivering the scale of change required.

819. **The planning system should move towards implementing a test for all developments to be net zero compliant**, ensuring enough lead-in time to prevent adverse economic consequences or stalling of current development plans. Across the economy the cost of building to net zero standards and using net zero technologies is coming down. Providing clarity and certainty on net zero requirements in the planning system could help drive further action and build supply chains, making net zero development the norm.

> *"Planning can be a driving force for not only net zero but for growth as well, helping to unlock opportunities across the country […] The reputation of planning in the UK would only be furthered if it were given the ability and position to be a key driving force for net zero. Our own research suggests that planning brings in millions to the UK and has the potential to have a much larger impact if the passion and expertise of our consultancies both large and small were showcased as one of our key exports"* – the Royal Town Planning Institute.[567]

820. There is also confusion over whether, where and how local authorities can exceed national standards on planning. The litigious nature of the planning system means local authorities are often unwilling to take risks, and so the system effectively puts a ceiling on local ambition.

821. For example, the Review heard from several stakeholders about the difficulty faced by West Oxfordshire District Council in their plans for the Salt Cross Garden Village.[568] The Council had proposed that development at Salt Cross would be required to demonstrate net zero carbon, with submission of a validated and monitored energy strategy. However, in May 2022 the Planning Inspectorate provisionally found that such a policy was not 'consistent with national policy or justified' and the plan was modified as a result. This is a clear example of the planning system being unclear in its support for net zero.

> *"Local authorities are wary of the threat of legal challenge, this means to make confident use of their powers, they have to undertake rigorous legal checks, which slows delivery, adds expense and makes some of them risk averse"* – Climate Change Committee (CCC).[569]

822. Similarly, some local authorities felt that planning requirements on viability presented a hindrance to net zero development. These local authorities felt that some developers use viability requirements to reject proposed net zero improvements. These local authorities suggested that such viability considerations should be reformed or scrapped, and that net zero should be a fundamental consideration when determining the viability of a project. Current guidance states that viability assessments "should not compromise sustainable development."[570] This language should be strengthened to ensure that viability assessments actively encourage sustainable and net zero developments, and that assessments take a longer-term approach to determining what is viable.

823. **Reforms to the planning system should therefore make it clear when local authorities can exceed standards** and provide guidance on how local areas could go further should they wish to.

824. The reforms outlined above should also encourage taking a system-wide approach to planning that is joined up across neighbourhood and community planning, as well as at the spatial level. The Intergovernmental Panel on Climate Change's (IPCC) sixth assessment report finds with very high confidence that **cities that use spatial planning to become more compact and resource-efficient could reduce greenhouse gas emissions by between 23-26% by 2050**.[571]

825. Approaches such as '20-minute neighbourhoods' aim to design places in such a way that residents can access all of their daily needs through just a short walk or cycle. There are advantages to taking a systems-level approach in this context – for example, considering public transport options or electric charging capacity when planning new housing developments.

826. This Pillar has already outlined some of the benefits of Local Area Energy Planning (LAEP). Plans of this nature could provide the basis from which energy projects could be efficiently delivered, with more targeted consenting and planning – for example, York and North Yorkshire told the Review that in their area, they have estimated that LAEP "will deliver £280 million in cost savings resulting from planned energy infrastructure investment over unplanned and piecemeal delivery."[572,573] LAEP could also provide the data to help underpin a net zero test in the planning system as described above, and provide a basis from which better spatial planning could be undertaken.

827. Along with the requisite powers, **Government should provide clear guidance on how areas can undertake LAEP, including with regards to their governance and implementation**. This guidance should require close community engagement to encourage community support and increase understanding of local energy and net zero plans.

828. Once areas have undertaken LAEP to identify future energy needs and projects, **Government should encourage and support them to create their own 'Net Zero Neighbourhood' plans**. Areas should engage closely with local communities when making these plans, which could also combine current plans for water, habitats and nature, farming support, air quality and coastal management where relevant.

829. The complexity of the system also makes it difficult for individuals and amateurs to navigate, and the system often moves slowly. **Government should undertake a rapid review to identify the bottlenecks in the planning system for local energy efficiency and renewable energy projects.** This should include looking at pre-application stages. Lessons should be learned from Project Speed and the review of Nationally Significant Infrastructure Projects (NSIP) planning processes and applied to smaller scale renewable energy and retrofit projects.

830. In addition, it is clear that if we are to reach our net zero goals, we will need a greater level of applications for renewable and energy efficiency projects in the coming years (see also **Pillar 2**). **Additional support should therefore be provided to Local Planning Authorities and other system actors as needed** so that they can reduce the average turnaround time of small- and community-scale energy projects, with target timelines put in place. There should be consistent reporting and monitoring of timelines across the country, as well as public data publishing, to identify areas where timelines are longest.

831. The Review also heard that **local consent for net zero projects can be an issue**. There is a balance to be struck between national need and local impact; at a national level, Government will need to take a more strategic approach to future energy infrastructure placement, and at a local level there must be improved efforts to involve communities and show the benefits of net zero action.

832. **One way of doing this is through direct community benefit.** The Review heard of many local energy projects which are delivering community benefits, from grants to install energy efficiency upgrades in community buildings to creating a cooperative community cycle club. The Scottish Government has published a set of good practice principles for community benefits from onshore renewable energy developments.[574]

833. **UK Government should give practical guidance and establish a framework on future community benefit with a clear plan for how this can be implemented within the planning system** (see also **Pillar 2**). Local communities should be directly involved in determining how this benefit is realised, but the starting point should be other net zero or climate positive actions such as retrofit or development of local green space. There should also be an effort to empower and upskill communities to better understand and engage with planning processes so that projects and benefits reflect true local feeling and consent.

834. On energy efficiency, the British Energy Security Strategy committed to reviewing the practical planning barriers that households face when installing energy efficiency measures, including in conservation areas and listed buildings. There are now around 10,000 conservation areas in England, covering an area the size of Luxembourg.[575] This represents a huge potential source of energy production through solar and demand reduction through energy efficiency measures. **Government should publish the findings of this review as soon as possible, and should eliminate relevant planning barriers for energy efficiency measures.**

835. Central government should reform the local planning system and the National Planning Policy Framework as soon as possible. The reformed system should have a clear net zero vision with

the intention to introduce a net zero test, give clarity on when local areas can exceed national standards, give guidance on LAEP, encourage greater use of spatial planning and the creation of Net Zero Neighbourhood plans, and mandate community benefits from energy projects.

836. Government should undertake a rapid review of the bottlenecks for net zero and energy efficiency projects in the planning system, and ensure that Local Planning Authorities and other system actors are properly resourced to deliver faster turnaround times.

4.2 Making net zero work for communities

The transition to net zero will affect every community in the UK. But for a transition that delivers real growth, we need wholesale community action and involvement – and we need to make the growth benefits of net zero more real for ordinary communities. Community energy projects are one way to do this.

4.2.1 Community engagement and involvement

837. Evidence submitted to the Review found that, while there are many barriers to community action, often the biggest factor determining the success or failure of a community project is the presence of a 'community champion'.

838. Community projects need to navigate a complex set of systems and actors, from local planning decisions to engaging with the energy system. Having someone on a community project who understands the system and who has the motivation to get things off the ground is key, but this can result in a 'postcode lottery' when it comes to turning community ambition into positive action.

839. As described in ***Pillar 5***, many people are unsure about how to reduce their own carbon footprint. **Community-level participation, with trusted sources of information and advice, can be a key step to encouraging this individual action.**

840. While there is large scale support for action on net zero and climate change, we must also be realistic and upfront about the scale of change required to meet our net zero ambitions. While central and local government must set the example, communities across the country will experience a multitude of changes – whether that be training for a job in a new green industry, cycling or using public transport more, heating their homes in new ways or reducing, reusing and recycling more to help create a circular economy. The Review has demonstrated that **net zero will bring positive economic and social changes, but they will be changes to which communities and individuals will have to adjust nonetheless**.

841. ***Pillar 5*** will explore the tools that individuals need to enable them to take action, including the need for a public engagement strategy on net zero. If central government is to bring communities along on the net zero pathway – which it must do to achieve a fair, popular and successful transition – it must start now to ensure widespread community support for local net zero action.

842. To achieve this support – and to deliver the scale of change needed – government must **involve communities directly in local net zero action and encourage communities across the UK to lead their own net zero and climate projects**. This should include encouraging younger generations, who have shown great passion for net zero, to be involved in and lead positive local net zero action. Doing so will allow communities to see first-hand the benefits that net zero can have, while allowing for local autonomy and building community pride. Research has shown that demonstrating these co-benefits has a positive impact on levels of public support for net zero-related policies.[576]

CASE STUDY: Culatra 2030

The 'Culatra 2030 - Sustainable Energy Community' initiative is a demonstration project on the island of Culatra in the Algarve, Portugal. Culatra is home to around 1,000 residents, with 7,500 tourists visiting every day in peak season. The island is relatively isolated and is located within the Ria Formosa Natural Park.

The project is focusing on the specific needs of the island in its green transition, as well as how to capitalise on its existing assets. The initiative has an all-encompassing strategy covering multiple aspects of green transition, including social issues such as energy poverty – a big issue on the island, where energy currently accounts for around 50% of household expenditure.

The Regional Authority of Algarve, local authorities, the University of Algarve and various businesses providing technology solutions, as well as citizens gathered under the Culatra Island Residents' Association, make up the initiative's 'Island Sustainability Committee'.

The central ambition of the initiative is to transform all structures on the island to become energy self-sufficient. The community will produce energy exclusively from renewable sources, use electric mobility, decarbonise its fishing industry and acquire sustainable habits and living practices. It will also manage its own energy system, recycle water for self-consumption and retrieve value from its waste.

The community is succeeding in tailoring new technological solutions according to the specific needs of the island, as expressed by islanders themselves. To date, interventions have included installing solar panels and lithium storage batteries, as well as developing a solar-powered boat to make oyster farming zero carbon.

Key to its success is the active participation of the island's whole community. A new governance system for participatory exploration of transition pathways has been put in place on the island. This participatory model is proving effective in improving decision-making, compared to the previous situation which was characterised by several scattered and uncoordinated initiatives. However, a major challenge for the initiative remains the establishment of a secure funding stream – funding so far has come from a scattered mix of local, regional, national and EU sources.

Beyond the immediate benefits for Culatra, the initiative also aims to position the Algarve region as a centre of excellence in renewable energy research and training, exploiting its distinctive resources in the decarbonisation of its economy. [577]

843. The Review heard that organisations such as Neighbourhood Watch may provide a useful model for organising effective local action. The organisation started at grassroots level in the early 1960s and now covers more than 2.3 million household members, as well as delivering training and working with businesses to tackle crime and safety issues.

844. **Government could also encourage this action by working with local authorities, communities, and business groups to establish a network of community champions** – Local Net Zero Heroes – who can reach local people, inspire them and build a ground-up movement for tackling net zero at the community level. Local authorities should use their expertise and their access to the new Office for Net Zero Delivery to support their own local champions, building community capacity and capability.

845. Central and local government should encourage larger businesses in local areas which are further developed in their decarbonisation and possess more resource and expertise to share

best practice with SMEs. Local government should use its convening power to set up information sharing forums and identify local businesses which might benefit most from external support.

CASE STUDY: Net Zero Champions

British Business Bank

The British Business Bank (BBB) established a UK Network Team to help build regional capability and provide detailed insights into regional characteristics, challenges, and priorities. Working on the ground with key organisations across the UK, the UK Network helps the BBB to understand the challenges facing smaller businesses in their access to finance journey. The UK Network spans across the whole of the UK, with field managers assigned to each region and nation of the UK.

The UK Network gathers information, reports on business finance ecosystems, and raises awareness of the BBB and the services it can offer. Part of this gathering and reporting of information is focused on net zero and the opportunities and barriers in the business support ecosystem. This helps shape guidance for SMEs on how they can take advantage of local green opportunities and make their business more sustainable.

In March-June 2022, the UK Network team hosted 12 roundtables with over 180 attendees including local stakeholders active in net zero and SMEs taking steps on their net zero journey to discuss BBB's research on net zero. A further two roundtables were held in July 2022 focused on generating evidence for the update to the Green Finance Strategy.

In November 2022, the UK Network team hosted Business Finance Week – a week-long series of events focused on raising awareness of finance options for smaller businesses. A themed day was dedicated to Green Finance, with five events focused on net zero actions for small businesses as well as demystifying green finance.

University of Manchester

In June 2022 the University of Manchester launched the first version of its 'Responsible Plastics Action Plan'. The plan details a number of practical steps that the University plans to take between now and 2025, such as introducing a £20p charge for disposable cups which is reinvested in local sustainability and community projects. This avoided more than 35,000 cups going to landfill in only two months and increased reusable cup sales by 36%.

Staff and student engagement is a key part of the plan. The University's '50,000 Actions' initiative is the biggest environmental sustainability initiative in the higher education sector, and challenges staff and students to take practical action in their everyday lives to reduce plastic use and live more sustainably.

A Step Up & Lead Sustainability Champions scheme was also launched as part of the plan. Sustainability Champions are students who take on an additional role promoting awareness of sustainability issues amongst their peers to encourage environmental action. The University plans to develop these roles and attract more student volunteers. [578]

4.2.2 Turbocharging community energy

Government should **commit to the Local Electricity Bill and publish a Community Energy Strategy** that addresses regulatory, legislative, funding and capacity barriers in the sector. The Strategy should also consider what support should be given to innovative projects such as community purchasing and community energy sharing and storage.

846. Community energy involves delivering renewable energy projects that are at least partly owned, led and/or controlled directly by communities. Community energy projects not only contribute to net zero but are a distilled example of energy security and sovereignty, with many communities moving towards a goal of energy self-sufficiency.

847. **Despite increasing concerns around energy security and energy prices, the community energy sector has been relatively neglected by government.** The rate of growth in the sector has slowed since 2017, with government support tapering off despite success (see Figure 4.5 below). Community Energy England, a representative organisation with over 280 members, told the Review that in the North West of England, projects from the previous government funding scheme had a "nearly 70:1 ratio of finance to development money", meaning that less than £1 million of development funding could enable projects with a capital expenditure of more than £64 million.[579] Ending this support represents a missed opportunity for Government.

848. Current regulations in the energy market mean that community energy projects cannot directly supply local communities, an issue which the Local Electricity Bill seeks to address. Community-owned projects can also face disadvantages in accessing government or private finance. The Environmental Audit Committee told the Review that the UK is "lagging behind nations such as Germany, Denmark and the Netherlands in growing the sector".[580]

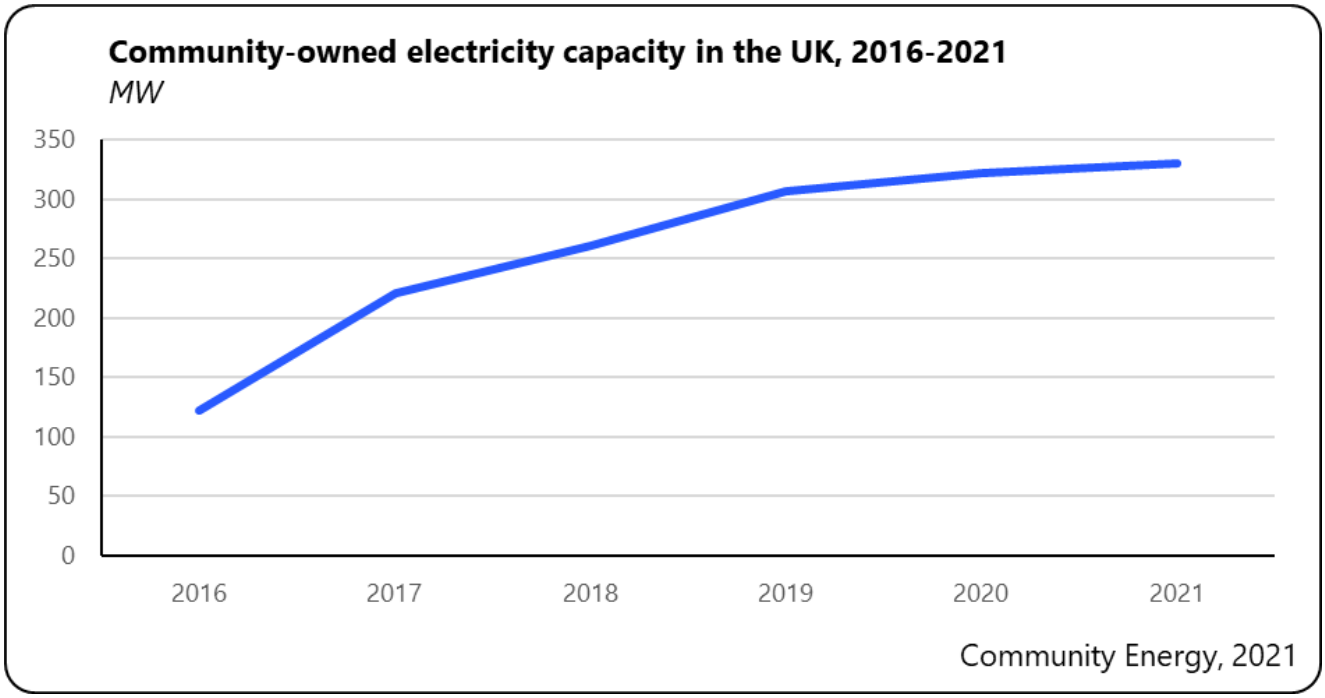


Figure 4.5 – *Community-owned electricity capacity in the UK, 2016-2021*[581]

849. **Government should commit to the Local Electricity Bill** that would enable community energy projects to provide energy directly to local households and businesses, **and work directly with the sector to create a Community Energy Strategy**. This should consider legislative, regulatory, funding and capacity barriers in the sector, and should create a comprehensive plan to turbocharge the sector. Central government should also consider what support it can give to innovative community-level energy projects such as community purchasing and community energy sharing and storage.

CASE STUDY: South East London Community Energy (SELCE)

Selce is a community energy group that places as much emphasis on supporting people to be more energy efficient and tackling fuel poverty as it does on generating renewable energy. It uses social business models to meet the needs of people in the local area across the wealth gradient.

Since its inception in 2014, Selce has provided one-to-one advice to thousands of low-income households struggling with their bills. For example, from August 2021-August 2022 they provided one-to-one support to 1,079 low-income households in South East London, all of which were struggling with their bills and half of which have a long-term disability or illness. Selce helped residents get the best deal on their bills, access grants and discounts and reduce their energy demand. Its multilingual and multi-ethnic team focus on enabling long-term gains in energy efficiency and empowering residents to take control of their energy costs. In the same period, its work resulted in a summed reduction in costs of more than £600,000 and avoided more than 5 million kg of CO_2.

The Selce team delivers advice in a variety of settings: in homes, by phone and at drop-in energy cafes that are designed to incentivise and destigmatise energy advice. Over 12 months, the team delivered 53 workshops, visited nearly 400 homes, and reached over 500 residents. This included delivering more than 350 bags of simple, easy to install energy saving measures such as draught proofing, LED lightbulbs and water saving measures.

Selce delivers advice in collaboration with other local organisations to ensure it reaches the most vulnerable residents. From August 2021-2022, they trained 103 front-line workers to better understand fuel poverty and embedded 10 energy advice volunteers in local organisations to deliver advice to their communities.

Selce has also created its own social enterprise, Future Fit Homes, to work with those who are able to pay for energy efficiency measures. The Future Fit Homes project is working intensively with one street in Lewisham to enable residents to work together to retrofit their homes, as well as with the Royal Borough of Greenwich to support SMEs to reduce their costs and their carbon emissions.

Selce owns and operates 510 kWp of community-financed solar PV across 11 sites, including seven schools, two leisure centres, one hotel and one church. These solar arrays collectively produce 438,730 kWh of solar electricity and avoid 84,654 kgCO_2e annually. Selce is working on a pipeline of six sites. In partnership with neighbouring community energy group Sustainable Energy24, Selce has used community financing to support four schools to replace over 6,000 lights and light fittings.[582]

850. Another key aspect of community level energy is heat networks, sometimes called district heating. These are systems of insulated pipes that distribute heat from a central source around a variety of places such as homes and businesses, often recycling waste heat or heat from otherwise inaccessible sources and increasing energy efficiency.[583] Heat network zoning is an approach that involves central and local government working with local industry and stakeholders to designate areas where heat networks can provide the lowest cost way to decarbonise heating.

851. Government should do more to support heat networks while ensuring that households and businesses are able to benefit from lower energy prices due to their efficiencies. This should include considering the use of innovative heat network technologies such as mine water heat projects or geothermal energy, and a particular focus on re-using waste heat.

CASE STUDY: Heat Networks

Somers Town Energy

Somers Town Energy is a district energy network between Euston and King's Cross stations that provides heating and hot water to over 600 homes, a new primary school and community facility, and power to the Francis Crick Institute, Europe's largest biomedical research facility.

The project involved the retrofitting of a new low carbon energy centre within an existing council-owned car park, alongside new cycle parking facilities. The project has seen a reduction in energy costs for residents living in the social housing connected to the network, while contributing to Camden's zero carbon ambitions.

Leeds PIPES

The scheme will provide low carbon heat and hot water to 1,983 council homes which will save tenants money on their energy bills while reducing the city's carbon footprint. This project also has wider connotations for the community, providing local employment and training opportunities.

So far, the project has helped to employ more than 430 people in the local low carbon sector - including 36 apprentices. It is also being used to educate local schools on climate change - with the Leeds PIPES network being named by a local academy. [584]

Pillar 5: Net Zero and the Individual

We all have a vital role in delivering net zero, from how we travel to work and heat our homes, to the products we buy and how we dispose of them. The actions we take to reduce our emissions can save us money and improve our health and wellbeing, while supporting the green economy.

But, without further action, these benefits are not guaranteed to everyone. There are three overarching issues that prevent people from maximising the benefits:

1. Agency: people need to be empowered to make the changes they wish to, engaged on the challenges, and armed with the information they need.

2. Affordability: Low carbon products must be affordable.

3. Accessibility: The necessary skills, services, and infrastructure must be accessible.

We need to make net zero work for everyone. Particular focus is needed on reaching net zero homes, which can offer lower energy bills and more comfortable living environments; we need a mission to bolster energy efficiency for households, including access to affordable low carbon heating.

Key recommendations (with all necessary legislation recommended to be tabled within this parliamentary session):

1. Gas free homes and appliances (no new or replacement boilers) and all homes sold to be EPC C by 2033.
2. Consider a Net Zero Homes Standard and Net Zero Performance Certificate as future benchmarks for an energy efficient home.
3. To expand the energy advice service in 2023 and create local retrofit hubs by 2025 to support consumers in making upgrades to their homes.
4. Expand support schemes for low-income consumers such as the Boiler Upgrade Scheme (BUS), Home Upgrade Scheme (HUG) and Social Housing Decarbonisation Fund (SHDF).
5. Invest in and increase skills and training capacity now for low carbon heating and energy efficiency measure installations.
6. Consider innovative green finance products and catalyse heat pump investment.

5.1 Ensure net zero works for everyone

5.1.1 People are vital to delivering net zero

852. **People have an essential role in delivering net zero.** The choices individuals make about what they buy and use will shape the transition**.** As we move towards 2050, we will see people adopting more sustainable modes of transport, public transport, and sharing services, and petrol- and diesel-run cars will be replaced by electric vehicles. Consumers will be able to choose more sustainable and longer-lasting products and dispose of them in more sustainable ways. Our homes will be more energy efficient and heated by low carbon technologies like heat pumps, with solar panels providing more of a household's energy. Smart meters will help us to manage our energy use. **Almost half of the actions in the Government's *Net Zero Strategy* require public action.**[585]

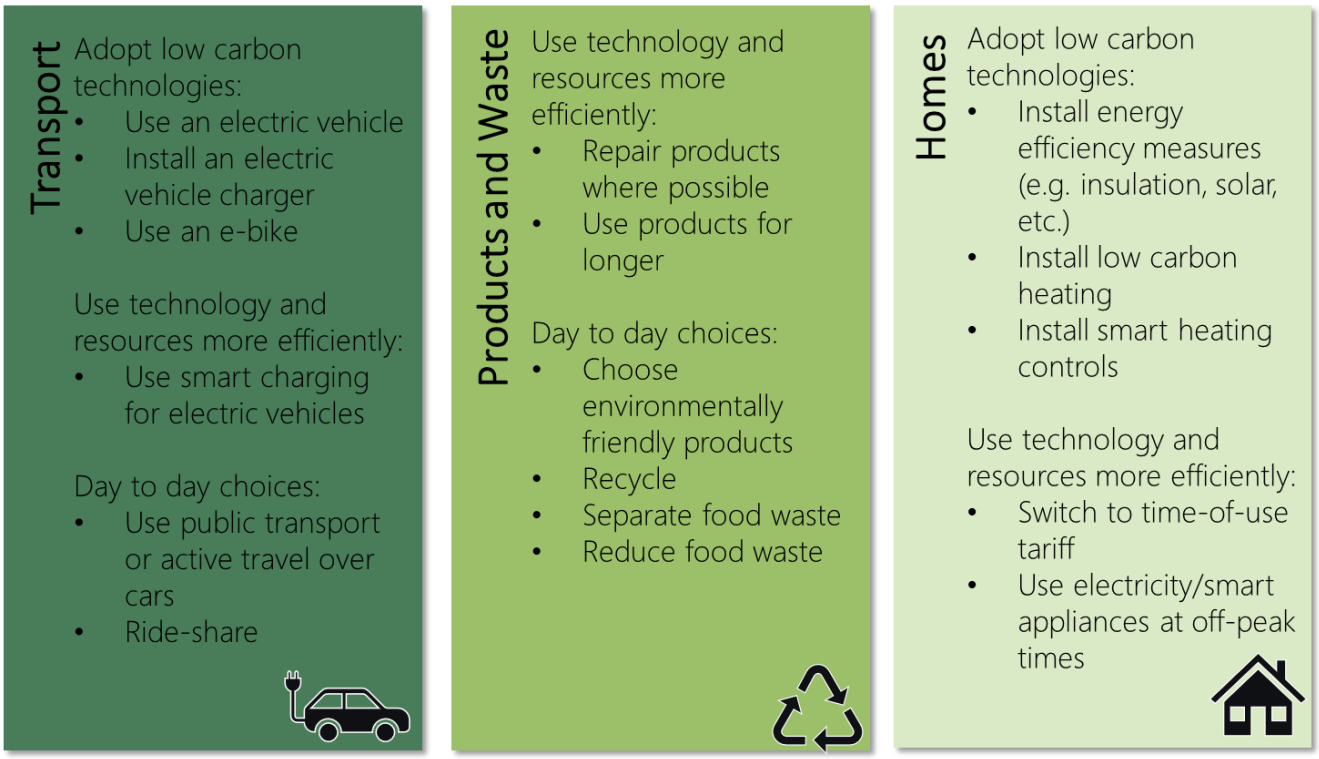


Figure 5.1 – *Net Zero Strategy summary of role of individuals*

853. **The average household produces 8.5 tonnes of CO_2 each year**, mostly from travelling, the energy used to create the products we buy and the food we eat, and from heating our homes.[586]

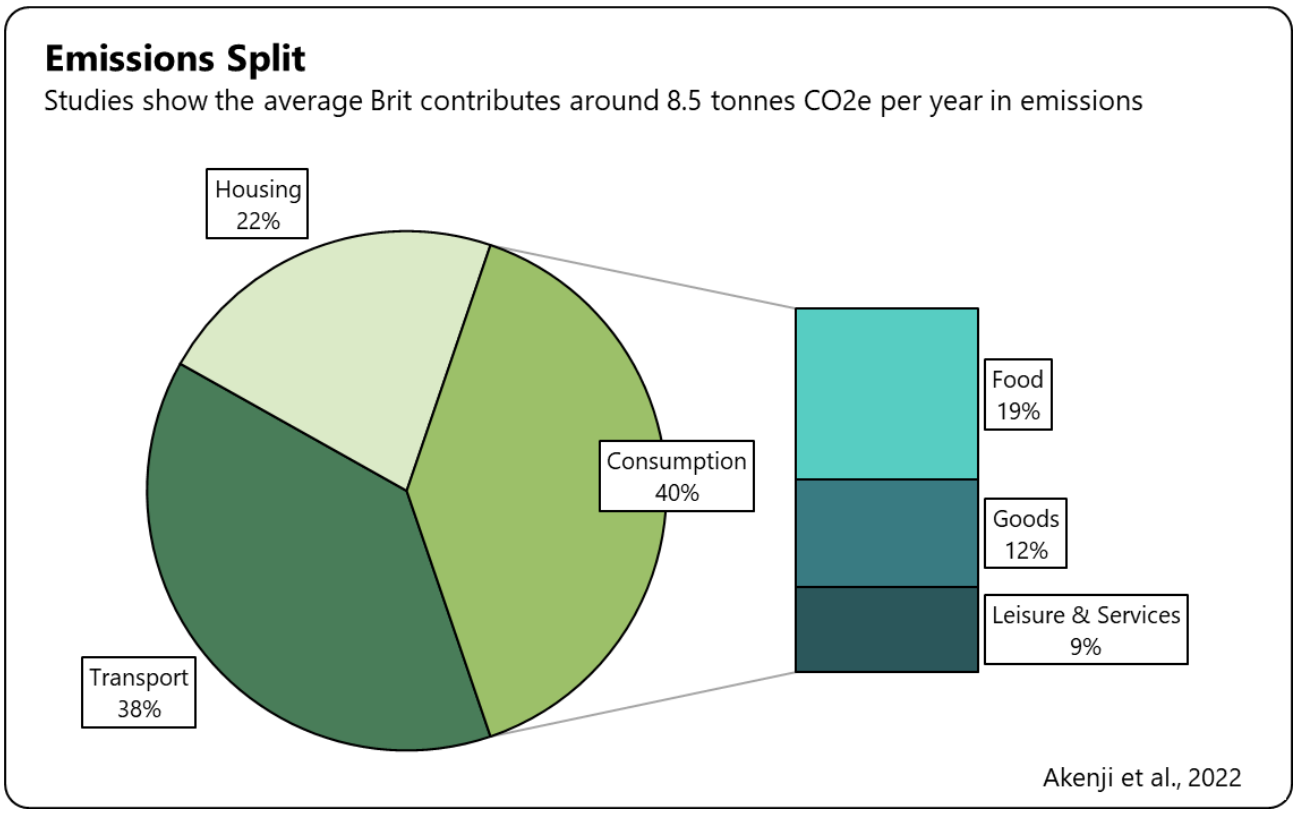


Figure 5.2 – ***Average lifestyle carbon footprint for a UK individual***

854. **Many people recognise the need to take personal action on climate change.** A 2022 survey showed that climate change is the fourth largest public concern, after the economy, the cost of living and healthcare.[587] Concern about climate change has remained largely stable, despite the current cost of living crisis.[588] People recognise that these issues are interrelated and do not necessarily require trade-offs, e.g. that you can grow the economy while improving health and tackling climate change.[589] People also recognise the need to take personal action: Ipsos Mori found that more than half (55%) feel that the responsibility to address climate change is shared jointly between government, industry and themselves.[590]

855. **We are already seeing these changes.** For example, one million electric vehicles have been registered in the UK, and 55,000 heat pumps were installed in 2021.[591, 592] But other countries are going further and faster. For example, the UK has a lower deployment of heat pumps per capita than other large European nations: in 2021, France, Italy and Germany were the largest markets, with 537,000 heat pumps installed in France, 380,000 in Italy and 178,000 in Germany.[593]

856. **Individual action can help to decrease the overall costs of delivering net zero.** Recent research from the Government Office for Science has shown that individuals and businesses making green choices, such as changes to travel patterns and making more sustainable purchases, will lower the overall costs of the transition – provided they are supported by systemic changes.[594]

857. This chapter considers our individual roles in tackling climate change – and the steps government needs to take to make this a success. There are clear opportunities – but also genuine questions about how to make the transition fair and affordable. There is an urgent need to look at how government can support everyone to reduce their energy demand, particularly heating our homes in the context of today's high energy bills.

5.1.2 There can be benefits and opportunities for everyone

858. **The Review has found clear evidence that net zero can offer real benefits to us all.** In particular, measures to reduce our GHG emissions can offer:

- Cost savings, including cheaper bills;
- Homes that are warm in winter and cool in summer;
- Cleaner air and less congested streets;
- Greater access to nature;
- Improved health and wellbeing;
- New jobs spread around the country; and
- A boost to local high streets.

859. **New analysis carried out by the Review finds that the average household will make a cumulative saving of £400-£6,000 by 2050, under planned net zero measures and the funding commitments made at the recent Budget.**[xxix] This is because electric vehicles are cheaper to run than petrol and diesel vehicles, and energy efficiency measures will significantly reduce people's heating costs. Heat pumps may be cheaper to run than gas boilers, depending on a range of factors.

860. **Some of these savings can be achieved today.** Actions taken today can save money, tackle the cost of energy crisis, and help to deliver net zero. For example, reducing energy demand by adjusting boiler flow temperatures can save people money and reduce pressure on gas supplies, while also providing greenhouse gas emissions reductions.

861. **Energy bills can be permanently reduced, helping to combat fuel poverty.** Greater energy efficiency, smart systems and other household technologies will reduce energy demand and cut bills, bringing particular relief to fuel-poor households.

862. **Net zero can also add value to homes.** Installing energy efficiency measures and low carbon heating will increase its value by around £10,000 on average.[595] Homes will also be able to produce power by installing, for example, solar panels, and then selling surplus energy – or indeed energy stored in electric vehicles – back to the grid. Green mortgage offers may be able to provide better rates for homes with higher energy efficiency ratings or who want to improve their property's rating.

863. **Health and wellbeing can also be improved.** Low carbon homes are warmer in winter and cooler in summer, making them more comfortable environments and improving people's health: 63,000 deaths were caused by excess cold in 2020-21, and many more people suffer physical and mental health conditions, in part due to living in cold homes.[596] Temperature rises mean that more people are suffering from extreme heat in the summer months too, which caused over 56,000 deaths in 2021.[597] Increased active travel, like walking and cycling, and access to green spaces, can improve people's physical health and mental wellbeing. This, alongside growing public transport use, can help to reduce air pollution and the many health complications that come with it. Ill health often necessitates heating your home more frequently, and so improving health and wellbeing can also help to avoid higher energy bills.

[xxix] In 2021 prices, undiscounted. This excludes impacts of any potential future changes in fuel duty.

864. **This will save the NHS money.** Illnesses caused by cold homes costs the NHS about £1.4 billion a year, while physical inactivity is estimated to cost it around £0.9 billion a year.[598, 599] By making people's lives longer and healthier, net zero can reduce burdens on the NHS, freeing up resources for investment elsewhere.

865. **Net zero can provide new job opportunities.** The Government's planned pathway to net zero carbon emissions by 2050 could support 1.18 million direct jobs by 2050.[600] Improved health outcomes will reduce the number of sick days that workers need to take. For example, active travel can help people to improve their physical activity and consequently take fewer sick days. Meanwhile, improving public transport services and active travel infrastructure can cut time spent commuting and increase people's access to jobs around the country, helping to ensure that the skills and services needed for a net zero economy are available.

866. **And with more money in their pockets, people can spend more.** With the right measures in place, this can boost the low carbon economy and support jobs creation; spending on making our buildings low carbon, for example, has supported 45,000 green jobs since November 2020.[601] Much of this demand can be met by small and medium sized businesses in local communities, and better connectivity and improved local environments are further attracting people to spend in their local highstreets. Individuals can drive growth both at a national level, and at a regional one.

867. **Many people recognise these benefits and are already taking action to secure them.** BEIS's Public Attitudes Tracker showed that 98% of people are already taking at least one action that can help to tackle climate change.[602] Opinium carried out an online survey of 2,000 UK adults aged 18+ in October 2022. Results show that:

> *"45% of the UK population are already taking personal action to reduce their carbon emissions. 11% plan to within the next 6 months, and a further 11% plan to in more than 6 months' time."*[603, 604]

5.1.3 But the benefits are not guaranteed – government must act now to ensure net zero works for everyone

868. **The benefits of net zero are not guaranteed.** Overall, 78% of the UK population say that there are barriers which prevent them taking more action on reducing greenhouse gas emissions.[605] In response to Opinium's poll, 10% said they do not know what actions they can take to reduce their emissions, 40% said that cost is the biggest issue preventing them from making green choices, and 20% said that difficulty avoiding unsustainable products and lack of infrastructure are prohibitive.[606] These issues came up frequently in engagement carried out by the Review.

869. **Government must act upon three key barriers:**

- **Agency:** People want to help reach net zero – but often they do not feel empowered to do so. People need to be engaged on the key issues and armed with the information and advice they need to make informed decisions.
- **Affordability:** Low carbon technologies like electric vehicles and heat pumps often come with high upfront costs, putting them out of reach for many.
- **Accessibility:** Accessing low carbon products, services and infrastructure is not always easy.

870. **These barriers can affect different groups in different ways, and government needs to ensure the transition is fair for everyone.** For example, those on higher incomes are more likely to be able to afford low carbon choices and the benefits they bring, and those living in urban areas are more likely to have access to key infrastructure (like public transport and electric vehicle charge points) than those in rural communities.

> *"A key challenge associated with the transition to Net Zero is how to fairly spread the costs and benefits of policies used to achieve decarbonisation across all aspects of society. This can be achieved if, at the same time as reducing emissions across the economy, all people, places and communities are supported, benefits from the transition are fairly shared and no-one is left behind."* – Centre for Research into Demand Solutions[607]

> *"Without a strategic approach, there is a risk of creating disproportionate impacts for households based on income- and place-based dimensions. For example, many of the changes required to decarbonise homes (e.g. energy efficiency retrofits, heat pumps, electric vehicles) are currently unaffordable and/or disruptive for households to adopt."* – London School of Economics[608]

871. **Government must act decisively in response to these barriers, to ensure net zero works for everyone.** Government should ensure that people are empowered to play their part, that green choices are affordable and accessible for everyone, and that the transition is fair and leaves nobody behind.

872. **Nuanced responses to these challenges are required.** In many cases, specific elements of the transition come with their own specific issues that warrant dedicated attention. Section 5.2 sets out a series of specific recommendations focused on how people travel, and the products people buy and throw away.

873. **The Review proposes a new mission to increase the energy efficiency of our homes, boost low carbon heating and reduce energy demand.** The cheapest energy is the energy we do not use. Major steps can be taken to reduce our energy use without any changes to our lifestyle. This, alongside moving to low carbon heating systems, can significantly reduce emissions and deliver other co-benefits. This mission is set out in section 5.3.

Agency – Engaging and informing people

874. **Public engagement on net zero is the missing piece of the puzzle.** Although almost half of the measures in the *Net Zero Strategy* require action from individuals, the Strategy said little about how government will engage with people on the many areas of their lives that will see change. There has been no overarching public campaign on net zero in the UK since the Act on CO_2 campaign, which ended over a decade ago.

875. **Previous government interventions on behaviour change are helpful blueprints.** For example, the Government's response to the coronavirus pandemic demonstrated how people's behaviours can be successfully influenced. Government was advised by the Independent Scientific Pandemic Insights Group on Behaviours (SPI-B) on how behavioural science could help people to take up the measures recommended by experts. Government provided clear messaging and information about what was needed and why, using experts to help communicate this. The adoption of masks and regular handwashing, amongst other changes, was consequently widespread. Separately, government also employed a multi-tool approach, using information provision alongside regulation and healthcare to significantly reduce the rate of smoking.

876. **Supporting people to make green choices at the scale required to deliver net zero is a big challenge.** A multi-lever approach, backed up by a clear and consistent policy framework, and which learns from previous interventions and behavioural science, is needed. This is an overarching issue, which requires a joined-up solution, alongside the sector-specific action set out in sections 5.2 and 5.3, and in parallel to interventions that bring down costs and make low carbon choices more accessible.

Affordability – Bringing down costs

877. **Citizens Advice told us that "the largest barrier to consumer uptake across a range of low carbon technologies remains the initial upfront cost."**[609] Half of those surveyed by Opinium who felt that current net zero measures are not working well attributed this to high costs, particularly upfront costs in sustainable transport and home heating.[610]

878. **New analysis undertaken by the Review shows that cost savings will take time to materialise, and not every household will gain.** The average household will save £400-£6,000 cumulatively by 2050.[xxx] With some of the policies suggested in the Review, this could go further – as much as £14,000 with electricity-gas price rebalancing. However, these savings are not immediate – according to our analysis they will not have materialised by 2040, when the average household will still have borne a cumulative cost of £4,000-£6,000 because of long pay-back periods from the investments (e.g. savings from better home energy efficiency).[xxxi] In some cases, there will not be a net saving by 2050 at all – unless the government acts.

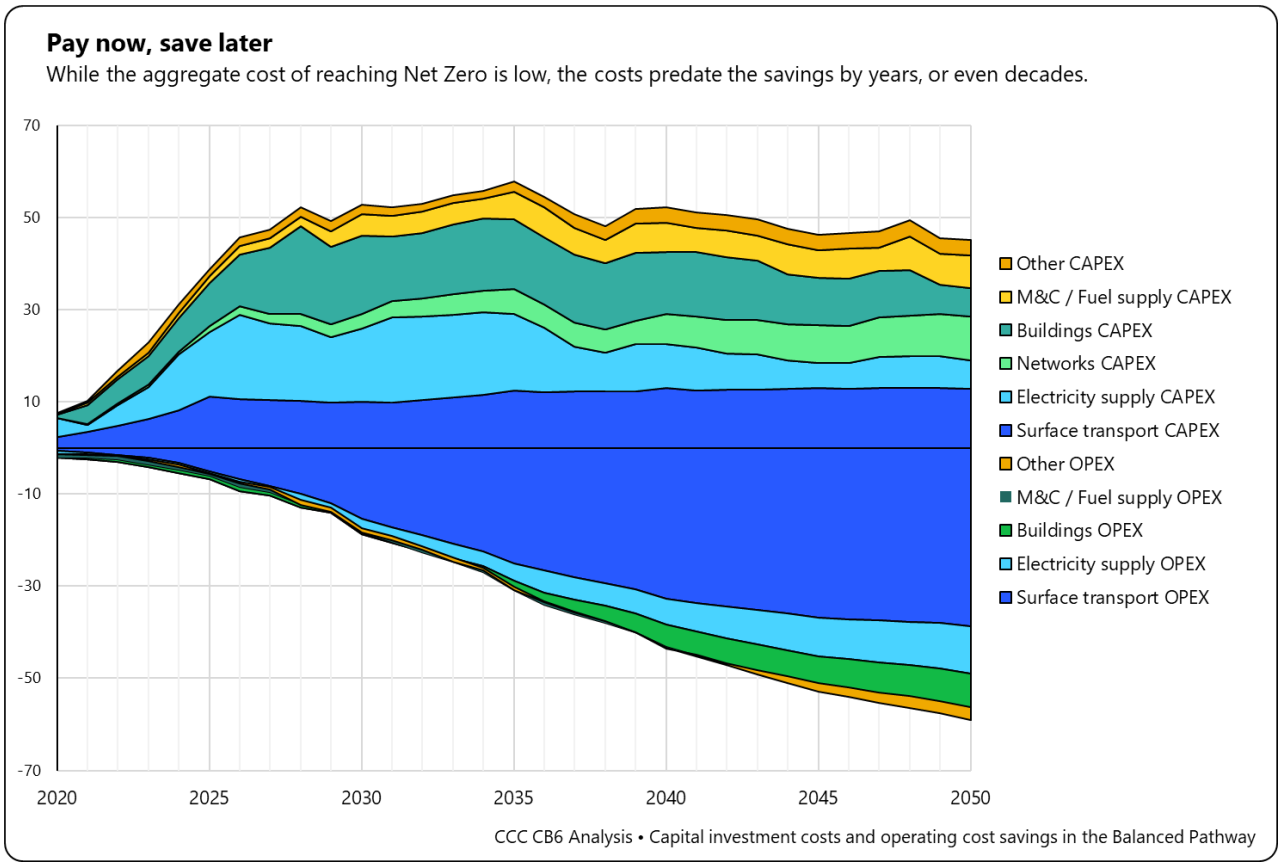


Figure 5.3 – ***Aggregate cost of reaching net zero***

[xxx] 2021 prices, undiscounted. Not accounting for any potential future changes in fuel duty.
[xxxi] In some scenarios. In scenarios with very high fossil fuel prices persisting (gas over 150p/therm) and average heat pump COP of 350%, the cumulative cost by 2040 is under £250.

879. **Support for low-income households remains essential.** Our analysis shows that even with additional measures to reduce the overall cost of the net zero transition for households, only 1.6% (or 450,000) households still would not make an overall saving by 2050. [xxxii] In scenarios with rebalancing and a 2033 backstop,[xxxiii] those households could break even with a £900 million (or £2,000 per household) well-targeted subsidy over the course of the whole transition. For many people, the long payback period means that even if they do break even or save by 2050, going ahead with changes to decarbonise their home and transport won't feel worthwhile. Government must take action to reduce costs and address these multiple barriers.

880. **Not only is supporting these households the right thing to do, but it promotes growth, unlocks significant health benefits and is popular.** National Energy Action (NEA), in conjunction with Newcastle University, have found that decarbonisation measures focused on low-income households boosts demand in the economy more than if measures are targeted at average income homes, unlocking £5.6 million compared to £4.7 million.[611] This is because those on low incomes are more likely to spend a larger proportion of any additional income in their local communities, while higher earners are more likely to invest overseas or to put money into savings. HMT's *Net Zero Review* also concluded that targeting support at low-income households would be most effective.[612] Additionally, as lower income households generally live in colder homes, they are more likely to see improvements to their health from moving to more efficient properties, resulting in fewer sick days and improved productivity. NEA told the Review "insulating fuel poor homes will have a direct impact on economic productivity."[613] Moreover, all groups are much more likely to support policies if they believe they benefit those most in need.[614]

881. **It is vital that government takes action to ensure the distributional impacts of the net zero transition do not unfairly fall on certain groups or those living in certain locations, exacerbating inequalities.** With smart policy design, net zero policies can be a vehicle to address some of these issues and improve the financial situation of all household types, including those which would lose out otherwise.

882. **Our analysis has found that various measures can make a significant difference to the way that costs and benefits are distributed, and can increase the overall savings households stand to make.[xxxiv]** These include: increasing the number of people with access to an overnight tariff to charge their electric vehicle, increasing the heat pump 'coefficient of performance' (i.e. the relationship between the power (kW) that is drawn out of the heat pump as cooling or heat, and the power (kW) that is supplied to the compressor) and decreasing heat pump and electric vehicle capital costs. These measures (discussed in detail in the *Transport* and *Homes* chapters) significantly reduce the number of households who do not save by 2050 and decrease the level of support needed if government were to try to ensure that all households break even. These measures should be taken forward alongside other interventions to make the transition more affordable, improve accessibility and empower people.

[xxxii] These are: low-income social housing tenants in urban areas on the gas grid, and low-income owner-occupiers in urban areas on the gas grid, adding up to 450,000 households.

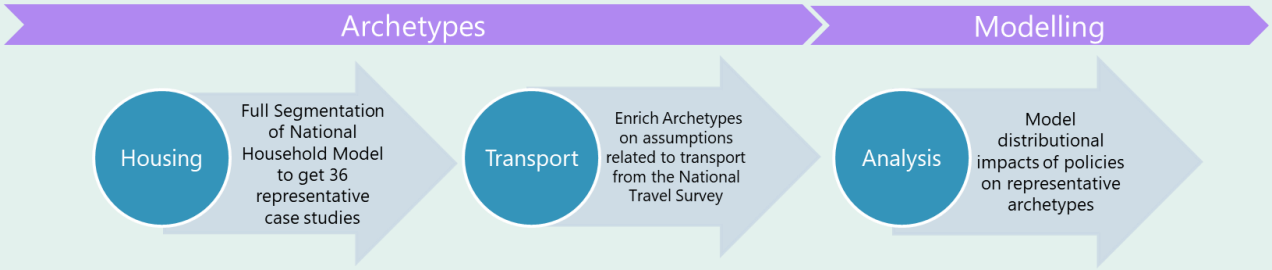
[xxxiii] Explained in detail in ***Pillar 2*** and recommendations section of this Pillar

[xxxiv] Above the many measures already set out in the *Heat and Buildings Strategy*, which are also paramount.

Focus Box: Net Zero Distributional Analysis

Our model estimates the distribution of costs to households under different low-carbon heat and transport policies required to deliver net zero. We consider annual bills and capital expenditure until 2050 and test multiple variables which affect the costs and benefits from the transition: fossil fuel prices, heat pump cost and coefficient of performance (COP), electric vehicle prices and types, and simple variations in current policy design. Costs and benefits are presented in 2021 prices, taking into account inflation but not applying the Green Book discount rate which decreases the measured value of costs and benefits which happen far in the future.

For the fullest analysis of policy impacts, we chose household case study types which together add up to 99% of the UK housing stock. Fuel usage and heat demand of these archetypes were taken from the National Household Model and data on transport behaviours predominately from the National Travel Survey.



The results have allowed us to form additional policy recommendations in the areas of transport and low carbon heating.

Due to time constraints and the complexity of the UK housing stock, this analysis makes some simplifications. We have not considered:

- Differences between households which fall into the same case study type;
- Regional differences;
- Ethnicity-based distributional impacts;
- Age-related distributional impacts;
- Impacts of any potential future changes in fuel duty, which could decrease the relative price of petrol vs. electricity. This brings the Exchequer's yearly revenues of the range of £26 billion, which, from 2037 onwards, is less than the annual total of household savings from the net zero transition modelled here if our proposed policies are taken on board (totalling £46 billion per year by 2050);
- Any specific analysis of households eligible for heat networks or modelling use for hydrogen for heat. This model simplifies the transition, effectively assuming that every household not currently heated with electricity could end up with a heat pump after energy efficiency measures bring its EPC rating up to EPC C. Households currently heated with electricity are assumed to retain their mode of heating supply;
- Analysis of the 1% of UK households using coal.

These limitations could be improved upon with dedicated time and resource, and we urge Government to take this forward.

Accessibility – Improving access to skills, services, and infrastructure

883. **Accessing green services or technologies can be harder for certain regions or groups, and action is needed to ensure that no one is left behind.** For example, the Review heard that there is a gulf between public transport services in rural areas and those in cities, making it harder for those in rural areas to switch from using cars. Renters can find it harder to access energy efficiency measures, as they are largely dependent on landlords or councils to make decisions about retrofitting, and this can result in tenants paying higher energy bills than owner-occupied households. Although many people are concerned about climate change and want to take action, many are time-poor and face other more immediate priorities, so navigating the bureaucracy that can be associated with accessing support can be challenging. 7% of people in England in 2020-21 did not have access to the internet at home, which can also make accessing support, services and products more difficult.[615] Often these issues compound for lower income households, who are more likely to rent and less likely to have access to home computers. Making green choices easy for everyone is essential.

884. **Difficulty accessing the skills and products needed to install or purchase green goods can act as a further barrier.** Even for those who can afford green choices and who do not face specific access barriers, skills gaps or limited supply chains can make it harder to find the services and products needed to enable switches to green technologies. This can also damage confidence, as people may be concerned that the skills and spare parts needed to repair or maintain green technology may not be readily available. Skills and supply chains are considered in ***Pillars 2 and 3***, with some specific recommendations relating to the key issues individuals face included here.

885. **While net zero will be a net positive for jobs, some will see work in their regions or demand for their skillsets decline**; ensuring these groups can access new jobs and develop new skills will be vital to delivering a fair transition. This is explored in ***Pillar 3***.

5.1.4 Ensuring net zero works for everyone

886. **We need to ensure net zero works for everyone.** Government should ensure that people are empowered to be agents of change and that green choices are affordable and accessible. It should ensure that the transition is fair and does not leave anyone behind.

Public engagement

Government to publish a **public engagement plan for England by 2023,** to ramp up public engagement on net zero.

887. **Awareness of net zero and of what it means for people needs to be improved.** BEIS' Public Attitudes Tracker shows that while 89% of people have some awareness of net zero, 41% say they know only a little or hardly anything about it, and while 83% are concerned about climate change, 15% are not.[616] The survey shows a correlation between concern about climate change and people making green choices: 65% of people who are very concerned about the climate consider energy efficiency when making a purchase, compared to just 32% of those not concerned.[617] The Review has shown that even without the need to reduce emissions, net zero measures make sense because they can provide cost savings and other benefits. We have heard that many people do not recognise the urgent need to take action and the many benefits that the transition can bring.

888. **Those who do want to take action lack clear, trusted information and advice.** Most people already think they are doing enough and are not clear on what further changes they may need to make during the course of the transition.[618] For those who do want to take action, knowledge of the options and their co-benefits is limited: Citizens Advice told the Review that "awareness of certain net zero technologies and their benefits remains low, and can be a barrier to their uptake."[619] BEIS' Public Attitudes Tracker shows that 47% of people feel that there is so much conflicting information that it can be difficult to know what to believe.[620] Often people do not know how best to prioritise actions, e.g. whether to install a heat pump before improving energy efficiency. There are also some common misconceptions which can limit the effectiveness of people's actions, e.g. many people expect to switch heat pumps on and off like a conventional boiler, rather than to leave them on permanently. Opinium's survey showed that 20% of people could benefit from advice on how to reduce their carbon footprint.[621]

889. **The Review recommends that Government ramps up engagement with the public on net zero and publishes a public engagement plan for England by 2023.** The Review heard that "we need to develop more positive visions of the future", which engage people and sell the benefits of net zero to them.[622] Government should provide clear, honest and positive messaging about what changes people will see during the transition, and where and why action from them might be needed. This should focus on the measures with the greatest carbon and economic impacts. It should demonstrate to people the many benefits that net zero will offer them, as well as being frank about the challenges.

890. **Engagement should consider how the transition will affect different groups in different ways, while reinforcing the message that no one should be left behind.** It should also consider how engaging people at the right moment in time (e.g., when buying a house) can help to inspire action. At the same time, it should recognise the need to make green choices more affordable and accessible. The Scottish Government has already published a net zero public engagement strategy (*Net Zero Nation: public engagement strategy*) and the Welsh Government is currently consulting on one. Many stakeholders have called for an engagement strategy for England, including most recently in the House of Lords' inquiry into behaviour change and net zero. Government should learn from the strategies published by other nations.

891. **Government should work with trusted actors to improve outreach.** Clear messaging from government is important and can enable other actors to act and communicate with confidence, but we know that government is not the most trusted source on climate issues and that different groups can be reached in different ways. Experts, local authorities, businesses, the media, teachers, faith groups, friends and relatives all have important roles to play in inspiring individuals to engage with net zero. Some initiatives already exist, for example all schools will be required to have a climate action plan in place by 2025, which should include ensuring that teachers are delivering climate education to students.

892. **The government's engagement strategy should consider how it can work with trusted groups to engage and inspire, and how existing initiatives can be supported to go further.** It should also consider the development of the evidence base on behavioural science relating to net zero. ***Pillar 4*** considers how action at the local level can also help to engage communities around the country.

893. **Government should consider how different points of contact in people's lives can be harnessed to engage them on net zero.** For example, government should work with energy companies to consider how energy bills could be used to communicate with households about the actions they could take to reduce greenhouse gas emissions in their home.

894. **And government should listen to the concerns of the public too, including those who are nervous, anxious, and even hostile to any future energy transition.** It is key that engagement takes place across all communities, political parties, and communities in the UK. We must take a whole of society approach to net zero that engages with everyone, not merely those who are willing make changes. Indeed, rather than simply imposing measures on people, individuals should be involved in shaping the actions that will affect them and should be trusted to do the right thing; this is about empowering people to make the informed choices they want to make, not telling them what to do.

895. In 2020, the Climate Change Assembly brought together over a hundred members of the public to discuss what the UK should do to reach net zero, but since then opportunities for the public to be involved in national conversations about net zero have been lacking. Government should learn from models such as this and consider how these perspectives can be gathered routinely. Improved monitoring of green choices (discussed later in this chapter) will help to ensure that people's attitudes and behaviours are reflected in government policy.

896. **People should be supported to reduce emissions from the things they consume, should they want to.** Government should ensure that consumers have the information they need to make informed decisions about their dietary choices, the goods they purchase, and the actions they take. This should take place alongside government ensuring that green choices are affordable and easy for people to make. Government should also look to improve the evidence base on how consumers can best be supported to reduce their emissions.

Carbon Calculator

Government to run a competition to create a Carbon Calculator to inform consumers of the carbon intensity of different choices, in 2023.

897. **Alongside enhanced public engagement, action is needed to ensure that people have the information they need to make green choices where they want to. The Review recommends that the government launches a competition to create a Carbon Calculator app in 2023.** This should provide people with information on the carbon intensity of different choices, from how they travel to what they buy at the supermarket, allowing people to make informed choices where they want to. This should show people the costs of different options and the potential financial savings by making lower carbon choices, as well as the other co-benefits. Where relevant, it should point people to where they can access lower carbon options, and link to any support packages that exist. This should be backed up by a government communications campaign to introduce this new resource.

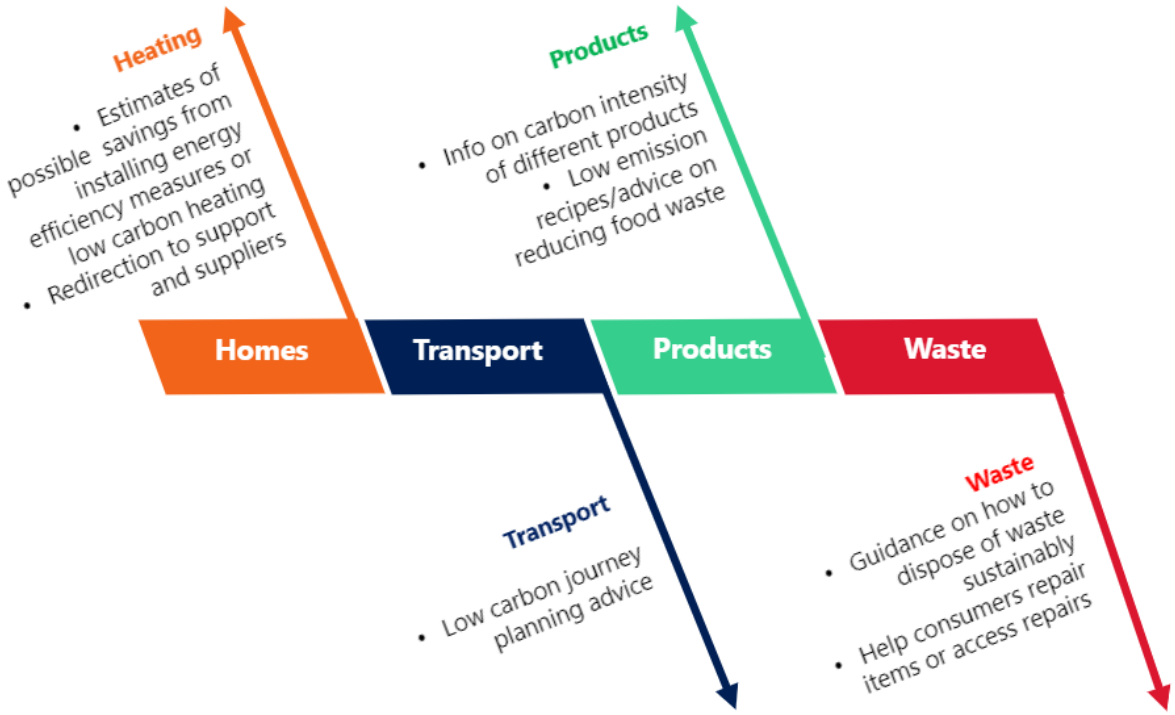


Figure 5.4 – *Carbon calculator proposal*

Ecolabelling

Government to **pursue ecolabelling to help consumers make more informed purchasing decisions**, by 2025.

898. **We recommend government pursues ecolabelling to help consumers make more informed purchasing decisions.** Some ecolabels already exist, however there is low take-up of these by businesses and low awareness of them amongst consumers. A lack of confidence about whether green claims made on products are authentic is also denting consumers' confidence: the Review heard that "labelling needs to be standardised."[623] Government has committed to exploring standardised ecolabelling for industrial products (e.g. glass, paper, chemicals) and should aim to roll this out for as many products as possible from 2025. Ecolabelling should be aligned across different products, to make it easy for consumers to recognise sustainable items. On food, government should continue to work with industry, via the Food Data Transparency Partnership, to develop a mandatory methodology that could be used for ecolabelling. This should prioritise setting a metric to monitor carbon impact. Government should continue to work with industry to ensure that the methodology is used to provide clear information to consumers. Government should consider how other sectors could also benefit from standardised ecolabelling.

899. **Using labels to provide information about how consumers can look after their purchases can help to maximise their lifespan and ensure cost-effectiveness.** The Review has heard that "we need clear recycling labels. People don't know what to do with their recycling at the moment."[624] Thinking on ecolabelling for non-food products should consider what information consumers need in order to look after, repair and dispose of products sustainably.

900. **Information and advice relating to energy efficiency is considered in section 5.3.**

Understanding public attitudes

901. **Monitoring is essential to understand what is working and where further action is needed.** Currently, different government departments and businesses use different methods to monitor green choices, meaning there is no central pool of evidence. Both the BEIS Public Attitudes Tracker and the Office for National Statistics UK Climate Change Statistics Portal gather evidence on green choices, but there is no commitment to continue to use these tools for this end long-term. The Review supports the House of Lords' finding that government should commit to regularly using one of these polls to collect data on people and net zero, from 2023.[625] Government should also consider whether further action is needed to better capture data on the green choices that the public make. Any survey should ask about the demographic characteristics of the person responding, their attitudes to climate change, the actions they are taking or planning to take to address it, and any barriers they perceive. This data should be reported through the new data portal recommended in ***Pillar 1***.

Embed thinking on green choices into policymaking

902. **Thinking on green choices should be at the heart of developing, implementing, monitoring, and evaluating policy.** Policies should be clear, consistent, and easy for people to follow and predict. Measures that consider the wants, needs and motivators of people are likely to be more successful than those that do not. As the transition to net zero increasingly requires action from individuals, embedding this thinking into policy development becomes increasingly vital.

903. **Guidance for national and local government and partners on behaviour change is available but not widely known about and not specific to net zero.** Government should consider how this guidance can be updated and better communicated, to support net zero, in 2023. Updated guidance should consider the latest academic research on behaviour change, as well as the findings that the government gathers from its increased engagement and understanding of people's experiences of net zero. It should also reflect the need to take account of how measures can impact different groups in different ways, and the need to ensure that policies are fair.

Distributional analysis

Government should develop the **distributional analysis of net zero policies** started by the Review in 2023.

904. The distributional analysis of net zero policies discussed above should be further developed by government.

The price of electricity

905. **Ensuring electricity is cheaper than oil or gas is essential to incentivising people to switch to low carbon technologies like heat pumps and electric vehicles**. Environmental levies placed on electricity mean that, without the Energy Price Guarantee, electricity is more expensive than gas. Government should deliver the Review of Electricity Market Arrangements (REMA) promised in the *British Energy Security Strategy* and rebalance these costs (as set out in ***Pillar 2***). Analysis done in this Review shows that the relative price of gas and electricity is the largest determinant of the savings which households could gain from the transition – for example, a long-term gas price of 150p/therm can cause cumulative savings of decarbonised households to increase from £6,000 to over £13,000 by 2050. In the short-term, government should ensure there is a clear price signal in favour of technologies that use electricity rather than fossil fuels.

5.2 Maximising benefits for people: transport, products and waste

906. **Action is needed to ensure that individuals can maximise the benefits net zero has to offer across the key areas that it interacts with them.** This section sets out how government can help people reduce emissions from the way that they travel, the products they consume and things they throw away, and realise the benefits of doing this.

5.2.1 Transport

907. **Sustainable transport can deliver positive impacts** on health, air quality and local environments, as well as creating opportunities to reduce costs.

908. **Many people recognise the benefits that sustainable transport offers**, as demonstrated by electric vehicle sales exceeding expectations in recent years.

909. ***Pillar 3*** considers how the transport sector can benefit the economy. **This section reflects on how sustainable transport options can be made cheaper and more accessible to people.**

Cut congestion and carbon

910. **Choosing active travel or public transport, or using shared services, instead of a private road vehicle, can provide carbon savings, cut congestion, and deliver other benefits.** There is a risk that as electric vehicles become more affordable and cheaper to run, more people turn to driving and congestion could increase. Similarly, increased uptake of some types of transport services, such as ride-hailing or goods deliveries, could increase car journeys. Congestion could rise from 9 to 32 hours a year by 2040, with costs from £59.5 billion to £121.5 billion.[626] This not only wastes people's time, but also creates higher costs for drivers, dents productivity and increases air pollution. Scotland have set a target for reducing the number of journeys taken by road and published a roadmap for delivering this.[627] Some countries are using fiscal measures like road pricing to discourage driving. The Review has received calls for interventions like these to be replicated, and notes that it is important that the government considers how congestion can be avoided.

911. **People must be brought along on this journey.** We have heard that:

> *"We need more honesty about the need to reduce private car use from government."*
>
> *"It is important that we help people to get a better understanding' [of the carbon impacts of their transport choices]".*
>
> *"Consumer understanding of their choices is far too limited." (comments made at Transport roundtable held as part of the Review)*[628]

912. **Government should use the public engagement strategy recommended above to communicate to people the need to reduce car journeys and the benefits of doing this.** The carbon calculator tool above should include information on the carbon intensity and costs of different transport options, including sharing options like carpooling, to support low carbon journey planning. There should be clear guidelines for businesses on how to calculate their carbon impact to ensure transparency for consumers.

913. **Enable individuals to identify appropriate actions as part of wider communities.** As part of the *Transport Decarbonisation Plan*, government committed to exploring a sustainable travel reward scheme to encourage use of sustainable travel, allowing different types of communities to set targets, monitor progress and receive rewards for achieving those. Government should bring forward its proposals on this.

914. **Supporting people to switch to public transport or active travel requires a combination of actions to ensure that these options are readily available, affordable, and attractive to individuals,** explored throughout this chapter.

Active travel

915. **Active travel is low-cost and can improve people's health and connections to their local area and high street, but a long-term approach is lacking.** Those who walk, wheel or cycle, rather than drive, spend on average 40% more on their local high streets, and contributed £6.5 billion to the economy in 2021.[629] Government analysis shows that high-quality cycling infrastructure, like cycle paths and bicycle storage, can increase levels of cycling on average by 37%, with benefits for people's health and local highstreets.[630] But bicycles, particularly electric ones, have upfront costs which can make them harder for lower-income groups to access. Cycle to Work schemes cover these upfront costs, with payments being deducted from wages in a way that is tax efficient and can save money. The government provides funding to local authorities for active travel through its Active Travel Fund. Up to £8 million will be spent piloting a programme to accelerate e-cycle uptake by offering short and long-term loans to people in Greater Manchester. The £200 million overall fund will focus on improving active travel infrastructure, making it easier for people to walk and cycle. However, stakeholders have highlighted that there is a lack of long-term funding and that the scheme will only support certain local authorities. **The Review recommends that the government commits to long-term funding for active travel, to ensure that more people will benefit.**

CASE STUDY: France's E-Bike Programme

The French Government are encouraging people to use bicycles and e-bikes instead of travelling by car. They want to increase the number of people travelling by bike to 9% by 2024. Residents are offered up to €4,000 for trading in an old car and instead purchasing a bicycle or e-bike, or up to €400 if not swapping from a vehicle. Low-income urban groups are prioritised in the scheme.[631]

Public transport

Government should **amend the regulatory framework to incentivise transport providers to increase demand and improve services,** and that it works with them on this vision, by 2024.

916. **The Review has heard repeatedly that the expense of public transport is a deterrent to people.** Public transport costs have risen faster than car travel since 2010.[632] This particularly affects those on lower incomes, who are also less likely to own a car and so are more dependent on public transport. Transport poverty is not officially defined in the UK, but Green Alliance has argued that the number of people unable to "attain a socially and materially necessitated level of transport services […] is almost certain to have increased during 2022" due to price rises and service cuts.[633] When coupled with fuel poverty, this creates a "double energy vulnerability".[634] By limiting people's ability to travel to jobs outside their immediate area, transport poverty can exacerbate the problem. For those who can afford to own and run a car, the costs of public

transport mean that there is little incentive to choose it even for journeys that could easily be done by train or bus. The coronavirus pandemic also had an unprecedented impact on how we travel, with public transport having recovered slower than car journeys. Many countries are now bringing down the costs of public transport to incentivise usage.

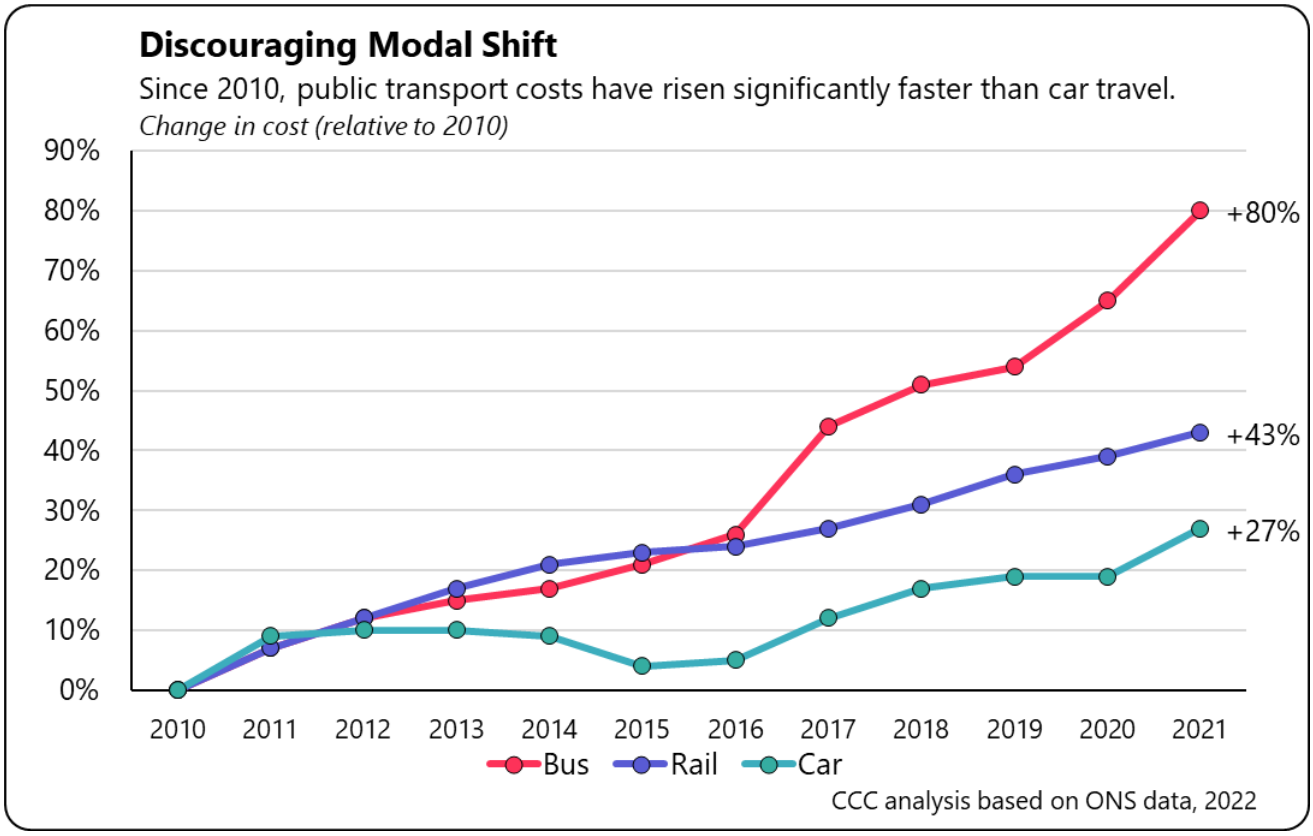


Figure 5.5 – *Cost of public transport*

CASE STUDY: Germany's Deutschlandticket

Germany have recently announced that unlimited regional public transport across the country will cost just €49 per month next year, with the aim of cutting emissions, helping with the cost of living and supporting domestic tourism. The 'Deutschlandticket' will cost around €3 billion per year and is funded by both federal and state governments.

This follows a trial in which a monthly ticket for all public transport for three months cost just €9. The trial saw significant increased take up of public transport: over 52 million tickets were sold and, according to a survey by the Association of German Transport Companies (VDV), around 20% of users had rarely used public transport before, with around 10% of trips replacing journeys that would otherwise have been done in cars. 37% used it to travel to work.

Emissions were reduced by about 1.8 million tonnes of CO_2 and traffic jams were reduced in 23 of the 26 cities surveyed.[635]

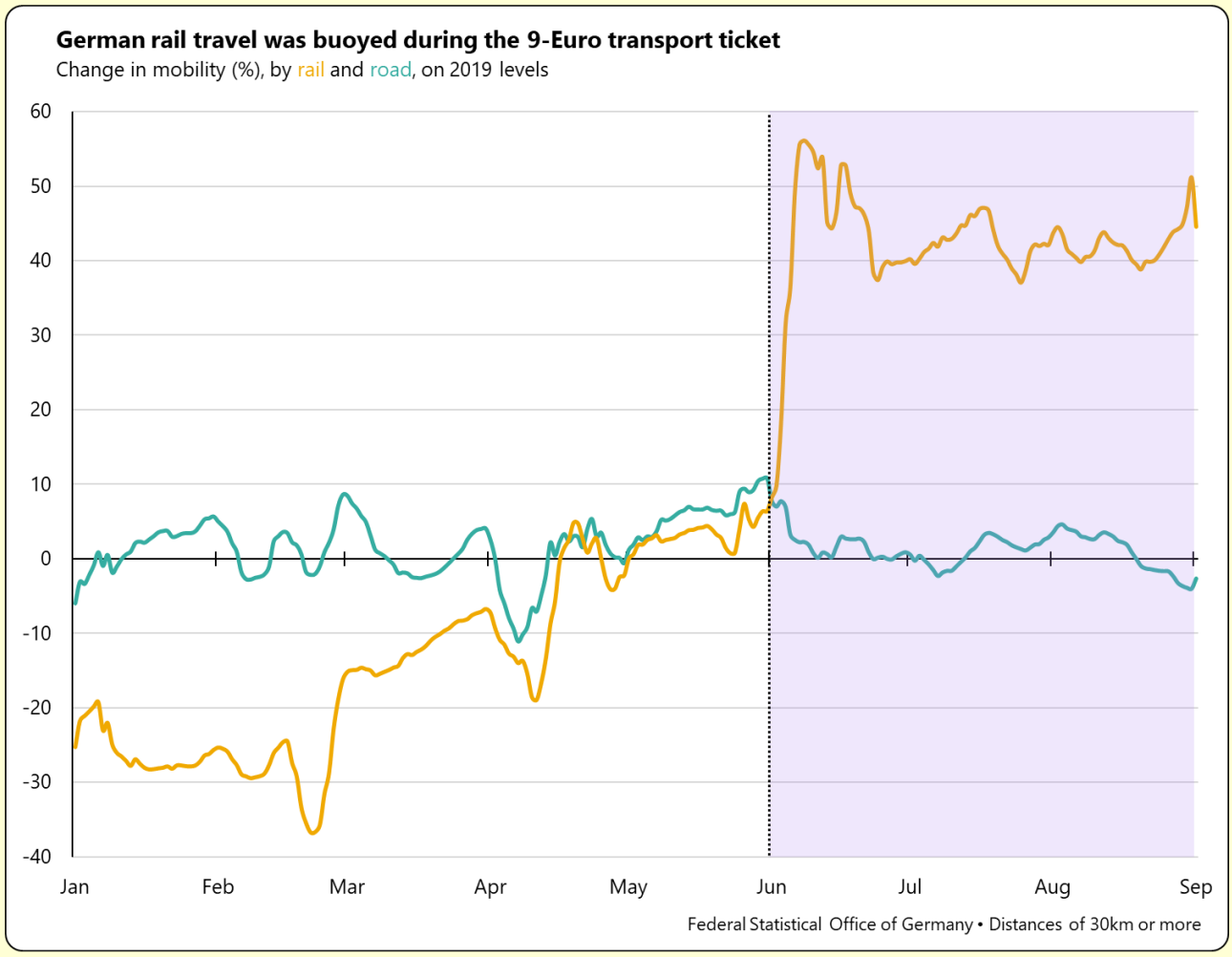


Figure 5.6 – *Germany case study*

917. **Government must act to reduce the costs of public transport.** Government recognised this in the *Transport Decarbonisation Plan* and has set an intention to make public transport better value and more competitively priced. Further action is still needed. The House of Lords inquiry into net zero and behaviour change heard that reduced costs could be delivered through a reprioritisation of funding away from large road and major infrastructure projects, as well as from new revenue-raising measures.[636]

918. **The Review heard that there is a gulf between public transport services offered in some regions compared to others.** As well as costs increasing, the volume of services on offer has been reduced in many areas, again affecting lower income households most. This is also likely to present particular challenges for people travelling with children, and disabled people, who often require more space than other passengers. 28% of people surveyed by Opinium thought that transport options could be improved.[637] Many countries are enhancing their public transport networks. Paris will soon have Europe's largest Metro network, with the Grand Paris Express. Germany is investing an additional €35 million in improving and expanding Berlin's public transport system. ***Pillar 4*** sets out how local communities across the UK could become '15-minute neighbourhoods.' The government should learn from the initiatives other countries have implemented to reduce public transport costs and consider how funding reprioritisation could help to deliver this in the UK.

919. **Long-term finance is also required for initiatives to decarbonise the existing transport fleet.** In response to the review, businesses highlighted the value of initiatives like the Zero Emission Bus Regional Areas (ZEBRA) schemes, which has helped businesses and local authorities to roll-out zero emission vehicles. However, there remains uncertainty about what future support will be available.

920. **Government should amend the regulatory framework to incentivise transport providers to increase demand and improve services, and that it works with them on this vision,** as set out in the government's plan for Great British Railways.

Intermodality and flexibility

921. **Intermodality – enabling people to take different modes of transport to complete a journey, for example cycling to a station and then riding the train – can make sustainable transport easier and more appealing.** Currently intermodality is not at the heart of transport planning, for example the Review heard that "in community rail [a grassroots movement working to engage communities in their local railway] the lack of integration is a huge barrier, and it is hugely challenging working at community level to get modes [of transport] working better together."[638] The Review also heard that "more flexibility has economic benefits in terms of having a resilient population with multiple ways to get to work."[639] ***Pillar 4*** considers how local authorities can support more sustainable travel, including through the use of spatial planning.

Electric vehicles

922. **Electric vehicles should be accessible for those who need them.** The market and current incentives available are succeeding in bringing down the costs of electric vehicles. Electric vehicles typically require a greater upfront investment but have lower running costs than petrol or diesel counterparts. Though government grants for electric passenger vehicles have ended, incentives are in place to promote uptake, e.g., exemptions from vehicle excise duty (until 2025), as well as the upcoming zero emission vehicle (ZEV) mandate, which will require manufacturers to sell a growing number of electric vehicles in the run up to 2035 (see ***Pillar 3***). Sales of electric vehicles have surpassed expectations: demand for electric vehicles is anticipated to result in a market share for battery and plug-in hybrid electric vehicles) of 22% in 2022, reaching 27% in 2023.[640] However, sales have so far been concentrated amongst higher earners. As the market grows, spurred on by the ZEV mandate, we are likely to see electric vehicles increasingly filter through to the second-hand market, offering lower prices and making them more affordable for lower income households. Government is providing research and development and supply chain support, which will help to reduce the costs of electric vehicles

(and chargers) further. Government should maintain and deliver on planned regulations, funding, and incentives to accelerate electric vehicle uptake and avoid undermining progress, as set out in ***Pillar 3***. This will help to develop a second-hand market over time.

Electric vehicle charging

Government to **equalise VAT on public and private electric vehicle charging** in 2024.

923. **Savings from the lower running costs of electric vehicles are drastically reduced when a household does not have access to home charging.** Installing home chargers comes with high upfront costs, though support is available through the *Government's EV Chargepoint Grant* and is now focusing on rented properties and flats. Not everyone has access to off-road parking; high-income households are 50% more likely to have a garage or off-street parking than lower income households.[641] At the start of October 2022, the UK had nearly 35,000 public standard, rapid and ultra-rapid electric vehicle charging devices, with more than 1,200 new rapid chargers and over 5,000 new standard chargers installed during the first nine months of the year.[642] With nearly 250,000 new plug-in registrations during the same period, that is just one new standard public charger installed for every 50 new plug-in electric vehicle registrations.[643]

924. **Prices at typical on-street charge points can be around two to three times higher than home electricity**.[644] Currently, home chargers command just 5% VAT, while VAT for public chargers is set at 20%. FairCharge have led a call for the government to cut VAT on public chargers, backed by 23 companies.[645] **The Review recommends that VAT on public and private electric vehicle charging be balanced.**

925. **For those dependent on public chargers, accessing them in some areas can be particularly difficult; some regions are 'blackspots', meaning people have to spend more money driving longer distances in order to charge.** For example, London has approximately 31% of the UK's chargepoints, while the North East has just 3%.[646] Government has published an *Electric Vehicle Infrastructure Strategy (EVIS)*, setting out its expectation for a minimum of 300,000 public chargers to be available by 2030. The Climate Change Committee (CCC) sets out that the government intends to rely primarily on competition to close the price gap between home and public charging, however there is little evidence to date that this is happening. Government should deliver the ambition set out in the *EVIS* and this should not be left only to private companies to deliver. Government should build on the Local Electric Vehicle Infrastructure pilot and enhance cooperation with local authorities to enable them to take a leading role in vehicle charging roll-out. A 'broadband style' approach should be taken to ensure that chargers are spread out fairly across the country. We need a complete chargepoint grid and full access to this across the UK.

Overnight tariffs

926. **Those who do have access to a home chargepoint can reduce costs further by charging overnight.** The Review's analysis found that if 50% of people with home charging use an overnight tariff (modelled on the current 'Intelligent Octopus' tariff), they could make annual savings of £250 by 2040 or £600 by 2050 on average. By charging overnight, people will call on the grid when demand is lowest. Those on time-of-use tariffs (where suppliers charge different prices for using energy at different times of the day) can save households money. To enable this for more households, the government should continue with plans to ensure that as many households and businesses as possible benefit from smart metering and should work with the

sector to increase the provision of new energy supply propositions in the retail market – including smart time-of-use tariffs. It is important to recognise the potential of smart systems and other household technologies for reducing energy demand. The need for smart, flexible solutions to help balance the power grid is also set out in ***Pillar 2***. Households that also have solar panels installed can bring down costs further, by using energy from them to charge their vehicle. Additionally, 'vehicle-to-grid' technology allows electric vehicles to be used to store energy which can then be sold to the energy grid, which could cut down costs for consumers significantly.[647]

5.2.2 Products and waste

927. **A circular economy can benefit in multiple ways**, offering more durable and efficient products which can be more cost-effective.

928. **Many people are taking action to reduce greenhouse gas emissions from the things they consume**. For example, nearly nine out of ten households recycle regularly.[648] The choices consumers are making are already shaping businesses actions:

> *"Growing consumer interest in local sourcing and traceability has encouraged retailers to look closely at how they can [reduce their greenhouse gas emissions]."* – British Retail Consortium (BRC)[649]

> *"Consumer concern about climate change is at an all-time high and our brands are dramatically rethinking what they do to respond to consumer concerns, and to stay relevant for the future."* – Unilever[650]

929. ***Pillar 3*** sets out a national mission to move towards a circular economy. In this section, the Review considers **how individuals can be supported to buy, look after, and dispose of products in a way that benefits the consumer and contributes to this mission.**

Consumers' role in a circular economy

930. **People need to understand the benefits of moving to a circular economy and need clear advice to inform their purchasing decisions.** The Aldersgate Group, an alliance including multiple industry stakeholders, has called for government to:

> *"Conduct public awareness campaigns to build consumer confidence and grow the demand for resource efficient products and business models."*[651]

> *"Although data shows that a significant majority of consumers are already changing their purchase preferences based on sustainability, consumers are often not aware of the environmental consequences of many of the common products they purchase and therefore their best intentions can go unfulfilled."*[652]

931. We heard from WRAP, (the Waste and Resources Action Programme, a climate action NGO) that:

> *"Raising public awareness to the same level we see on energy efficiency and energy bills, we could generate much greater consumer understanding which should lead to less waste and lower food bills."*[653]

932. M&S, for example, told the Review that the 'Sparking Change' pilot that they ran in 2021, and which offered consumers information and advice, including on how to reduce food waste and

make more sustainable food choices, helped consumers to reduce the cost of their weekly grocery shop by 39%, an average of £22.[654]

933. **The public engagement strategy proposed in section 5.1 should be used to communicate the value of a circular economy and consumers' roles in it.** This should be used to help build trust amongst consumers, for example by ensuring consumers are aware of their rights when it comes to getting goods repaired. Since the products that reach our shelves have already had 80% of their environmental impact determined at design stage, it is vital that consumers have information about the sustainability of the specific product they are buying, as well as an understanding of why they should consider this aspect.[655] Ecolabelling (discussed in section 5.1) is key to this. With sweeping reforms to the waste system planned (discussed later), specific engagement should be employed to help households understand how changes will affect them.

Reducing food waste

934. **Reducing waste saves people money and reduces emissions.** This is a particular issue for food waste; households throw away up to a quarter of the food they pay for.[656] WRAP (the Waste and Resources Action Programme) is looking to update its *Food Waste Reduction Roadmap*, and this should pay particular attention to how consumers can be supported to reduce waste and save money at home. Government should work with WRAP and industry to deliver this.

Affording and accessing repairs

935. **Currently repairing products can be costly; we need to change this dynamic so that repairing products is cost-effective.** Often people want to repair products:

> *"Rates of repair vary across product types, being most common for clothing and footwear (11% of people said they had repaired an item in the past year) and least common for digital products (6%). 25% of people tried to repair a large household appliance the last time one broke, but only about half of these managed it successfully."* – Which?[657]

936. However, people face barriers to doing this:

> *"People were deterred by the cost of repair relative to replacement (39%), the hassle of getting it repaired (13%) and the difficulty of finding a repairer (10%)."* – Which?[658]

937. **Repairing products should be affordable.** Often it is cheaper to buy a replacement product rather than to repair an existing one. The Review has heard calls for VAT on repairs to be cut for individuals. The Aldersgate Group, for example, has argued "a priority tax reform should be to zero-rate VAT on all repairs."[659]

938. **Accessing repairs should be easy.** For electronics, consumers have a legal right to have access to repairs; Right to Repair Regulations require manufacturers to provide spare parts to consumers or third parties. However, this excludes certain products, like phones and laptops. Which? have called on the government to expand these rules to cover more products and to require spare parts to be made available immediately and for longer, rather than just within two years and for just ten.[660] Even when regulations are in place, it can be hard for people to find professionals with the skills needed to fix their products. Innovative models are helping to fill this gap. For example, Sojo is an app which connects users to local tailoring businesses who can repair damaged clothing. Local repair hubs are also springing up across the country.

939. **The Review has heard of the importance of people knowing "that they can trust the professionals and tradespeople who advise them and where needed refit, repair or install.** If things should go wrong, they must have a simple, but reliable route to effective redress."[661] The Aldersgate Group has argued for warranties and safety guarantees to be applicable to remanufactured and refurbished goods, to promote trust.[662] Government should consider how repairs can be made more affordable and accessible to consumers.

Disposing of waste

940. **Clear, nationwide collection and recycling is key.**[663] The *Net Zero Strategy* announced that the Government would bring forward funding to enable local authorities to collect a core set of materials, including food waste at no cost to households from all homes in England, from 2025. This consistency will allow more homes to dispose of waste properly and make it easier for households to know what and how they can dispose of things. Government has also committed to introducing a deposit return scheme for drinks containers, which would reward people for recycling bottles and cans. This was consulted on in 2021 but the government has not yet published a response. As set out in ***Pillar 3***, these waste reforms should be implemented urgently. Government has also partnered with industry to trial kerbside collections of soft plastics, and government should look to roll this out across the country.

941. ***Pillar 3* sets out further measures to support the transition to a circular economy.**

5.3 Net zero homes, energy efficiency and low carbon heating

942. **Making homes lower carbon by improving energy efficiency – and so reducing energy demand – and installing low carbon heating can provide many benefits**. For households, it can cut bills, improve health and wellbeing, and increase the value of homes. Now is the time for government to create a mission for energy efficiency and low carbon heating. This should focus on making low carbon technologies more affordable and accessible, and ensuring that people have detailed, bespoke information to inform their decision making.

943. **While the UK is forging ahead with the deployment of clean, green energy supply, we are falling behind on reducing energy demand – a necessity for reaching our net zero goals.** Increasing the energy efficiency of appliances and buildings is also a key driver of economic growth, estimated to support up to 175,000 jobs and add £6 billion in Gross Value Added (GVA) to the economy by 2030, and contributes significantly to reducing energy bills. While early indications suggest Europe may stave off gas shortages this winter, the possibility is set to return next year.

5.3.1 Decarbonising homes is essential to delivering net zero, energy security and supply, and reducing energy bills

944. **Homes are at the heart of the net zero equation.** The UK's ~30 million buildings are responsible for ~30% of our greenhouse gas emissions. Direct greenhouse gas emissions from buildings (largely combustion of fuels for heating) currently make up ~20% of UK territorial emissions.[664] Progress has been made in reducing indirect greenhouse gas emissions from the home (e.g., appliances, lighting, catering etc.), as the power sector has decarbonised, but direct emissions from heating have not changed significantly since 2015, as per the figure below.[665]

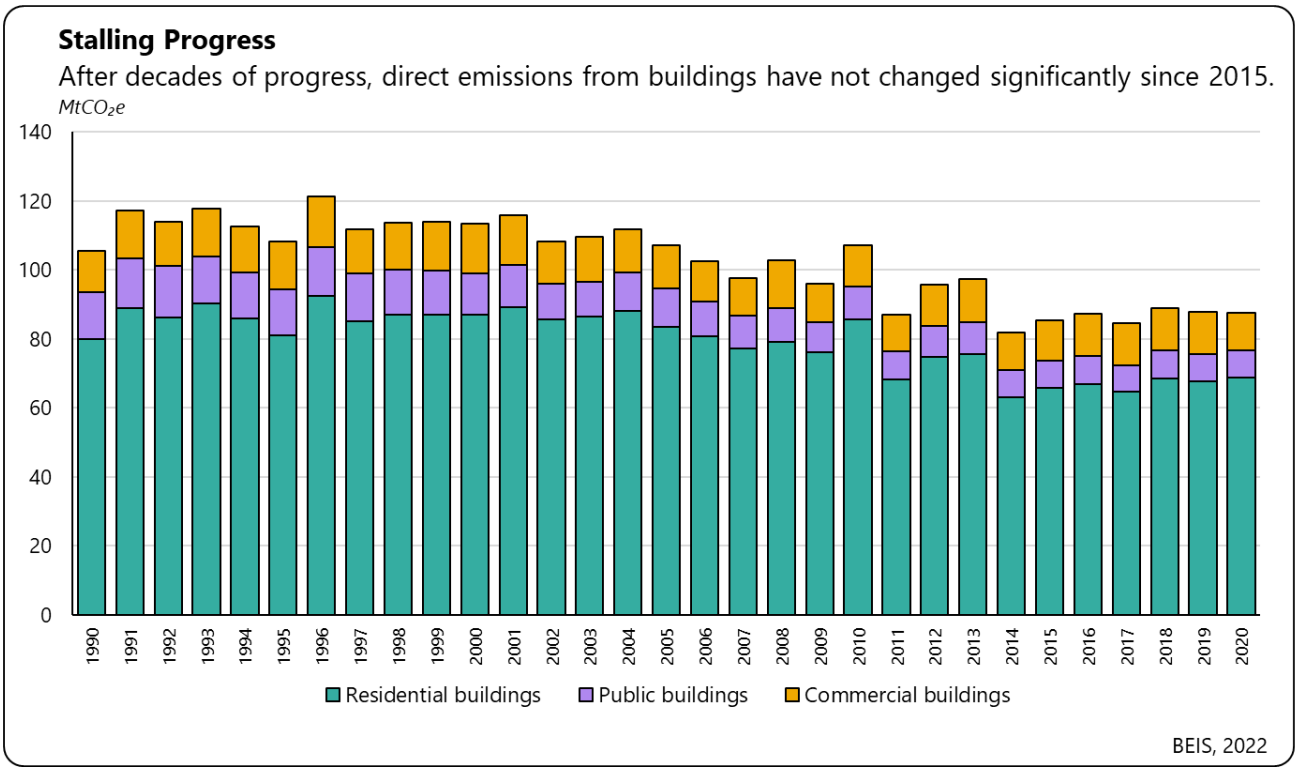


Figure 5.7 – *Direct greenhouse gas emissions from buildings*

945. **Decarbonising homes through energy efficiency measures and low carbon heating will deliver many benefits to individuals**, as set out in section 5.1. In particular, it will:

- Bring down energy bills
- Make homes warmer in winter and cooler in summer
- Add value to homes
- Boost the economy

946. **Crucially, given the current energy context, it will also safeguard energy security and supply.** The Energy Price Guarantee, which is limiting the impact of increased energy prices on households, will be reviewed before April 2023.

947. **The *Net Zero Strategy* and the *Heat and Buildings Strategy* set out the government's ambitions** to significantly cut greenhouse gas emissions from the UK's 30 million homes and workplaces in a simple, low-cost and green way, while ensuring this remains affordable and fair for households across the country. The Interim Uplift,[xxxv] which came into force in June 2022, will result in a 30% reduction in greenhouse gas emissions from new homes.

948. **Key technologies will get us to homes that are net zero**: energy efficiency measures (like insulation) will reduce overall energy demand, while low carbon heating solutions, like heat pumps, will cut our dependence on fossil fuels. These technologies work in tandem with one another. Solar panels will provide home-grown energy which will further help to reduce energy usage. ***Pillar 2*** calls for a 'solar revolution' to ramp up the number of buildings with solar panels installed.

Energy efficiency - reducing energy demand from homes

949. **Energy efficiency – broadly defined as 'using less energy to perform the same task or produce the same result'– has a vital role to play in decarbonising homes and saving consumers money.** [666] The appliances we use in our homes (like cookers and fridges) as well as the building itself (e.g. through insulation) can be more or less energy efficient.[xxxvi]

> *"[Managing demand provides] not only a potentially large financial saving for customers, putting more money in their pocket, but will improve the balance of payments for the country and support the creation of highly skilled jobs consistent with the government's growth and levelling up agendas."*[667]

950. **The cheapest energy is the energy that we do not use – and energy efficiency offers other benefits too.** Improving energy efficiency can cut energy bills – cavity wall insulation alone can save households £250 a year on average[668] – and provide wider benefits. Energy Savings Trust says:

> *"retrofitting poorly performing homes to EPC-C standard will lower energy bills by £8.1 billion annually and reduce gas imports by 15%, bolstering energy security to benefit the wider economy and supporting 190,000 jobs across a range of trades to 2030."*[669]

[xxxv] Planning applications need to comply with this new regulation for energy efficiency in homes

[xxxvi] Energy efficiency measures include: cavity wall and solid wall insulation, roof and loft insulation, floor insulation, small measures such as draught proofing, reduced infiltration, low-flow shower heads, hot water tank insulation, behavioural measures (such as turning off lights), and other measures such as energy-efficient appliances and transitioning from gas to electric stoves.

951. Energy efficient homes are more comfortable environments and can support health and wellbeing too.

952. **Overall benefits for individuals are summarised in section 5.1. The opportunities offered by improved energy efficiency of homes are further demonstrated in the table below.** [670]

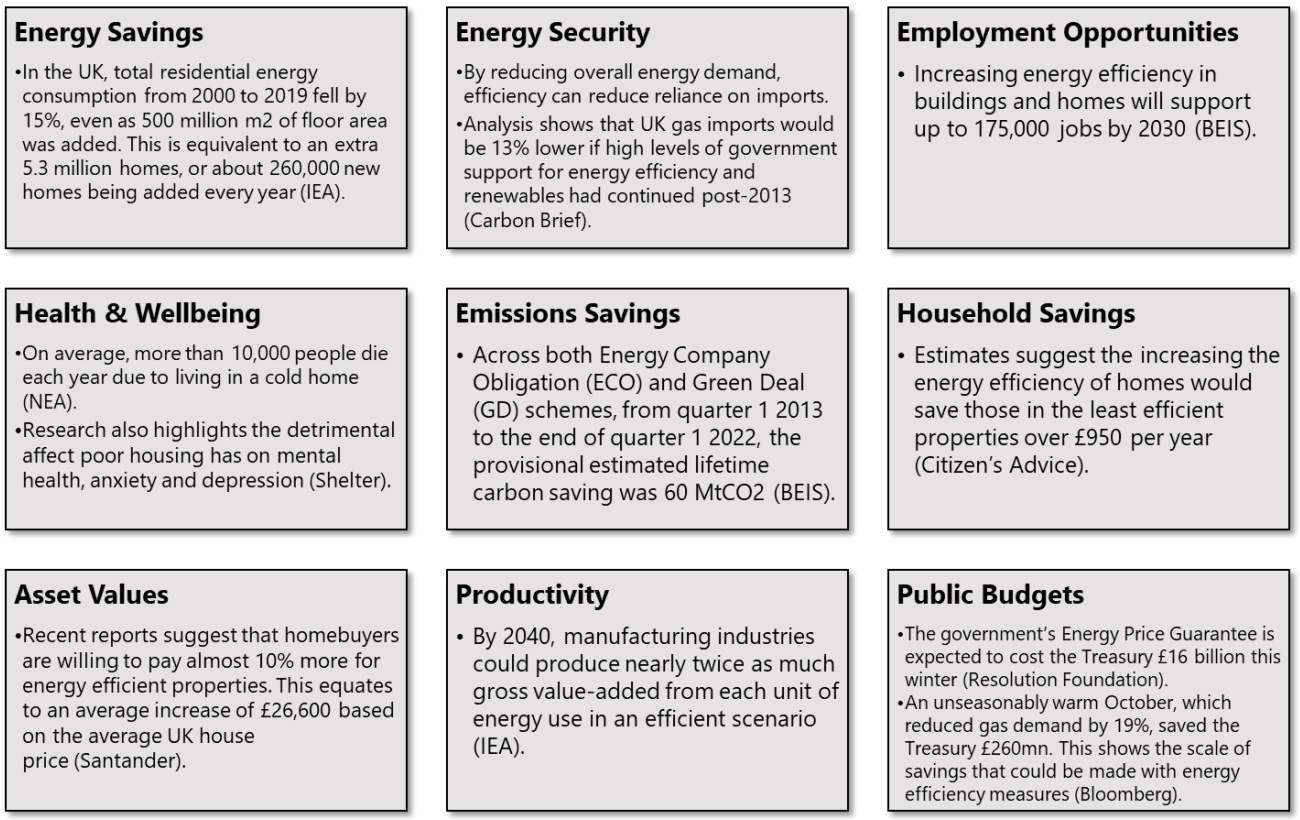


Figure 5.8 – *The wider benefits of energy efficiency*[671]

953. **Improving the efficiency of other household services and appliances can save households money too.** The Energy Saving Trust says that

> *"About 12% of a typical gas heated household's energy bill is from heating the water for showers, baths and hot water from the tap."*[672]
>
> *"Heating water for use in our homes makes up about 5% of the UK's total carbon dioxide emissions."*[673]

954. **Similarly, energy efficient lighting will lower electricity bills and reduce carbon dioxide emissions, with lighting making up 11% of the average UK household's electricity consumption**.[674] The government banned halogen light bulbs from September 2021 with fluorescent light bulbs to follow suit. It estimates that this shift will cut around one million tonnes of CO_2 – the equivalent of removing over half a million cars from UK roads.[675] While the Review notes that households with light fittings that are incompatible with LED bulbs will incur further costs, LED lights last longer than halogen lightbulbs and use 80% less power making this a significant shift to lower cost of energy for consumers in the long-term.[676]

Low carbon heating – decarbonising the supply of heat for homes

955. **The heating mix in UK homes is dominated by natural gas. As such, replacing fossil fuel boilers is essential. There are three main ways to do this:**

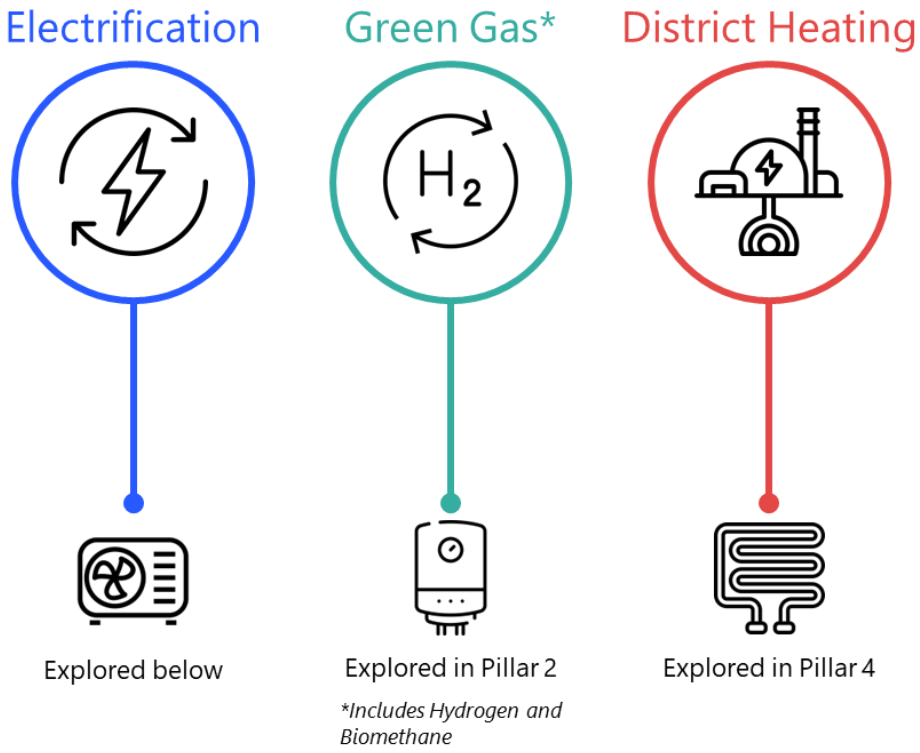


Figure 5.9 – *Three ways to decarbonise home heating*[677]

956. **Heat pumps, powered by low carbon electricity, are the central technology in the global transition to sustainable heating**.[678] The Climate Change Committee (CCC) estimates that 19 million heat pumps need to be installed by 2050 in the UK to meet net zero.[679] A heat pump can warm the home in winter and cool it in summer, using technology like that found in a refrigerator or an air conditioner. Heat pumps extract heat from a source, such as the surrounding air, geothermal energy stored in the ground, or nearby sources of water or waste heat from a factory. They then amplify the heat and transfer it to where it is needed in the home.[680]

957. **Heat pumps are efficient, cost-effective and offer many other benefits.** As heat pumps mostly transfer rather than generate heat, they produce multiple units of usable heat for each unit of electricity consumed to operate them.[681] For example, the energy output of a heat pump is four times greater than the electrical energy used to run it.[682] This makes current heat pump models 3-5 times more energy efficient than gas boilers.[683] Currently, heat pumps are cheaper to run than gas boilers.

958. **The low carbon heat industry can also boost the economy.** Developing a strong UK manufacturing base in heat pumps could contribute £500 million GVA per annum in export opportunities, driven by the large market size for heat pumps particularly in north-western Europe.[684] In response, UK boiler manufacturers like Vaillant and Ideal could capture nearly 10% of the EU's market.[685]

5.3.2 Challenges and opportunities

959. **Despite the benefits that energy efficiency and low carbon heating offer, they are not yet being take up at the scale required.** The number of annual home energy efficiency improvements has been slow, having peaked a decade ago, where up to two million energy

efficiency measures were being installed a year. In comparison to European markets, the roll-out of heat pumps in the UK has been relatively modest. Some 1.8 million gas boilers are sold on average each year in the UK while just 37,000 heat pumps were sold in 2020, and 55,000 in 2021 (~3% of residential heating units).

960. In part, this is because the UK faces particular challenges when it comes to decarbonising homes. These challenges can affect different groups in different ways.

961. **Firstly, the UK's housing stock is older than similar nations,** with over half of homes in England built before 1965 and almost 20% built before 1919.[686] According to the ONS, the age of a property is the single biggest factor affecting its energy efficiency.[xxxvii] Nearly half of low-income households in England still live in homes with an Energy Performance Certificate (EPC) rating of D or below, meaning they may use 27% more gas and 18% more electricity on average than EPC C-rated homes. [687, 688]

962. **Secondly, heating in the UK is dominated by natural gas,** which serves as the main source of heating for around 80% of homes.[689] Another 10% rely on oil – largely in rural areas without access to the gas grid. [690]

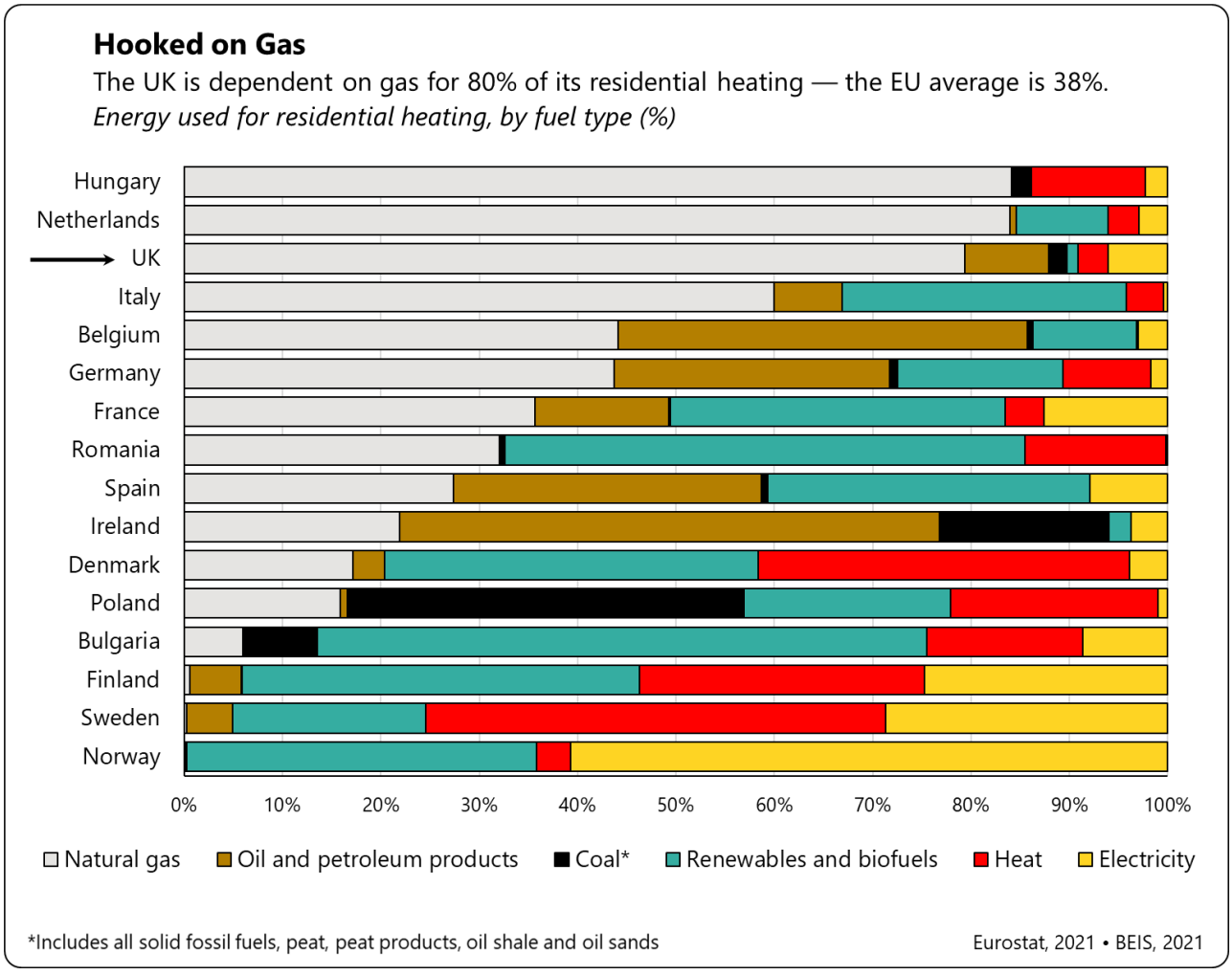


Figure 5.10 – *Energy used for residential heating across Europe, by fuel type*

[xxxvii] Newer homes (those built after 2012) are almost 200 times more likely to have a band A to C energy efficiency rating in England and 300 times more likely in Wales, than properties built before 1982.

963. Thirdly, **the UK has experienced years of low home insulation rates**. In 2013, government cut support for insulation and rates fell by around 90%, with successive policies failing to resurrect the industry due to being ended early or not funded enough. See graph below.[691]

964. **This means a typical UK home uses more energy than many of its European counterparts, as it loses heat faster**. This has left the UK particularly exposed to volatile gas prices, which has significantly contributed to economy-wide inflation; electricity prices rose by 66% and domestic gas prices have doubled in the 12 months to October 2022.[692]

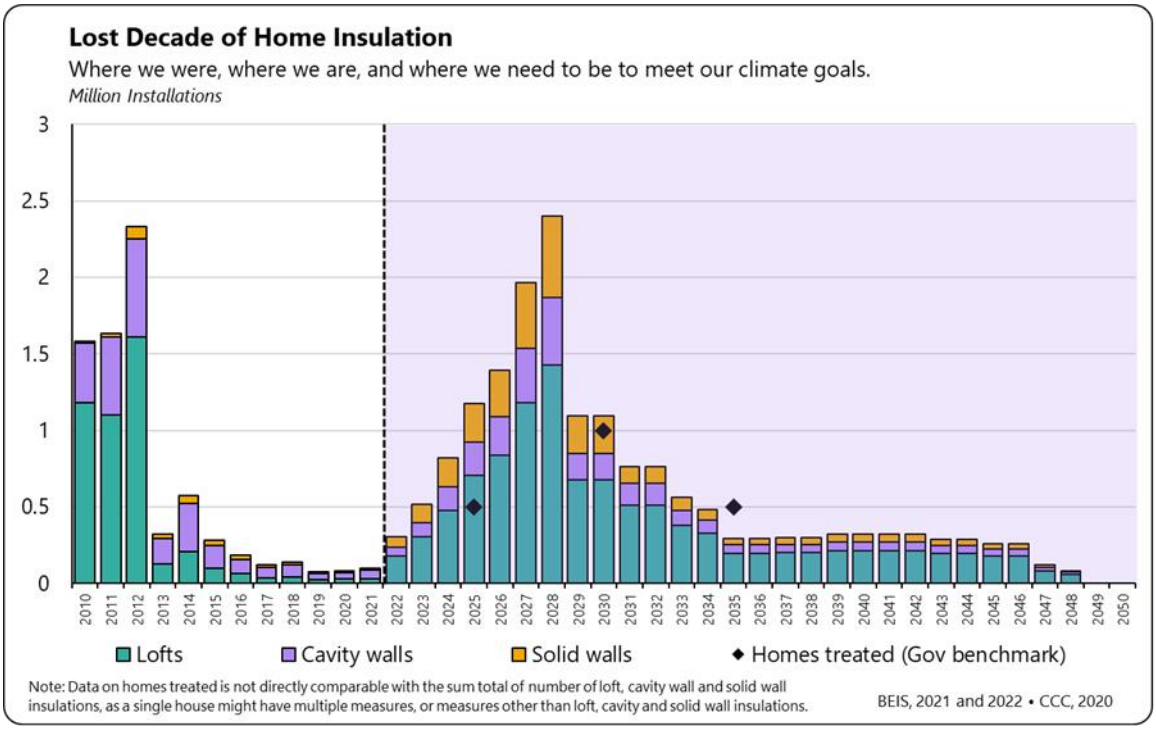


Figure 5.11 – *A lost decade of home insulation*

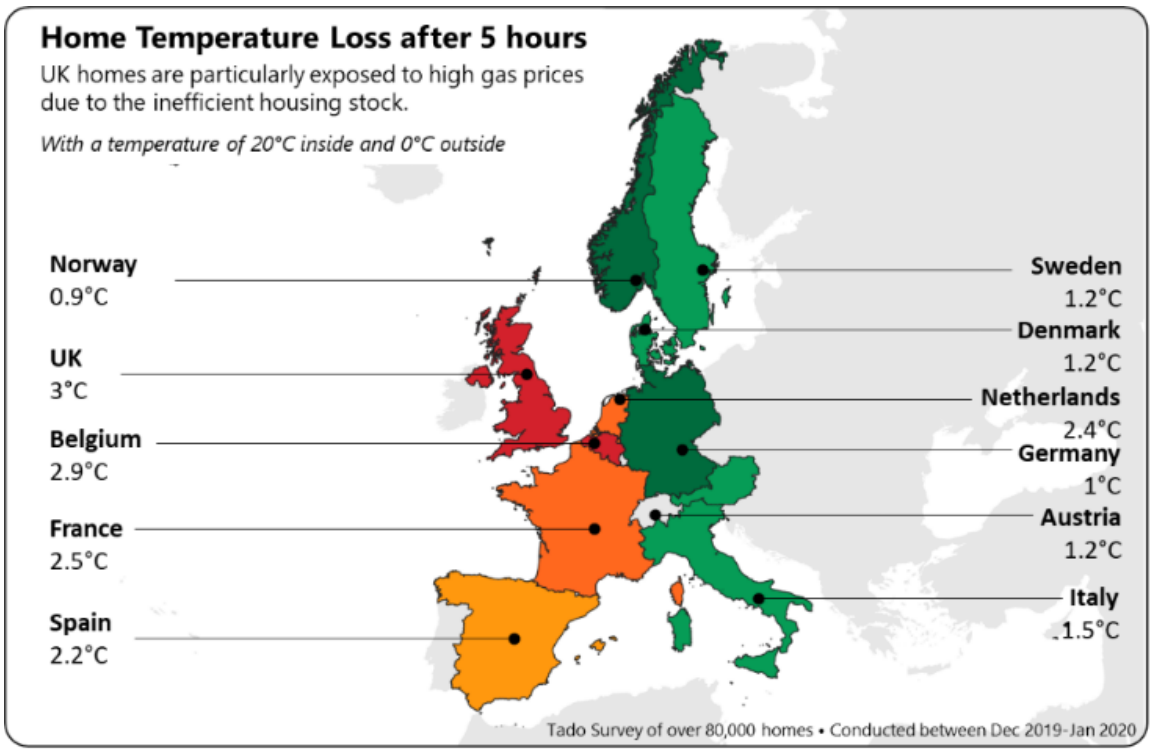


Figure 5.12 – *Comparison of home temperature loss*

965. **While it is true that the UK must go further than many other European nations to eliminate greenhouse gas emissions from its homes, the UK also stands to reap great benefits from the change, such as warmer homes and lower bills**.

966. **Alongside these challenges, households need to feel empowered to make changes in the home and these changes need to be affordable and accessible** (as described in section 5.1). The Review has heard that cost is the number one barrier to people improving the energy efficiency of their homes, with 34% citing this as preventing them from doing so.[693] This view was supported by the BEIS Public Attitudes Tracker, specifically for owner-occupier homes, which comprises the largest proportion of homes rated below EPC C. Nationwide Building Society has shown that:

> *"Installing all the recommended energy improvement measures in homes currently rated F or G would result in an average saving of around £1,780 per year. However, the installation cost for such measures is also high at an estimated £25,800, meaning a payback period of around 14 years… The average cost to improve a property to an energy efficiency [rating] of band C is £8,100, though the cost is considerably higher for properties rated F or G."*[694]

967. **Without government intervention, spending on energy would be equivalent to an eye-watering 7% of GDP, more than the health budget** (before the current Energy Price Guarantee was announced).[695] This starkly illustrates the economic cost of our reliance on gas, with the impact greater where people spend a higher proportion of their money on their bills. When the Energy Price Guarantee ends, households will be exposed and the pressure for government support will still be there. These costs must still be paid for, even with bill support transferred from households to taxpayers. Energy efficiency measures deployed at scale could ease this burden.

968. **While current circumstances mean a well-installed heat pump should be cheaper to run than a gas boiler, there are multiple conditions that underpin this, and a suite of policies must be implemented to ensure: a) the market delivers on this momentum and b) this market involvement remains a permanent fact**.

Government should regulate through a suite of measures to **create the conditions for sustained growth of new markets for low-carbon heat**, so that at least 600,000 heat pumps are installed each year by 2028, and up to 1.9 million by 2033. The Government should implement the **off-gas grid regulations that envisage the end of new and replacement fossil fuel heating systems** in the mid-2020s.

969. **The UK is not alone in its energy efficiency efforts**; other countries' efforts can be seen below across the globe:

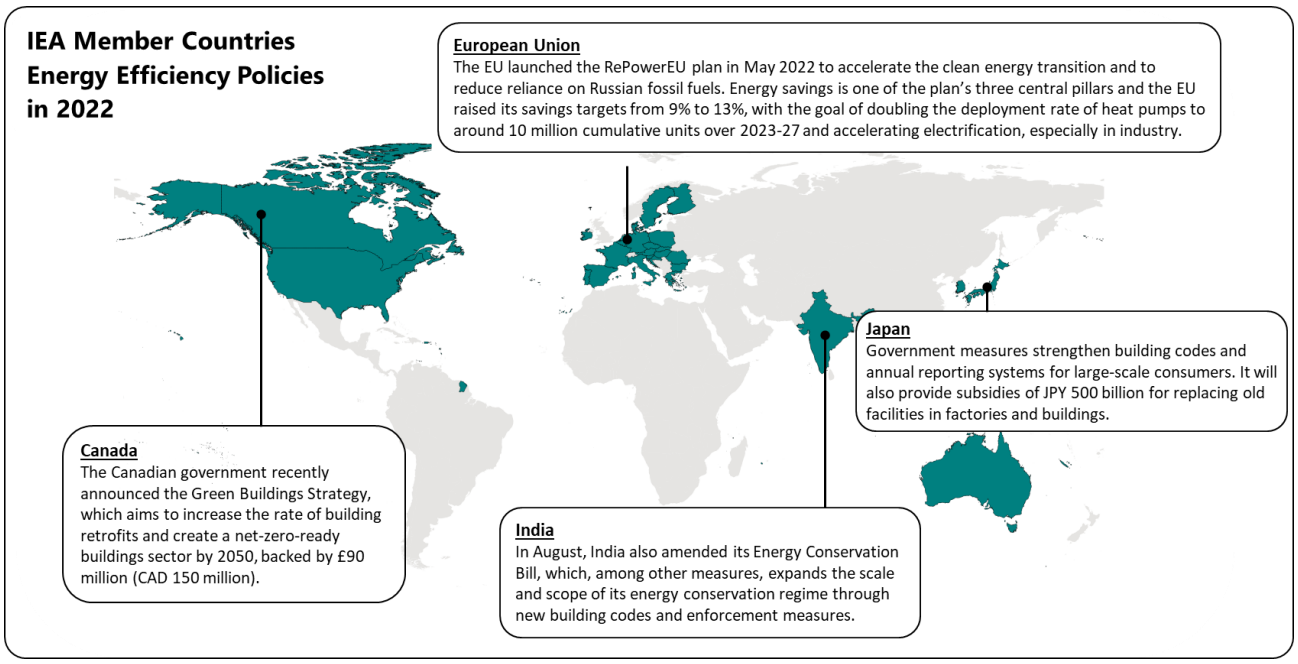


Figure 5.13 – *International examples of energy efficiency measures*

5.3.3 Deliver the *Heat and Buildings Strategy*

970. **The Review has heard multiple calls for government to deliver its *Heat and Buildings Strategy***, but also to take a more holistic approach by packaging these measures into an ambitious National Retrofit Strategy.

971. **Investors respond best to a long-term, predictable policy framework and positive evidence of this has already emerged.** Major insulation manufacturers (such as Rockwool and Saint-Gobain) operate several factories across the UK and companies such as Octopus Energy are investing £10 million in a new training centre to train 1,000 heat pump installers per year in addition to existing UK manufacturing facilities owned by organisations such as Kensa Heat Pumps Ltd (ground source manufacturer pumps). Some government capital schemes such as the Public Sector Decarbonisation Scheme have received significant uptake and could be expanded if the right signals are given to industry.

972. Views from E.ON, Energy Efficiency Infrastructure Group (EEIG) and the Heat Pump Association are captured below:

> *"The supply chain remains blighted by short term certainty (1–3 year scheme lengths). Funding and scheme certainty of ten years in length are required to deliver the scale of energy efficiency measures and retrofitting required in the UK housing stock."*[696]
>
> *.." the recent Heat and Buildings Strategy left unclarity regarding the government's intended direction of travel for owner occupier households, which represent the majority of the building stock and the highest emissions."*[697]
>
> *"The government presently has only an "ambition" to end new fossil fuel boiler sales by 2035. That is insufficiently certain for the major investments necessary if we are to switch from 1.8 million gas boiler installations per year to similar numbers of heat pumps."*[698]

973. **Government must implement the *Heat and Buildings Strategy* without delay, bringing together a programmatic approach to its various support schemes enabling a whole-house plan for every home**.

974. In particular, the Review notes the importance of delivering on the below measures, included in the *Heat and Buildings Strategy*:

- Government should implement the Clean Heat Market Mechanism to increase heat pump deployment, as envisaged by the Energy Security Bill.
- Government should shape the market for cooking appliances through product standards and financial incentives towards electric solutions, which will be cheaper for consumers and reduce our dependency on gas.
- Government should retain energy-related products standards and look to strengthen these, as they can save consumers hundreds of pounds off their energy bills while delivering net zero.
- Government should deliver a new regulatory framework for heat networks and implement heat network zoning, both of which are in the Energy Security Bill. Government should also continue to deliver the Green Heat Network Fund, extend GHNF to 2028 and scale it up over time.
- Government should ensure support for biomethane beyond the current Green Gas Support Scheme which ends in 2025.

CASE STUDY: Future Homes Standard

The Government's Future Homes Standard will mandate greater energy efficiency measures in homes built after 2025, but new houses built before then will not need to meet these standards. ***Retrofitting a new home to meet high energy efficiency standards*** *– including replacing its gas boiler with a heat pump –* ***could cost a household an average of £26,000****, according to Climate Change Committee (CCC) data.*

That is over five times more than the £4,800 it would have cost to meet the standard when a property was first built.[xxxviii] *The Zero Carbon Homes Standard was supposed to be implemented from 2016 onwards but was scrapped in 2015 – this led to over a million homes being built to poor standards, which will ultimately cost the thousands of people who bought those homes millions of pounds.*

Government is still committed to a manifesto pledge of building 300,000 homes every year by the mid-2020s, ***the delay to 2025 to enforce the Future Homes Standard will create a missed opportunity in making new builds more efficient and require costly retrofits****. Loopholes could also allow developers to continue selling homes with gas boilers until 2026. The home building sector generates £38 billion in economic activity each year and is uniquely placed to support the government and consumers to achieve economic growth in the transition to net zero.*[699]

The latest ONS figures show two-thirds of new homes in England are still being connected to the gas grid.[700]

Government should **bring forward all consultations and work to mandate the Future Homes Standards** by 2025 to prevent further delays by **ensuring the standard applies to all developments**. This should include a **consultation on mandating new homes to be built with solar and deliver the Net Zero Homes Standard**, ensuring that the planning system (discussed in ***Pillar 4***) is flexible enough to enable this.

[xxxviii] Future Homes Standard case study - the Part L 2021 standard came into force in June 2022. Homes built under the new standard will be better insulated and will have heating systems designed to run at 55 degrees Celsius - so heat pump ready if a heat pump is not already fitted.

975. **A Net Zero Homes Standard could serve as the benchmark for all homes.** By combining fabric and low carbon heating measures, homes that have taken the appropriate steps to be as efficient as possible will save their occupants money on their bills and be more financially desirable to future buyers, as stated above. Establishing a Net Zero Homes Standard will ensure that as time goes on, more and more homes will reach this standard, and more occupiers will reside in homes that benefit both their health and their finances.

976. **Lessons can and should be learnt from the past and other countries.** For example, the National Audit Office (NAO) found in its review of the Green Homes Grant Voucher scheme that the "the scheme did not deliver the expectations of number of home energy efficiency installations or support the expected number of jobs."[701] The scheme came in parallel with three other schemes, limited resourcing in BEIS and with a short timescale, which left installers and consumers frustrated. In its recommendations to government, the NAO said that the department should, by the end of 2021, set out how its various home efficiency schemes fit with its overall plans for decarbonisation, setting out timescales in a more detailed and longer-term plan – to help promote interest in future schemes.

5.3.4 Beyond the *Heat and Buildings Strategy*

977. **The *Heat and Buildings Strategy* only commits to government spending in this Parliament, but more is needed to drive down the cost of heat pumps and deliver energy efficiency.** The Review heard that the *Heat and Buildings Strategy* also does not go far enough to address issues that we have seen reflected in our own analysis and is crucial to allowing all households to benefit from the transition: long-term support to low-income households with upfront capital costs, electricity rebalancing, electric vehicle charging price, and access to finance. Coordinated action across multiple sectors is needed to ensure consumers can realise their net future benefit in the long term.

978. **Government needs to go further and faster to decarbonise our homes beyond EPC C and maximise the opportunities that energy efficiency and low carbon heating have to offer by looking ahead to a new NZPC (Net Zero Performance Certificate). That is why the Review is calling for a new mission, to bolster energy efficiency for households, including low carbon heating and solar.**

Mission: Energy efficiency for households. This will not only reduce energy demand and bolster our energy security, but also save consumers money on their bills. This should be driven a set of specific actions to be taken over the next ten years.	
Issue	**Action recommended**
The distributional impact of current energy efficiency policies means that not every household is benefitting.	**Government to choose from options that help increase heat pump efficiency:** • Mandating minimum efficiency for installations • Heat pump coefficient of performance competition • Accelerated training and installation standards

There are high upfront costs for energy efficiency measures and low carbon heating, and running costs are high especially in inefficient homes.	**Government should extend the Boiler Upgrade Scheme to 2028 and consider whether grant levels should be increased in light of inflationary pressures, before being scaled down over time. This should happen alongside efforts to increase awareness of government support. Support for those unable to afford the upfront costs associated with improving energy efficiency and moving to low carbon heating systems should be continued and expanded, namely through the Home Upgrade Grant (HUG), Social Housing Decarbonisation Fund (SHDF) and other existing schemes for low-income households.**
There is a significant skills supply gap for energy efficiency and low carbon heating.	**Government should set the policy framework and supportive investment environment to encourage reskilling and greater training opportunities in the heat pump sector and work to encourage adoption of standards to increase firms able to take up existing schemes.**
There is a lack of legislative certainty on what is the expected standard for homes.	**Government should legislate for all homes sold by 2033 to also have an EPC rating of C or above in line with the aforementioned NZPC, with exclusions around certain properties (e.g. listed properties, on grounds of affordability). Government should also mandate landlords to include 'average bill cost' alongside the EPC (and possible future NZPC) rating, when letting a property out. This will help renters understand what costs to expect, while also helping to put a premium on energy efficient homes.**
There is a lack of information and advice for consumers on how to upgrade their home.	**Government should expand its energy efficiency advice service in 2023, ensuring that it helps consumers to access qualified traders and providers in local areas.** **Government should support establishing retrofit hubs by 2025 to bridge the gap between households and suppliers. These could enable installers to seek training and impartial advice and could connect households to suitable installers.**

Government should ensure the right policies are in place to **achieve the UK's demand reduction targets,** building on the 2022 Autumn Statement announcement, with interim targets and milestones to hit this goal. Noting the UK's 2050 net zero ambitions, the government should **publish clear analysis of which mix of policy measures gets the UK to the 15% target and assure future funding for those policies.**

Energy efficiency advice and public engagement

979. **The public lack information about how to improve the efficiency of their home and reduce their energy bills.** NatWest told us that:

> *"Although public awareness around energy efficiency is on the rise, there remains a profound gap between the desire to make home improvements and the knowledge around how to undertake the change."*[702]

980. The Heat Pump Association told the Review that "heat decarbonisation advice to consumers is inadequate and inconsistent." 33% of people do not know enough about what energy efficiency options exist and 44% are not aware of government support schemes.[703] The uncertain future of hydrogen heating (discussed in ***Pillar 2***) can also be confusing for people and dent their confidence when it comes to choosing a low carbon heat system.

981. **In addition, the Review has heard that it can be hard for people to access the right skills and supply.** Skills gaps mean it can be challenging to find a local engineer with the relevant skills, and limited supply chains mean it can be hard for people to access a heat pump or spare parts without delay. The immaturity of the supply chain means that some people have bad experiences, which can deter them and others from choosing low carbon heating. All this can not only make the process of switching to a heat pump more challenging for people, but can also increase their nervousness, due to concerns that should it break, you may not be able to get it fixed straight away. The solar mission in ***Pillar 2*** includes a suggestion to provide a list of certified installers at a local level, which could be useful here too.

982. **Even when technology is in place, some people are not clear on how best to use it.** For example, unlike a gas boiler, a heat pump should be constantly switched on, but many people are not aware of this, meaning its usage is not always the most effective.

983. **Currently, advice and engagement are limited.** Octopus told the Review that by providing consumers with low-cost, easy tips for reducing their energy demand, they were able to cut bills by 8% on average. The government has launched an energy efficiency advice service which tells people what improvements they could make to their home to increase its EPC rating. NatWest told us "this is a good step in the right direction, but a broader, far-reaching campaign is needed." Recently, government supplemented this with a public energy efficiency campaign, focused on giving households tips designed to help reduce energy bills, like draught-proofing and turning down radiators. This campaign is focused on addressing the cost-of-living crisis and is not directly linked to net zero.

Government should expand its energy efficiency advice service in 2023, ensuring that it helps consumers to access qualified traders and providers in local areas.

984. Government should accompany this advice service with a widespread public engagement campaign. This must be designed to help households recognise how and why they should take action to reduce the carbon footprint of their homes, and to understand what support is available. It should be honest about the challenges and should dispel common misconceptions, for example that certain housing types are not suitable for heat pumps. It should also focus on helping consumers make use of low carbon heating systems in the most efficient way. This should happen alongside the public engagement strategy discussed in section 5.1.

Retrofit hubs

985. **In the transition to energy efficiency measures being delivered more locally, it is paramount to ensure that the transition minimises disruption, so a clear evolutionary plan of how to get there is essential and should be done in a way that does not require existing programmes to be reconstructed extensively to fit local needs.** As trailed in ***Pillar 3***:

Government should **support establishing retrofit hubs** by 2025 to **bridge the gap between households and suppliers.** These could **enable installers to seek training** and impartial advice and could **connect households to suitable installers**.

986. This should stem from local partnerships including industry stakeholders, training providers, repair and maintenance teams and citizen representatives. A local approach would allow regions to set their own targets for building decarbonisation and potentially to go further faster. These hubs could also help to build trust, by serving as a point of contact for accreditation, customer reviews of retrofit work and by demonstrating success and communication where something has failed and can be learned from. Working quickly and learning at every opportunity is key.

Net Zero Performance Certificate (NZPC)

987. Energy Performance Certificates (EPCs) provide households with information about the energy efficiency of their home. **There is scope to utilise the EPC system better to help to support people to retrofit their homes. Currently, the EPC measure does not work for net zero.** The EPC rating of a property can sometimes show a worse score after installing a heat pump because of the inclusion of the cost of heating in the score, and this assessment being based on outdated assumptions. EPC ratings can overestimate the cost of running a home with a heat pump due to outdated measures of heat pump efficiency and the history of gas prices being artificially lowered in comparison to electricity prices (because the gas bills would bear fewer policy costs). The figure below shows how strongly bills projections would have changed between 2019 and 2022.[704] Under the Energy Price Guarantee, the same amount of energy usage in a G-rated dwelling as in 2019 would incur a bill of £6500 compared with £1500 in a B-rated building.[705] This measure needs to be improved as a priority.

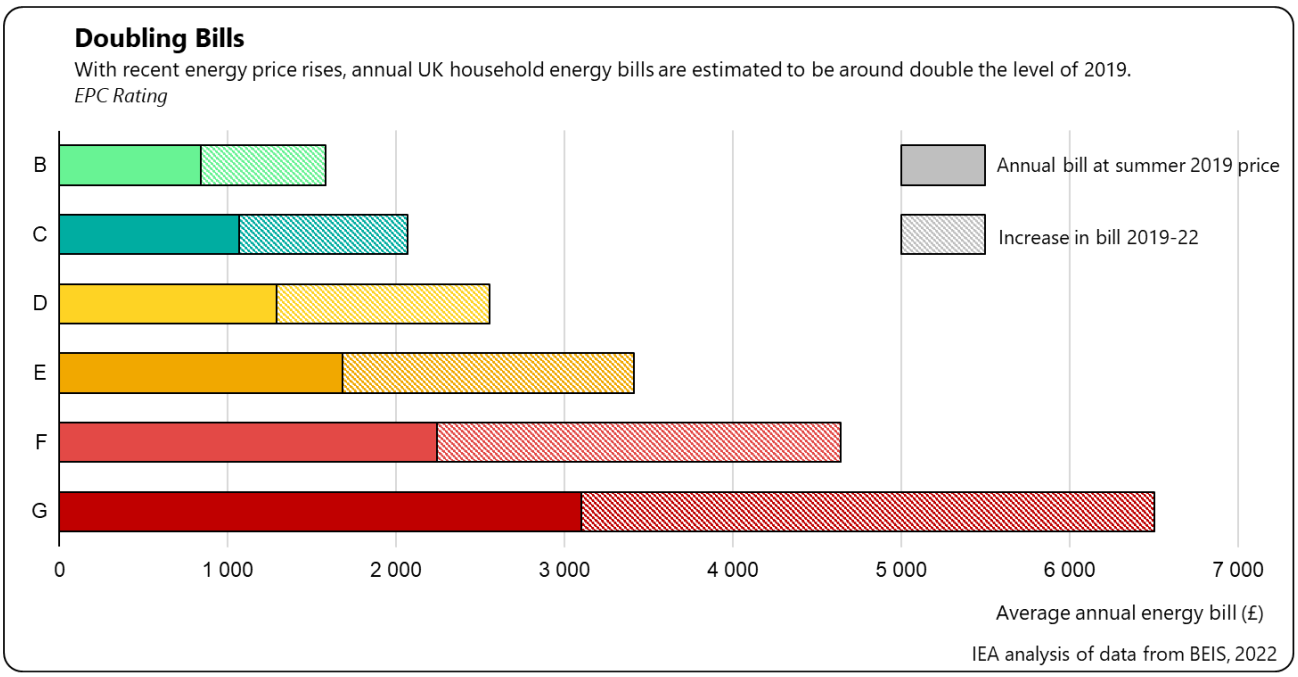


Figure 5.14 – *Typical household energy bills*

Government should mandate that EPCs are updated on a regular basis, using a new metric which better reflects current relative costs of heat pump and accounts for wider benefits from low-carbon heating systems. Under this new metric, EPC ratings could become a more holistic Net Zero Performance Certificate (NZPC), giving consumers more detailed information about the heating technology used in the property and its associated financial and social effects.

Ending gas boiler sales and increasing minimum energy efficiency standards

988. **Government has an objective for as many homes as possible to reach EPC C by 2035, but this is not yet set out in legislation.** Currently, almost half of low-income households in England live in homes that are EPC band D or worse, meaning they may use 27% more gas and 18% more electricity on average than EPC C rated homes.[706] Minimum Energy Efficiency Standards require domestic private rented properties to be at least EPC E, and this is expected to increase to EPC C from 2028. As decisions about energy efficiency installations are usually made by landlords, tenants can require particular support.

989. **People need clarity on what is expected of them, particularly where large investments are concerned.** Making it clear to people that heat pumps are the future, by setting a legislative target, would prevent households from installing a gas boiler which locks them into higher greenhouse gas emissions and will result in them needing to spend more on replacing the boiler later. Gas free housing developments are also being chosen by major UK housebuilders. Barratt Homes opened an 82-house site in Somerset, where all homes have been fitted with an air source heat pump.[707] This paves the way for future developments to follow suit in the UK and ensure that new homes are automatically built with a low carbon heating system. In Washington State in the USA, all new houses and apartments from July 2023 will require a heat pump to be fitted.[708] This shows that these regulations can be rolled out on a larger scale at pace.

990. **Our analysis finds that moving the date by which gas boilers are phased out to as early as possible increases the gains which households experience by 2050.** It would therefore

save people more money to move the gas boiler phase out date to as early as 2030 – but modelling and stakeholders warn that the UK supply chain for heat pumps could not ramp up quickly enough to deliver this.[709] Years of policy delivery delay have caused UK households a portion of their net future benefit and this underlines the need to move faster than in current plans, and crucially, prevent any further delays.

Government should **provide certainty by 2024 on the new and replacement gas boiler phase out date** to drive industry and investor confidence. The Review recommends **bringing the proposed date of 2035 forward and legislating for 2033.**

Government should set a legislative target for **gas free homes and appliances by 2033,** to contribute to a gas free grid in future.

Government should legislate for all homes sold by 2033 to also have an EPC rating of C or above in line with the aforementioned NZPC, with exclusions around certain properties (e.g. listed properties, on grounds of affordability). **Government should also mandate landlords to include 'average bill cost' alongside the EPC (and possible future NZPC) rating, when letting a property out.** This will help renters understand what costs to expect, while also helping to put a premium on energy efficient homes.

Government should **consider options to support homes to include roof solar panels installation as part of its retrofit provision** to support homes reaching the Net Zero Homes Standard.

Innovative green finance support

CASE STUDY: Germany's Green Finance Support for Home Energy Efficiency

"In Germany, the state-owned development bank, KfW, offers low-interest loans of up to €120,000 to fund installation of energy efficiency measures into homes as part of their Energy Efficient Renovation scheme."

"The scheme incentivises uptake by offering a subsidy of up to 40% of the loan value. This is dependent on the retrofitted property meeting specific energy performance measures and a higher subsidy is received for a higher standard of performance."

"For every €1 invested by KfW to incentivise energy efficient renovation, building owners were motivated to borrow and spend €6."

"The programme cost the federal government €1.7 billion in 2016, unlocking €8.4 billion from building owners and nearly covering its own cost through the resultant VAT revenue alone (€1.6 billion). Between 2005 and 2017, this scheme has led to installations in 2.8 million properties, invested €73 billion, and delivered 7.5 $MtCO_2$ savings." – Environmental Audit Committee (2021)[710]

991. **As set out above, the upfront costs of energy efficiency measures and low carbon heating can be prohibitive, and action is needed from government to support households with these.** The Review has repeatedly heard of the need for long-term, low-interest loans for energy efficiency and low carbon heating. Innovative products are coming to market but are not being deployed at the pace and scale required.

992. **In a recent letter to the Chancellor, the Climate Change Committee (CCC) said "our updated analysis suggests that over 60% of households can achieve levels of energy efficiency that are compatible with net zero for less than £1,100".** However, both the CCC and evidence received by this Review notes that many households and businesses are unable to afford additional costs. Government's role in facilitating access to finance is therefore critical.

993. **This is supported by evidence provided to this Review with industry players,** such as E.ON, calling for government to introduce incentives such as guarantees to the banking industry to offer green mortgages and loans at low interest rates (see Germany case study). The Review has also heard about the importance of timing for the provision of green finance products – for example, the point of purchasing or re-mortgaging a home can be a sensible time to carry out installations, given the property is likely to be empty for a period of time, so incentives offered at this point can be particularly effective.

994. **There are many international examples of innovative financial solutions coming to the fore.** The USA is progressing with its PACE financing model (Property Assessed Clean Energy financing) – an innovative mechanism for financing energy efficiency and renewable energy improvements on private property. Residential PACE is typically enabled through state legislation and authorised at local government level and provides long term financing for up to 20 years. This mechanism tackles the barrier for a householder to have to pay back the complete loan for energy efficiency measures passing repayment obligations and energy bill savings to the property owner.

995. **While this Review notes that the UK context is different, using all of government's levers is critical** to build industry and consumer confidence and to crowd in private finance, maximising value for money for public support initiatives. This view was reinforced by evidence provided to the Review by the Environmental Audit Committee who recommended in their inquiry on 'Energy Efficiency of Existing Homes' that:

> *"The government should work with the financial sector and landlords to stimulate renovation through the introduction of green mortgages, green finance and low-cost loans; and pilot a stamp duty rebate for homeowners that improve the efficiency of their homes within the first year of purchase".*

CASE STUDY: E.On and BNP Paribas Personal Finance

E.ON partnered with BNP Paribas Personal Finance in 2018 on a green mortgage trial with the aim of providing a competitively priced mortgage to fund a range of personalised energy efficiency solution bundles delivered by E.ON. Improvements to EPC rating could then enable participants to receive lower interest rates. [711]

CASE STUDY: Octopus Energy

Octopus Energy have recently teamed up with Halifax on a scheme which will bring the upfront costs of installing a heat pump down to £2,000, on par with gas boilers. Octopus will install heat pumps, while Halifax mortgage customers will be awarded with a £1,000 green living reward, which can be combined with BUS grants.[712]

The company has also teamed up with Ilke homes, using funding provided by asset manager Gresham House, to pilot zero bill homes. 6 properties in Essex have been equipped with air source heat pumps, solar panels and battery storage.

Octopus provide 'zero bill' smart tariffs, allowing residents to use power from their solar panels on sunny days, and to use credits from surplus energy sold back to the grid to use energy from the grid when its cloudy. More of these 'bill free' homes are planned around the country.

996. **The UK's financial sector can lead in this space.** For example, lenders are already stepping into the green mortgage market, providing preferential treatment on the basis of a home's EPC rating. These are primarily for those purchasing homes with a higher EPC rating (e.g. NatWest provides a preferential interest rate if you purchase or re-mortgage a property with EPC A or B).[713] Some options exist for homeowners to carry out green home improvements. The Review has heard the risk of lenders primarily focusing on properties with already high EPC ratings, and low uptake overall for green mortgages.

997. **Tax and subsidy policy can act in tandem to turbocharge the transition**. Government has already cut VAT on energy efficiency measures, heat pumps and solar panels to zero, for the next five years. This is helping to reduce costs and incentivise homeowners to make changes to their properties, and we recommend this should be maintained permanently.

998. **The Review has also heard calls for an energy-adjusted Stamp Duty Land Tax**, which would encourage owners to improve the energy performance of their homes, boosting the energy efficiency retrofit market. The Green Finance Institute argue that this would also help to encourage lenders to develop green finance solutions. Stamp Duty applies only to property purchases over £250,000 but increasing house prices have put more homes within this bracket.

999. Government should include **an Energy Efficiency Taskforce workstream on green finance products** to report by end of 2023. This should help to support those in **low EPC rated properties to carry out green home upgrades and should identify opportunities to crowd-in private finance**, alongside public funding.

Government should deliver th**e Heat Pump Investment Accelerator to catalyse private investment for at least two major heat pump factories in the UK.**

Heat pump efficiency

1000. **When installed well, and despite the Energy Price Guarantee being in place, heat pumps are cheaper to run than gas boilers, but action is needed to ensure that this remains the case, and that the market delivers on this momentum.**

1001. **Improving the efficiency of heat pumps reduces running costs significantly.** Nesta, a UK innovation agency which designs, tests and scales new solutions to society's biggest problems,

told the Review that making heat pumps just 8% more efficient a year could achieve savings for households of £65-£150 a year. The Review's own analysis has found that bringing the coefficient of performance (power supplied to the home by the heat pump vs. the amount supplied to the compressor) up from 300% to 350% could dramatically improve savings for the average household and equalise the distributional impacts of net zero so that more household groups end up with a net saving. The coefficient of performance can be affected by different factors, from the unit itself, the nature of the home it has been installed in, the time it is turned on and the quality of the installation.

Government should choose from multiple options which could help increase heat pump efficiency:

- Suppliers say this could be done via a **mandate stating the minimum efficiency which needs to be achieved by all installations**. Government should test whether this could be done by most major installers for most properties.
- **Set up a heat pump coefficient of performance competition**, run for example by the Energy Efficiency taskforce. This will show the state-of-the-art technologies with higher efficiencies and allow others to replicate these.
- Quality of the installation matters; **training and installation standards need to be accelerated** to support this.

Support for low-income households

1002. **Support for lower income households exists but is not delivering at the pace** and scale required. However, current measures aimed at supporting households to manage the high upfront costs of decarbonising reach only 12%-22% of households in the bottom three deciles.[714] The Energy Company Obligation (ECO) scheme requires energy companies to support low-income households to access energy efficiency measures (including solar). The Review welcomes government announcing that it will expand the ECO scheme. As well as ECO, there are the following other support schemes currently running – the Home Upgrade Grant (HUG) and the Social Housing Decarbonisation Fund (SHDF).[715]

1003. The government has heard positive feedback on the Boiler Upgrade Scheme (BUS), which provides grants of up to £5,000-£6,000 for heat pumps. So far this year around 10,000 vouchers have been given out, significantly short of the trajectory needed to meet government's target for 600,000 heat pumps to be installed by 2028, also taking into account it is not the only policy needed to reach the 600,000 figure.

1004. Evidence provided to the Review by the Building Engineering Services Association (BESA) representing more than 1,000 members with combined turnover of £3.6 billion recommends that:

> *"Government consider where quick wins can be secured". They suggest example initiatives including "increasing the Boiler Upgrade Scheme funding over to encourage a wider range of heat pump types." BESA also called on government to "work with the wider domestic heating sector on establishing a system upgrade scheme focused on delivering simple and quick wins that would deliver immediate and affordable solutions. This might include swapping out internal components in existing heating systems and, where compatible with an existing boiler, using weather compensation technologies to be reactive to outdoor temperatures. BESA would be happy to recommend a series of low-cost measures (sub £100)."*[716]

1005. The World Wide Fund for Nature (WWF) representing nearly 100 companies globally recommends that the government: *"scale up the Boiler Upgrade Scheme over time and extend it beyond 2025".*[717]

1006. The Heat Pump Association told the Review that *"whilst welcome, [the Boiler Upgrade Scheme] is not expected to lead to growth at the scale needed to meet the 600,000 target."*

1007. **New analysis carried out by the Review shows that supporting low-income households to decarbonise is essential** (see section 5.1).

1008. **Further measures will be needed to distribute the cost of the gas grid fairly as more households move away from using the grid.** Government will need to ensure that households that cannot access the finance to upgrade their homes are not left to pay for the upkeep of the gas grid as the transition progresses. Stakeholders pointed out that if lower-income households disconnect from the grid in slower time, their costs might increase irrespective of the fuel gas price. Government should consider how to prevent this from 2025 onwards, and by 2030 at the latest.

1009. **The Review recommends that government considers ways in which it could go further by bolstering existing schemes with additional funding support.** For example, with the increase in energy prices, owner-occupiers now have a strong incentive to retrofit their homes to save on energy prices. Grant funding for owner-occupiers, in parallel with the Boiler Upgrade Scheme (BUS), would catalyse the transition. The government could also consider linking these measures to demand measures, such as installation of smart controls and smart meters.

Government should extend the Boiler Upgrade Scheme to 2028 and consider whether grant levels should be increased in light of inflationary pressures, before being scaled down over time. This should happen alongside efforts to increase awareness of government support. Support for those unable to afford the upfront costs associated with improving energy efficiency and moving to low carbon heating systems should be continued and expanded, namely through the Home Upgrade Grant (HUG), Social Housing Decarbonisation Fund (SHDF) and other existing schemes for low-income households.

Skills and market transition

1010. **We need a skilled workforce to decarbonise our homes, as covered in more detail in *Pillar 3*.** The Heat Pump Association estimate that there are currently only 3,000 trained heat pump engineers in the UK, but at least 27,000 will be needed in the next six years, requiring increases of 4,000-6,000 per year.[718] This means training more new engineers every year than are currently in the whole industry.

1011. **Training provisions exist but need expanding.** There are already recognised Ofqual qualifications in low temperature heating. There is also extensive training capacity for up to 40,000 training places per year from Heat Pump Association members already available to train heat pump installers. To make more progress, the Review has heard the following views:

- **An 'Early Bird' training support scheme for the first 20,000 installers, part-funded by industry, and part by government.** This would encourage early adopter installers by compensating them for their training costs, including loss of earnings while undertaking the training.

- **A requirement for a low-temperature heating system qualification for all Gas engineers at the five-yearly ACS renewal**, and the requirement for a suitable heat pump Competent Persons Scheme. Industry is ready to support installers with the necessary skills, training, and tools to achieve this.
- **Apprenticeship programmes, to bring through new high-skilled career opportunities for a generation of young heating engineers.** This would help to create long-term, sustainable jobs, helping improve youth employment, and encouraging social mobility.
- **Building professionals working in repair, maintenance and improvement are vital 'middle actors' to facilitate zero-carbon buildings.**[48] They are highly influential to households and can develop agency to decarbonise homes. It is important that they have the skills and knowledge to take advantage of delivering zero-carbon solutions in the course of their work. A diverse range of training pathways (across vocational trade, engineers, designers, project managers) is required.
- **The industry is ready for constructive dialogue to help the government implement its Market-Based Mechanism for Heat Pump deployment.** The Heat Pump Association are working on the following areas in preparation for this: safeguards for consumers, quality controls for products and installations, and correct specification of systems and best use of existing products.

Government should set the **policy framework and supportive investment environment to encourage reskilling and greater training opportunities in the heat pump sector** and work to encourage adoption of standards to increase firms able to take up existing schemes.

Pre-payment meters and energy debt

1012. **Additional support is needed for those on pre-payment meters and who are in energy debt.** Fuel poor homes in arrears cannot switch their energy supplier to a tariff which may be more suitable for different low carbon heating technologies. Low-income households face financial difficulty paying off large standing charges on bills, which often need to be paid before gas connections can be capped if the household is no longer using gas as heating or cooking fuel. Government should address these access issues now to improve low carbon heating technologies' accessibility.

Heat as a service

1013. **The Review has shown that there are many challenges to decarbonising homes – from a lack of information, to high upfront costs and difficulty accessing skills and supply.** Energy suppliers could be harnessed to provide more holistic solutions for households. Government could encourage energy suppliers to bridge the current gaps by providing households with multiple choices at once. Some options are:

- Information on low-carbon heating/storage assets and their benefits to the household and the environment
- Liaising with finance providers and government to ease the administrative burden of accessing a green mortgage and subsidies
- A low-carbon heating system, supported by a government subsidy or mandate for a specific proportion of installs to be, e.g. heat pumps

- A guarantee of a new heating system provided to the household when the old heating system breaks
- Energy efficiency measures paid for by the energy provider (because this reduces their costs of providing heat to the home)
- Solar panels
- Batteries/thermal storage
- Smart vehicle charging

1014. **The above would help to coordinate the demand response, as the amount of shifting provided by an individual household is not comparable to the bigger demand response provided by many homes collectively.** The supplier could capitalise on this by selling this back to the grid at peak times. Octopus Energy offer a 'smart tariff', which allows customers to save money by shifting their energy usage to lower cost times of the day, when demand is lowest.

1015. **One way of providing this would be via a heat as a service scheme, where suppliers offer a contract for customers to get the heating profile of their choice in exchange for fixed-monthly price.** This could include multiple elements which are cost saving and so provide a solution to the problem of upfront capital. The risks of this approach would include monopoly power on the part of the supplier, increased vulnerability to cybersecurity risks, and difficulties in monitoring the suppliers – all of these would have to be actively guarded against by active policy.

1016. **Other solutions would see the supplier solving the initial demand coordination problem but not going as far as to own the assets.** This can be observed in the Polish heat pump market. There, heat pump suppliers provide the information, access to finance (via explicit partnerships with banks), and administration of applying for the government subsidy of circa £5,000 for a heat pump and £6,000 for a heat pump with a solar panel and thermal storage. The process of obtaining all the changes at once is made much easier, as evidenced by the record growth in heat pump deployment in 2021. In this model, the household still owns the assets, pays its own electricity bill, and gets money back for the electricity produced from its solar panels and sold into the grid; the suppliers' active role helps to break down the barriers between demand-side response, storage, renewables, low-carbon heat and retrofits.

Pillar 6: Net Zero and the Future

Decisions taken today will be critical for the UK's ability to reach net zero by 2050 in a pro-growth and low-cost way. They will also set the stage for the kind of economy and society we want after 2050. The UK must apply this long-term view to all the issues raised in this Review. In particular, there are three areas that require action today, with a view to the 2040s, 2050s and beyond:

Research and development. The UK must take advantage of its world-leading university and research sectors to deliver the technologies of the future and capture growth.

Carbon markets. The UK must ensure that the true price of carbon emissions continues to be better reflected in the economy, going further on its Emissions Trading Scheme whilst mitigating the risk of carbon leakage, and setting out clear standards for the Voluntary Carbon Markets.

The UK's international presence. Following its successful COP26 presidency, the UK must review its international strategy for net zero.

We must act now. On all three, we are at diverging paths. We can either choose to take advantage of emerging R&D discoveries and technological opportunities and to grow carbon markets, or miss the chance to support our innovators who could be enticed by other exciting opportunities abroad.

Key recommendations

R&D and technology innovation for Net Zero

1. Work backwards from 2050 and apply whole systems thinking to create a roadmap, by Autumn 2023, which details decision points for developing and deploying R&D and technologies that are critical for enabling the net zero pathway to 2050.
2. Review how to incentivise greater R&D for net zero, including considering the role of clarity on research priorities and government support, tax credits, greater ring-fencing of R&D spend, and enabling regulations.
3. Make regulatory processes more agile to match that of innovation by a) establishing up to three new R&D demonstrator projects, out to 2035, aligning with the ten-year missions set out by this review, and b) including in forthcoming work from the Office for Science and Technology Strategy (OSTS) how regulators can provide more opportunity for demonstrations for net zero technologies.

Carbon leakage

4. Government should progress with the consultation on carbon leakage measures and speed up decision-making to enable government to implement effective future carbon leakage mitigations from 2026.

Carbon Markets

5. To provide businesses with certainty and increase the incentives to invest in new, green technologies, by 2024 the Government should work within the UK ETS Authority to develop a pathway for the UK ETS until 2040.

International Trade

6. By 2024 government should establish baseline environmental and climate protections in FTAs and for removal of trade barriers to environmental goods and services

International Climate Leadership

7. Strategic review of the UK's international climate leadership by 2023 and ensure the 2030 Strategic Framework on Climate and Nature provides practical direction for the UK's international climate and nature leadership.

6.1 The future of net zero and beyond

1017. **This Review is looking beyond the urgent questions of today – to the opportunities for success in the future.** The national strengths and challenges set out elsewhere in the report are often the result of success or failure over many years. Single policy decisions by themselves rarely achieve transformational results – good or bad. Responses to the Review have been strikingly consistent in setting out the importance of long-term, consistent thinking in achieving success. This seems particularly true of net zero, which focuses on a target almost 30 years in the future. We must take a long-term approach and lay the groundwork for success over many decades. This must account for the interim milestones that need be met to deliver us to 2050 (for example, meeting our Sixth Carbon Budget and our Nationally Determined Contribution aims for 2030).

1018. **The future is inherently uncertain – but we know some things will matter greatly.** We know that new technology and new business models will be vital for our progress up to 2050 and for what the world looks like afterwards. The UK is well-placed to drive innovation here – capturing growth opportunities and leading global collaboration. We know that the economy requires a fundamental change in its incentive structure to move us away from burning fossil fuels that are cheap in the moment but create devastating and expensive harm in the future. The UK can continue to drive reform here, supporting companies to invest in offsetting their emissions and building a global market that reflects the true price of carbon. Finally, we know that net zero relies on global collaboration. Following the UK's COP presidency, now is the time to ask ourselves what our long-term strategy is for working with the rest of the world to respond to climate change.

6.1.1 Enabling the future of innovative R&D and technology for net zero

1019. **Research and Development (R&D) and technological innovation is an essential component for achieving net zero.** Without it, it would be extremely difficult to achieve our decarbonising ambitions to 2030, 2050 and beyond.[719] The UK excels in innovating and driving forward investment into early-stage R&D and technology. However, if the UK is to achieve both a) its net zero ambitions, and b) the creation of thriving net zero technology markets in 2050 and beyond, relevant R&D and technologies must scale up at pace. The UK must address the immediate and long-term barriers which limit this ability to scale-up.

6.1.2 The sector today

1020. **Through its world-leading university and research sector, the UK is well positioned to play an important global role in net zero R&D and technology innovation.[720]** Of the actions that must be taken to deliver on the UK's 2035 decarbonisation ambitions, 84% requires low

carbon technologies or fuels in combination with behavioural change (Figure 6.1).[721] The Climate Change Committee (CCC) has estimated that additional capital investment into low carbon technologies and infrastructure needs to reach £50-£60 billion per year by the early 2030s to meet the UK's net zero targets.[722]

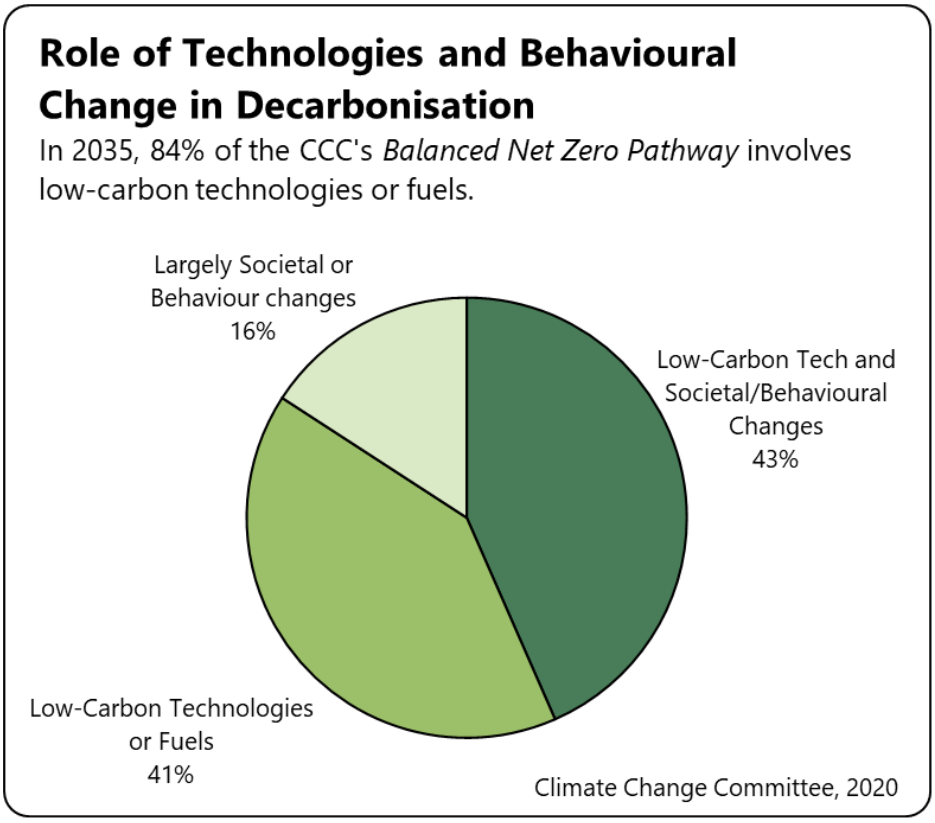


Figure 6.1 – *Role of technologies and behavioural change in decarbonisation*

1021. **Technological innovation is pivotal to sustained economic growth – and to avoid putting difficult asks on the population.** Forthcoming research from the Government Office for Science's *Net Zero Society* study demonstrates that achieving net zero without new technology would require significant societal changes which may not be acceptable to all.

> *"While science and technology alone cannot achieve net zero, we shall not achieve net zero without science and technology".* – Royal Society[723]

1022. **The UK can capitalise on the economic growth opportunities from R&D.** Members of the Council for Science and Technology (CST), who include leading voices from academia and business, told the Review that if the UK can maintain and scale-up R&D and support emerging technologies to market, it stands in a strong position to create high-growth and wage industries for net zero into and beyond 2050:

> *"The net zero space is forecast to be a significant growth area as carbon-neutral solutions ramp up towards government targets and new technologies come online. Research and innovation supporting and enabling net zero for the UK can and will deliver a series of benefits in meeting our economic growth target of 2.5% a year"* – Council for Science and Technology members.[724]

1023. **The UK has recognised this potential and placed an emphasis on supporting innovation in net zero.** Agencies including UK Research and Innovation (UKRI) and Innovate UK support a range of net zero innovations. The Catapults network (a network of technology and innovation

centres established by Innovate UK) have been successful in bridging the gap between early-stage research and commercialisation by investing over £2.5 billion to move innovations towards commercial stages. For example, the Offshore Renewable Energy Catapult network was integral in supporting subsea cable manufacturer JDR Cables to bring its pioneering 66kV cable technology to market, allowing increased transmission between turbines at higher-capacity offshore wind farms. This has been a factor in reducing offshore wind costs and created hundreds of roles.[725]

1024. **The Government recognised the importance of the R&D and technology sector for net zero in its 2021 *Innovation Strategy*, acknowledging that the net zero target was a pivotal moment for the UK's future prosperity.** The strategy committed to increasing annual public investment in R&D to a record £22 billion. This was accompanied by publication of the *Net Zero Research and Innovation Framework*, which provides a first statement of the key research and innovation to prioritise over the next 5-10 years and will be further complemented by a delivery plan. Moreover, the Government's Net Zero Innovation Board provides £1 billion of funding to accelerate the commercialisation of low-carbon technologies and infrastructures.

6.2 Getting R&D and technology for net zero ready for the future

1025. The Review has heard from many voices– including members of the Council for Science and Technology and multiple roundtables with representatives from academies, industry, and trade unions – **that the UK can do more to optimise growth in net zero R&D and technology.** The Energy Systems Catapult for example told us that "…many UK innovators face systemic barriers preventing products, services and business models getting to market at scale".[726]

1026. **Much of the progress being made in innovation and research into net zero technologies remains at low technology readiness levels (TRLs)** (see Figure 6.2 below).[727] Technologies remaining at a low readiness level – i.e. being further away from being ready to use – is problematic given R&D and technology need to be deployed at a commercial scale to help achieve net zero ambitions.

1027. **There is a gap in the stage that investment occurs.** PwC outlined in their *Net Zero Future50* report that: "Investment has been skewed towards the "low-hanging fruit" of well-proven technologies, leaving a series of sectors underfunded, where there are commercially viable approaches with high carbon abatement potential.[728] Many stakeholders, including venture capitalists and private equity firms and attendees at a roundtable hosted by the Royal Society, highlighted a gap in investment between technologies at the very early stages of development, and those which are mature, late-stage technologies. This gap is known as the "valley of death".[729] It needs to be addressed: the International Energy Agency, in their 2020 *Special Report on Clean Energy Innovation,* warned that "40% of emission reductions rely on technologies not yet commercially deployed on a mass-market scale."[730]

Maturity	Area
Success – TRL9 achieved	• Battery-electric passenger cars • Hydrogen/fuel cell passenger cars • Wind power • Solar PV • Large scale (>1GW) nuclear power • Electricity HVDC inter-connectors and HV transmission systems
Ripe for Development – Currently at c. TRL7	• Carbon capture, utilisation and storage • Battery-electric and/or hydrogen fuel cells for heavy vehicles, buses and trains • Bio-energy with carbon capture & storage • Small, modular nuclear power • Domestic heat pumps in substantial quantities • Flow batteries • Direct reduced iron
More work Required – Lower TRL's	• Domestic retrofit insulation & heating in quantity • Direct air capture of CO_2 • Compressed air, liquid air, and gravity energy storage • Nuclear fusion • Space-based solar power

Figure 6.2 – *Institution of Mechanical Engineers 175 (2022), 'Engineering a Net Zero Energy System'*

1028. **The stakeholders we spoke to said that the following areas must be addressed to enable R&D to move at the appropriate scale and pace:**

1. The prioritisation and direction of R&D and technology development for net zero needs to be more clear
2. More technologies need to be scaled up to more mature commercial products
3. Regulators should be agile enough to match the pace of innovation

Understanding net zero R&D and technology priorities

1029. **The UK needs to understand which technologies provide the UK with greatest strategic advantage in terms of their current and potential decarbonising capabilities and drive economic growth between now and 2050.** This was raised by the Industrial Decarbonisation Research and Innovation Centre (IDRIC) and echoed by attendees at a R&D and technology roundtable. They advised that the UK should ensure it is identifying, nurturing, and supporting sectors in which we already have strengths and those of strategic importance with potential for future high returns, while ensuring a full toolkit of decarbonising options is available to industry.

1030. **Government is taking action to understand these priorities.** BEIS's R&D prioritisation for the Net Zero Innovation Portfolio, worth £1 billion over the 2021-2025 spending review period, was set up based on evidence from the Energy Innovation Needs Assessments (EINAs). Their use for prioritisation was tailored to technical and commercialisation needs for 2019-2024. Additionally, we understand that Government intends to undertake analyses to determine which technologies should be defined as priorities for decarbonisation and economic growth. This will help to determine how the Government can best support UK science and technology for net zero.

1031. **This Review advises that government should consider updating the Energy Innovation Needs Assessments ahead of the Government developing the post-2025 net zero innovation portfolio, to reflect the fast rate of change in the clean technology sector.** This would help determine priority technologies to accelerate decarbonisation and economic growth. The outcomes of this and the Government's priority technologies work should be used to inform the below roadmap recommendations.

6.2.1 Providing a direction of travel with decision points

Government should **create a roadmap,** by Autumn 2023, which details decision points **for developing and deploying R&D and technologies that are critical** for enabling the net zero pathway to 2050.

1032. **Greater clarity is needed on the long-term direction of net zero R&D and technology.** Stakeholders across industry and academia were clear that for the UK to have technology which meet net zero ambitions, there must be a clear understanding of the R&D and technological developments that must occur between now and 2050, and the factors which will impact these. The British Private Equity and Venture Capital Association and Royal Society, for example, advised that there must be a clear overarching roadmap that outlines the key decisions that need to be made for the development and deployment of net zero R&D and technologies leading up to 2050. The Review supports this call. Based on the evidence provided, this roadmap should include all net zero sectors, including for example aviation and maritime for which suitable zero emission technologies still need to be defined (see ***Pillar 3***).

This overarching net zero R&D and technology roadmap should include decision points for all relevant net zero technologies in their varying stages of development and the R&D to enable them; from those which are already mature, to those in very early stages of development. The decision points in the roadmap must be clear and transparent to give confidence in the market prospects of these technologies to innovators and investors.

1033. **The BEIS *Net Zero Research Innovation Framework* and *Net Zero Strategy* goes some way to provide this detail, looking ahead to the next 5-10 years.** However, some stakeholders felt that neither of these provide decision points for critical R&D fundamental to developing relevant net zero technologies, nor do they "provide a clear enough direction of travel to industry" (Royal Society – written evidence provided to the Review).[731] The British Private Equity and Venture Capital Association told us:

> *"The UK Government needs to develop a detailed Net Zero Roadmap, setting out clear commitments and actions on public investment and policy covering how it is going to get the UK to Net Zero. This will catalyse investment into the areas that will be crucial to achieving Net Zero as it gives investors, including PE [Private Equity] and VC [Venture Capital], clarity on the industries the UK will support"* – British Private Equity and Venture Capital Association[732]

1034. **Stakeholders recommended a roadmap working backwards from 2050 to determine the critical points at which decisions must be made for the development and deployment of these technologies (and relevant R&D).** They also echoed the sentiments of the Council for Science and Technology's 2020 *Achieving net zero through a whole systems approach* letter to the Prime Minister, advising that any such roadmap must take a whole systems approach to determine the dependencies and factors that enable these developments. For example, IDRIC advised that timelines for planning and consenting, legislative timetables, upgrades to new and existing infrastructure, incentives, and resources required were all vital for informing decisions. The Royal Society told us:

> *"Working together, through an agreed roadmap, academics with businesses and consumers can have the confidence in the direction of travel to a long term and predictable goal"*[733]

1035. **To gain buy-in from sectoral leads and deliver the certainty needed, the roadmap must be informed by those it is relevant to.** Stakeholders including members of the Council for Science and Technology and Royal Society advised that a range of relevant stakeholders from across sectors, including but not limited to those in academia, government, finance, and industry should be consulted to inform this work. These stakeholders can then lead on developing solutions to meet the roadmap's decision points.

1036. This Review recommends that, by Autumn 2023**, a roadmap must be created which details decision points for developing and deploying R&D and technologies** that are critical for enabling the net zero pathway to 2050. This must:

- Set out the **Government's expected pathway to net zero** from now to 2050.
- Set out the **overarching key decision points** a) for all technologies that must be developed and deployed which will enable this pathway, and b) the R&D to enable these technological developments.
- Incorporate a **whole systems approach**. The roadmap must be informed and taken forward by a cross-sectoral range of relevant stakeholders and consider interdependencies such as timelines for planning and consenting, legislative timetables, infrastructural requirements, public and private financing, and business model improvements.

Financial signalling for certainty

1037. **The UK must take steps now to ensure the net zero R&D and technology sector can rapidly scale up to match the pace of what net zero requires.** Many stakeholders in our roundtables pointed out that interventions need to be made to ensure net zero R&D and technologies can be rapidly scaled up to meet ambitions for 2030 and beyond.

1038. **The net zero technology sector is valuable and growing – and returns on investment rank competitively against other technologies.[734] Despite this, some investment into the sector is slowing (Figure 6.3).[735]**

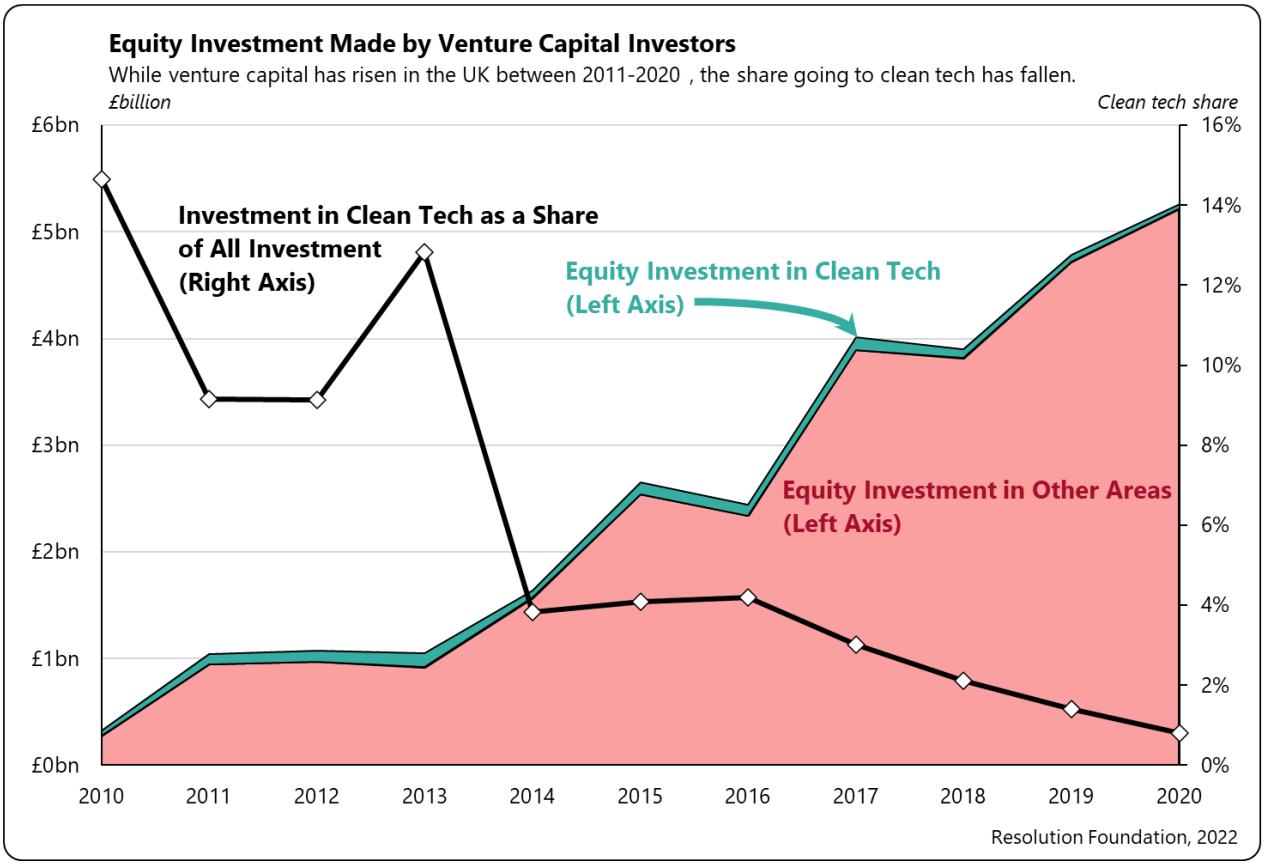


Figure 6.3 – *Equity investment made by venture capital investors*

1039. **Many stakeholders told us that a lack of investment is preventing the scale-up of net zero technologies to commercialisation**. Stakeholders raised that the UK net zero R&D and technology sector is experiencing the "valley of death" between early-stage technologies and commercial scaled-up products.

> *"It is difficult to sell small projects to investors as an investment proposition. Furthermore, there are some strong ideas with weak deployment."* Council for Science and Technology Members[736]

1040. **Other countries are moving ahead of the UK in R&D spending.** Imperial College London raised how proactive other international partners are in providing early-stage funding compared to the UK. Stakeholders suggested that without further financial intervention, the UK could lose economic advantages from emerging R&D and technologies for net zero to other nations.

> *"… the global move towards a low carbon future are recognised by our competitors: the US recently proposed its largest-ever increase in non-defence R&D spending, Germany is targeting 3.5% of GDP on R&D and China's R&D spending hit a record high of 2.4% in 2020*

and is now targeting annual increases of 7% or more in each of the next five years. Recent data from the IPPR has shown the UK's share of global R&D investment has fallen by a fifth since 2014." - Imperial College London[737]

1041. **Stakeholders suggested that a lack of market signals and government commitment is a factor behind the limited investment and scale-up past research stages.** They advised that investors need confidence that the emerging R&D and technologies for net zero have a sustainable future and commercial viability, and that there are economic opportunities to be reaped.

"Government should signal to the world the UK is the place for businesses to undertake late-stage R&D and unleash net zero innovation with clear signposting of the UK offer" - Royal Academy of Engineering[738]

6.2.2 Reviewing financial levers

By Autumn 2023, Government should review **how to incentivise greater R&D for net zero**, including considering the role of **clarity on research priorities and government support, tax credits, greater ring-fencing of R&D spend, and enabling regulations**.

1042. **Roundtable attendees advised that tax credits for early-stage (and often SME) R&D could incentivise investment into technologies in the earlier stages of their investment.** A range of stakeholders feeding into this Review, from green tech start-ups through to academies and universities suggested that the Government considered how best to implement R&D tax credits for net zero. They advised that doing so would signal the Government's commitment to the sector – and in doing so encourage private investment, thus reducing the cost of capital scaling up products from low TRLs, and driving down costs.[739]

1043. **Stakeholders pointed to the move by the USA to champion tax credits for decarbonising technology in their Section 45Q and Inflation Reduction Act** (discussed more in ***Pillar 3***). We heard from SMEs, particularly in the Greenhouse Gas Removals sector, of the appeal such tax credits provide to re-locate from the UK. The Government should consider the case for similarly bold action as part of a wider review of tax incentives for business investment if it is to a) retain new and current decarbonising technology businesses and b) support technologies to move towards commercialisation.

1044. **Stakeholders were clear that tax credits alone will not be enough to demonstrate Government commitment.** Some including Business in the Community stressed the need for increased R&D expenditure and its role in driving economic growth. Imperial College London explained that "…£1 of public R&D investment leverages around £2 of private investment and, at Russell Group universities like Imperial, an average return of £9 to the UK economy." [740] Stakeholders told us that increasing R&D spend is vital if the UK is to maintain its competitive position the USA, China, and Germany.

"Failure to invest in R&D will have a detrimental impact on the UK's ability to innovate and scale up technologies and solutions and could cost the profound benefit of first-mover advantage" – Imperial College London[741]

1045. **This Review recommends that by Autumn 2023, BEIS and HMT review how to incentivise greater R&D for net zero**, including considering the role of clarity on research priorities and government support, tax credits, greater ring-fencing of R&D spend, and enabling regulations.

Regulatory agility to match rapid innovation

Government should establish **up to three new R&D demonstrator projects**, out to 2035, **aligning with the ten-year missions set out by this Review**. These should be considered when creating the overarching R&D and technology roadmap.

Government should include in forthcoming work from OSTS **how regulators can provide more opportunity for demonstrations** for net zero technologies.

1046. **The regulatory environment is a critical factor in determining the commercial success of net zero R&D and technology innovation**. Stakeholders including Coadec Startup Planet and Imperial College London supported this, and members of the Council for Science and Technology advised that relevant regulations and standards "must be agile and responsive to enable companies to capitalise on the opportunities from emerging technologies relevant to net zero".[742]

> *"…it is not the absence of regulation that has greater potential to drive markets and growth, but rather the presence of smart regulation that is responsive to emerging developments"* – LSE[743]

1047. **The Government recognised the need for greater regulatory agility to match innovation.** It acknowledged this in the 2021 *Innovation Strategy* which sought to consult on how regulation can ensure that the UK is well-placed to extract the best value from innovation.

1048. **Demonstrations are vital for emerging net zero technologies.** Stakeholders including the Royal Academy for Engineering and Energy Systems Catapult raised how vital demonstrations are to provide assurance to potential investors in the viability of an emerging technology. An example of can be seen in the below case study.[744]

1049. The Faraday Battery Challenge is a good example of the Government using demonstrator projects to show its long-term commitment to support net zero critical innovation. The Government committed up to £541 million to develop the UK battery technology industry. This included funding feasibility studies, industrial research and experimental development – funded in partnership with industry.[745] This programme was specifically developed in recognition that R&D was crucial to addressing a strategic challenge coupled with an economic opportunity (in this case, the growing reliance on battery technology). This Review has found many other such challenges, as summarised in its ten strategic missions.

1050. **Regulators can support demonstrations of new technologies to interested innovators.** SMEs and roundtable attendees felt regulators could play an important role in enabling demonstrations. Nesta for example noted in a working paper on the "rise of 'anticipatory regulation' approaches" to match the pace of emerging net zero technologies which include various forms of demonstration.[746] The European Marine Energy Centre advised the Review that "[regulatory bodies] must introduce an element of flexibility for testing and demonstration purposes. Otherwise, we will never be able to learn about these new systems and develop learnings around their functionality, management, and safety dimensions for future standards to be defined."[747]

CASE STUDY: Regulators and Demonstrations

Ofgem Sandboxes

Through the provision of an Ofgem 'Sandbox' award, Emergent Energy have been able to trial a "smart local energy system" business model operating microgrids that connect individual houses and flats to on-site net zero technologies to supply green electricity and heat generate on-site to residents.

The aim is to integrate the equipment to cut running costs and reduce residents' bills. The Sandbox enables Emergent to trial this process whilst also scaling up its offer for housing companies.

These Sandbox awards enable innovators to trial new business models and products without some of the usual regulatory rules applying. After the trial has ended Ofgem will consider the results during future policy development.[748]

1051. Building on the success of the Faraday challenge – and to demonstrate long-term commitment to the biggest issues in the net zero transition – **we recommend establishing up to three new R&D demonstrator projects, out to 2035, aligning with the ten-year missions set out by this review. These should be considered when creating the overarching R&D and technology roadmap.**

1052. The Government Chief Scientific Advisor (GCSA) was tasked in the recent Autumn Statement with reviewing how the UK can better regulate emerging technologies to ensure growth. **We recommend that this forthcoming work from the Office for Science and Technology Strategy (OSTS) considers how regulators can provide more opportunity for demonstrations for net zero technologies.**

Mission: Catalyse decisions and action with an R&D and technology roadmap to 2050, pushing for more agile regulation, and supporting up to three 10-year demonstrators	
Issue heard by the Review	**Action recommended**
Stakeholders suggested that **a lack of market signals and Government commitment towards net zero R&D and technologies** is a factor behind limited investment and scale-up past research stages.	**By Autumn 2023, Government should review how to incentivise greater R&D for net zero, including considering the role of clarity on research priorities and government support, tax credits, greater ring-fencing of R&D spend, and enabling regulations**
Demonstrations are vital for emerging net zero technologies. Stakeholders raised how vital demonstrations are to provide assurance to potential investors in the viability of an emerging technology.	**Government should establish up to three new R&D demonstrator projects, out to 2035, aligning with the ten-year missions set out by this review. These should be considered when creating the overarching R&D and technology roadmap.** **Government should include in forthcoming work from OSTS how regulators can provide more opportunity for demonstrations for net zero technologies.**

Greater long-term clarity is needed on the direction and development requirements of net zero R&D and technology.	**Government should create a roadmap, by Autumn 2023, that details decision points for developing and deploying R&D and technologies that are critical for enabling the net zero pathway to 2050**.

6.3 Carbon leakage

Government should **progress with the consultation on carbon leakage measures** and speed up decision-making to enable Government to **implement effective carbon leakage mitigations** from 2026.

1053. **UK efforts to reach ambitious net zero carbon targets could be undermined by carbon leakage.** Carbon leakage is the displacement of production and associated emissions from one jurisdiction to another, due to different levels of climate action across jurisdictions including through carbon pricing and climate regulation. As a result, global emissions in affected sectors could stay the same or rise further. The Net Zero Review conducted by HM Treasury in 2021 suggested that some UK manufacturing sectors have substantially lower emissions intensities compared to some trading partner.[749] This means overall increase in emissions in addition to the displacement of UK industry.

1054. **Carbon leakage poses a risk to UK growth through forgone investment in UK industry, offshoring of production and jobs, and greater impacts from climate change associated with higher global emissions**. Current carbon leakage policy for UK sectors at greatest risk of carbon leakage is based on Free Allowances under the UK Emissions Trading Scheme (ETS). This provides an asset that can be monetised to support efficiency and decarbonisation, or mitigation against carbon costs. The free allocation approach is being reviewed to seek improvements and, while that is going on, free allocation is guaranteed at current levels until 2026 (worth £2.4bn in 2021).[xxxix] Additionally, the Government recently extended the Energy Intensive Industries Compensation Scheme until March 2025, compensating firms at risk of carbon leakage for the indirect emission costs in electricity prices due to the UK ETS.

1055. **Carbon leakage should be considered within the UK ETS.** Any development of the UK ETS carbon pricing regime (see below) to reduce the cap, phase out free allowances, or include additional sector should consider the risk of carbon leakage and ensure that sufficient mitigation measures are in place.

1056. **Sectors at greatest risk of carbon leakage are highly-traded and energy intensive.** They include steel, chemicals, refineries, glass (including ceramics), aluminium, cement, paper and pulp, agriculture, and textiles. The highest-risk energy intensive industries, not including agriculture, represent approximately £39 billion (or 1.9%) of the UK's GVA, approximately 360,000 direct employees and approximately 10% of total UK greenhouse gas emissions (2019), with hubs in the North East, Yorkshire and the Humber, West Midlands, and Wales.[750] Similar concerns have been voiced by industry stakeholders for the Review:

> *"High UK carbon prices and reduced allocation of free ETS allowances, will increase the risk of carbon leakage and reduce availability of capital to invest in decarbonisation. Decarbonisation should not lead to deindustrialisation."* – Manufacturers' Climate Change Group (MCCG) and Energy Intensive Users' Group (EIUG)[751]

1057. **Through the roundtables, the Review has heard concerns about carbon leakage from numerous energy intensive industry stakeholders, calling for the Government to speed up action and decision-making.** In particular, a Carbon Border Adjustment Mechanism (CBAM) similar in design to the EU's (see below) is a popular policy proposal to mitigate carbon

[xxxix] Using average UK ETS price for 2021

leakage. A CBAM would apply the UK ETS price to imported goods, ensuring that UK producers and consumers play on a level playing field. Encouraging UK industry to decarbonise without applying similar standards and costs to imported materials and goods will make the UK uncompetitive, stakeholders argued.

1058. **Any international solution to carbon leakage requires progress on establishing methodology to establish the fair comparison of measuring emissions and mitigations.** This requires the development of a common international approach to measuring the carbon footprint of key products and assessing the comparability of different approaches to emissions mitigation. The Government is parts of efforts to build consensus across the G7, G20 and OECD, and should extend this work in order to improve the integrity of domestic carbon leakage mitigation measures.

1059. **Internationally, other actors are taking action to mitigate carbon leakage.** The most advanced policy is the EU's proposed CBAM, the design of which was going through the final stages of negotiations at the time of writing. The EU will implement reporting requirements from 2023, moving on to a full rollout in parallel to the phase-out of EU ETS Free Allowances[xl]. The full CBAM will involve charging imports a charge corresponding to the EU ETS price the good would have incurred, had it been produced in the EU. The EU model includes a deduction based on the carbon price paid in a third country, such as the UK, but those exporters would still need comply with the reporting requirements. This highlights the difficulty that multiple different unilateral measures could pose for free trade even between countries with similar levels of climate ambitions and carbon pricing. In an attempt to provide a forum for like-minded countries to work together on mitigating carbon leakage, the G7, led by Germany, is looking to set up a Climate Club.[752] Nonetheless, WTO non-discrimination rules could make it difficult for to coordinate trade policy on CBAMs, particularly considering that the USA and Japan do not currently have a carbon price.[753] In addition to the EU's plans for a CBAM, the Canadian government published a consultation for a Border Carbon Adjustment at the start of 2022.

1060. **At a time when stakeholders need certainty in the face of high energy prices, the Government should move forward with its plans to consult as quickly as possible and provide industry with a clear timeframe for decision-making and implementation.** Given the difficulty agreeing on mitigations internationally, a meaningful international solution to carbon leakage should be considered a long-term solution and as such the Environment Audit Committee noted in 2022 that "work should start now on a comprehensive UK carbon border approach to address the risks of carbon leakage… [which will] spur international action on multilateral approaches to carbon pricing".[754] In May 2022, the Government announced an intention to consult on a range of carbon leakage mitigation measures by the year of the 2022, but this has still not gone ahead. Government should move forward with these plans as quickly as possible, identifying the most appropriate form of carbon leakage mitigation for the UK. This could include a CBAM or mandatory product standards, but care needs to be taken with regards to the risk of circumvention and WTO compliance.[755]

1061. **As evidenced above, other major international actors have more progressed policies than the UK** – for comparison the European Commission consulted on the EU CBAM in 2020. When other jurisdictions restrict access to their markets, the risk of carbon leakage and dumping of high emission goods in the UK would presumably increase further, and as such

[xl] At the time of writing the exact timing of this was still subject to inter-institutional negotiations at the EU level.

weakening the position of UK producers. This highlights the need for the Government to take action swifty to reassure stakeholders.

1062. **The Government should progress its consultation on carbon leakage measures, including a CBAM and mandatory product standards.** The UK is falling behind on carbon leakage mitigation measures compared to other major actors, such as the EU and Canada. Additionally, industry is increasingly concerned about the lack of certainty of carbon leakage mitigations in the light of current the review of the UK ETS and Free Allowances (see below). **While progressing on the carbon leakage consultation, the Government should continue to pursue international coalitions on carbon leakage** to minimise trade disruption amongst climate ambitious countries caused by multiple different unilateral carbon leakage measures.

6.4 Future carbon markets

6.4.1 The future of the UK ETS

1063. **Carbon pricing is the most cost-efficient way to support transition to net zero on an economy-wide scale. It is an instrument to capture the societal cost of greenhouse gas emissions and tie them to emitters through a price paid for the carbon emitted.** This means the burden for carbon emissions is shifted to those who are responsible for emissions, incentivising them to reduce those emissions. As such, carbon pricing does not dictate who should reduce their emissions or how, but instead provides a price signal to emitters to decarbonise or pay for their emissions.[756] **By placing an adequate price on emissions, businesses are incentivised develop clean technologies, mobilising the financial investments required to stimulate green innovation and fuel low carbon drivers for economic growth**.[757] The UK Emissions Trading Scheme (ETS) is the UK's principal mechanism putting a price on carbon and functions as a cap-and-trade system where government sets an emissions cap and issues emissions allowances consistent with the cap. These emissions allowances can be bought and traded between participants.

1064. **The UK has been a pioneer of emissions trading since 2002, establishing Europe's first emissions trading scheme as a pilot for the EU ETS.**[758] In 2021, to replace the EU ETS after leaving the EU, the UK ETS was established. The UK ETS currently covers power, heavy industry, and some of the aviation sector; around 25% of UK territorial emissions. For firms covered by the ETS, the carbon price informs decisions by individual businesses about whether it is more cost-effective to invest in decarbonising or to pay to continue emitting. It provides a long-term price signal that, when supported by complementary mechanisms, can deliver a stable investment case for decarbonisation, reduced fossil fuel consumption and optimised energy efficiency, and an incentive to develop the low-emission technologies needed to enable a thriving net zero economy.[759] [760] The Government recognised the cost effectiveness of carbon pricing in delivering decarbonisation in the 2021 *Net Zero Review* published by HM Treasury,[761] and the UK ETS and the compliance carbon market remains central to achieving Net Zero by 2050.

6.4.2 Reforming the UK ETS

1065. **The UK ETS has a cap set on the total amount of certain greenhouse gases that can be emitted by sectors covered within the UK ETS scheme.** With the cap on total emissions set to decrease over time, this provides a clear signal to businesses to invest in decarbonisation as the cost of ETS allowances is likely to increase as the cap is reduced. The current legislated ETS cap only runs until 2030, and, as the Climate Change Committee (CCC) emphasised in its advice on the Sixth Carbon Budget in December 2020,[762] it is not aligned to delivering net zero by 2050.

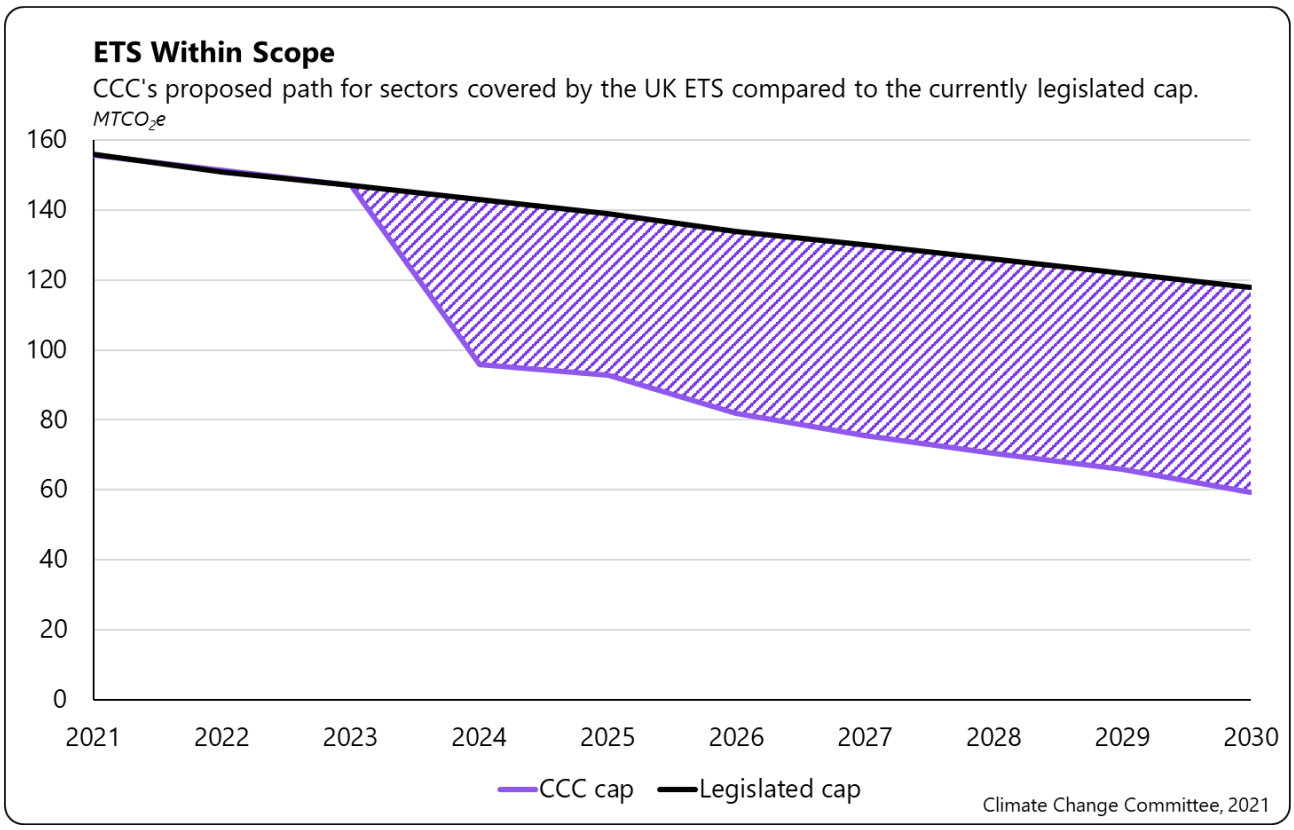


Figure 6. 4 – *CCC's proposed path for emissions for sectors covered by the UK ETS, as per their updated 2021 advice, compared to the currently legislated cap*[763]

1066. Following these recommendations, the UK ETS Authority[xli] has committed to making this adjustment by 2024 by aligning the cap with net zero and the interim Carbon Budget targets for covered sectors. The Authority published a consultation in March 2022 and the market is expecting this change. The Review has heard a mixed signal from industry stakeholders with regards to whether these changes are already factored in by industry. This reflects the need for ongoing engagement and clarity by the Government on emerging plans.

1067. In addition to making the cap net zero aligned, **the Authority is also consulting on expanding the UK ETS to the domestic maritime sector by the mid-2020s and has launched a Call for Evidence to expand the UK ETS to waste and energy from waste by the mid- to late-2020s.** Through adding these sectors, up to an additional 12$MtCO_2e$[xlii] of current UK annual emissions could be covered by the UK ETS, depending on scope of the scheme.[764] For waste specifically, we have had stakeholder feedback that an important barrier to their investment in green technologies is the lack of a carbon price on their emissions. With an investment horizon of more than 15 years, the Government needs to provide policy stability to the sector.

1068. **The consultation also suggests accounting for investments in greenhouse gas removals (GGRs) to the UK ETS. Adding GGRs into the UK ETS could help establish the demand for carbon removal measures by providing a mechanism for companies with existing ETS obligations to use of removals in addition to emissions reductions by 2050.** The longevity, integrity and long-term policy certainty offered by the UK ETS provides a credible commitment to future demand for GGRs. Including GGRs would evolve the ETS so that it

[xli] The UK ETS Authority is composed of the UK Government, Scottish Government, Welsh Government and Northern Ireland Executive.

[xlii] 12 $MtCO_2e$ is made of 6 $MtCO_2e$ for maritime transport and 6.4 $MtCO_2e$ for energy from waste.

becomes a market framework within which businesses can make economically efficient choices between paying to emit, paying to sequester, or investing to lower emissions. This requires government to set clear guidelines for how and when GGRs can be utilised alongside emissions reduction efforts. An integrated market framework could sustain net zero – or net negative – beyond 2050 whilst enabling growth. The UK Government has not yet taken a final decision and UK ETS integration should be considered alongside other ways to support GGRs, taking fiscal impacts into account.

6.4.3 The UK ETS beyond 2030

By 2024, Government should work within the UK ETS Authority to develop a pathway for the UK ETS until 2040. This pathway should:

- Set out a vision on the future design and operation of the ETS
- Set out a timeline for expanding the coverage to the rest of the UK economy, as well as sectors consulted on including maritime and waste.
- Address inclusion of GGRs to incentivise early investment in new technologies and potentially nature-based solutions.
- Provide reassurance to businesses around how the Government will mitigate the risk of carbon leakage as a result of expanding the ETS.

1069. **Government needs to be clear about the future of the UK ETS beyond 2030**. While some initiatives in the consultation, such as the inclusion of GGRs, speak to futureproofing the UK ETS, there is currently no legislated cap or government strategy for what the UK ETS should look like beyond 2030 and even the road leading to 2030 is not clear for businesses currently. The feedback the Review has received from industry has consistently been that lack of clarity and certainty on the future of the UK ETS, combined with lack of certainty on carbon leakage measures (see above), contribute to delays in investments.

1070. **This lack of certainty and clarity about the future of the UK ETS risks delaying investment in green technologies.** The Authority's current approach of consulting on and introducing changes with two to four years' notice lacks the long-term price signal which could provide clarity for businesses to invest in long-term decarbonisation solutions and as such new green technologies.

1071. **The UK ETS needs to expand to new sectors.** HM Treasury acknowledged in the 2021 *Net Zero Review*[765] that widespread carbon pricing can apply a consistent incentive across all sectors of the economy, allowing the private sector to decide how to decarbonise most efficiently across sectors, and to do it at minimal cost. As such, the Authority should make clear an intention to expand the UK ETS beyond the sectors currently under consideration.

1072. By 2030, the current sectors covered by the UK ETS will only cover 18 % of UK territorial emissions[766] and as the table below shows, sectors such as agriculture and international aviation and shipping will continue to increase their share of the UK's emissions towards 2050 as other sectors decarbonise. This highlights the need to expand the scope of the UK ETS in order to ensure a meaningful carbon market of sufficient magnitude and further encourage other sectors to decarbonise.

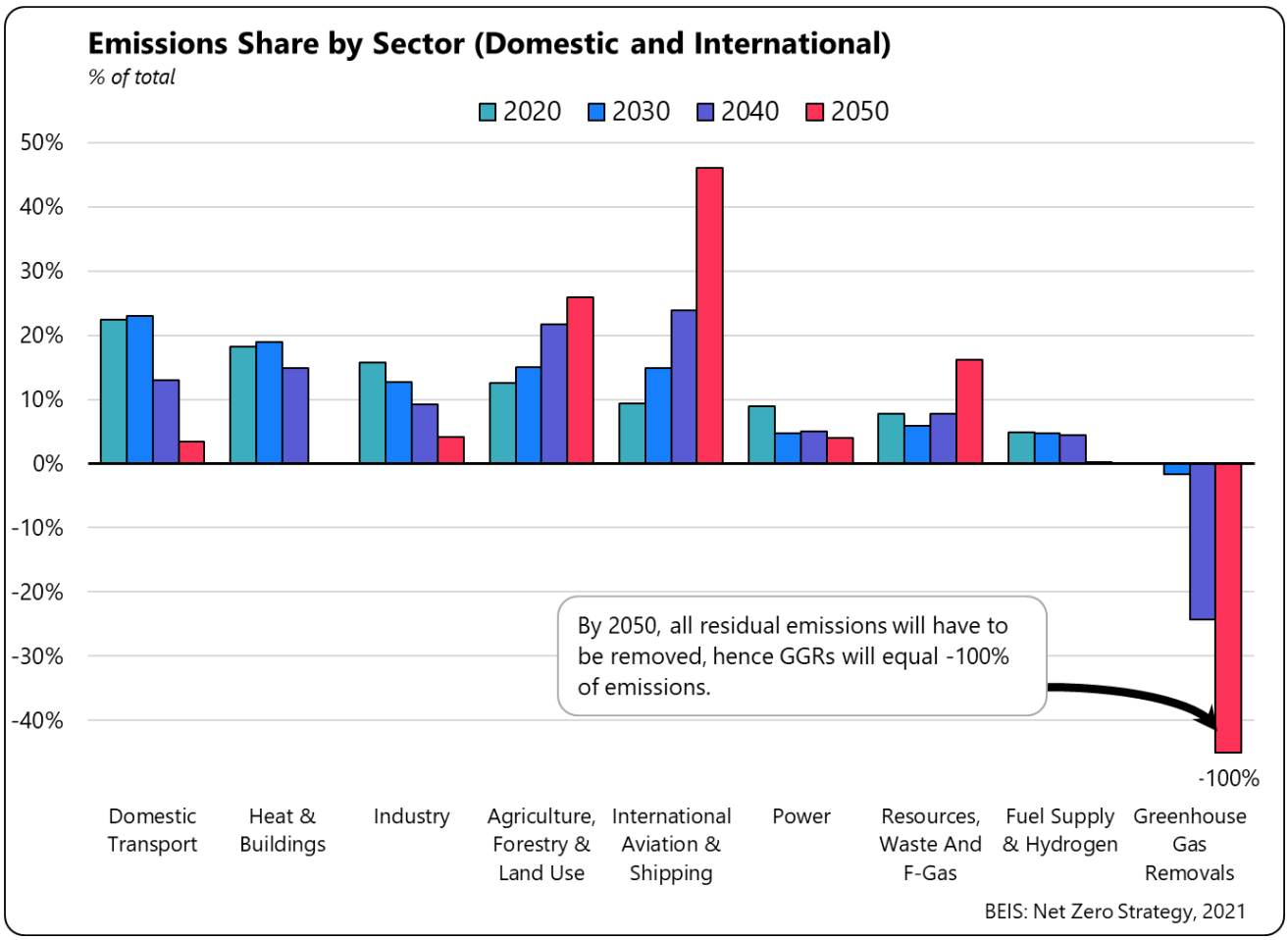


Figure 6.5 – ***Emissions share by sector: Domestic and international, 2020, 2030, 2040 and 2050***[767]

1073. Following the pathway set out in the Government's *Net Zero Strategy* and used for this chart, the **Government needs to consider expanding the UK ETS to sectors** such as domestic transport and heat and buildings by 2030 as these sectors will continue to have a high share of the UK's territorial emissions. However, such a move should be followed by government measures to mitigate the impact of this policy on particularly low-income households and small businesses.

1074. Expanding coverage of the compliance carbon market to cover a larger proportion of the economy and emissions is something other countries have done. Surrender obligations (the obligation to pay the auctioned price for one's emissions) under the New Zealand ETS currently covers 50% of the country's greenhouse gas emissions[768] and transitional arrangements are in place to bring the agriculture sector in by 2025 (see case study below). Similarly, the EU is currently negotiating the EU ETS II to cover transport and buildings. This is meant as a transitional measure to bring these sectors into the main ETS market and additionally raises funds to protect households from increased prices.

CASE STUDY: The New Zealand ETS

The New Zealand Emissions Trading Scheme was launched in 2008, but has undergone considerable reforms since, so it today covers a broad range of sectors; power, industry, buildings, transport, aviation, waste, and forestry. The most recent reforms included removal of the previous price ceiling and a new cap on unit supply which must be aligned with the country's economy-wide emissions budget.

Biological emissions from agriculture must be reported, but the sector currently faces no surrender obligation. Agricultural emissions will have a carbon price levied from 2025, either through the ETS or a separate pricing scheme.

The New Zealand ETS also allows the generation of credits from removal activities which are forecast to generate credits worth 16.5 million tonnes CO2 (or equivalent in other greenhouse gases) in 2022, primarily from forestry activity.[769]

1075. To provide businesses with certainty and increase the incentives to invest in new, green technologies, **the Government should work within the UK ETS Authority to develop a pathway for the UK ETS until 2040 by 2024**. This pathway should:

a) Set out a vision on the future design and operation of the ETS

b) Set out a timeline for expanding the coverage to the rest of the UK economy, as well as sectors consulted on including maritime and waste.

c) Address inclusion of GGRs to incentivise early investment in new technologies and potentially nature-based solutions.

d) Provide reassurance to businesses around how the Government will mitigate the risk of carbon leakage as a result of expanding the ETS.

6.5 Setting standards for voluntary carbon markets and offsetting

1076. **In the interim of expanding the compliance carbon market across most of the economy, voluntary carbon markets (VCMs) can provide an avenue for businesses to offset their carbon emissions by investing in greenhouse gas removals or energy efficiency measures (offsets), enabling businesses to reach net zero emissions ahead of the economy as a whole. This can further help pave the way for the compliance market.**[770]

1077. VCMs can mobilise much-needed investment in nature-based solutions and engineered GGRs and there is a potential to expand this to energy efficiency measures in local communities across the UK.

1078. The Government included questions about VCMs in the Call for Evidence for the updated Green Finance Strategy which has yet to be published. This highlights an increasing focus from government on the opportunities and risks brought about by a growing global carbon market, but this should be accelerated to ensure confidence in the market.

6.5.1 Standard setting

Government should **endorse international VCM standards as soon as possible** and consult on **formally adopting regulated standards** for VCMs and **setting up a regulator for carbon credits and offsets** by 2024.

1079. **High-integrity offsets bought by businesses can play an important role in the transition to net zero.** The Review's engagement with key investment stakeholders shows a real appetite to go further by offsetting greenhouse gas emissions outside of the UK ETS. However, before voluntary carbon markets can grow responsibly, businesses need assurance of the integrity of any offsets and greenhouse gas removal (GGR) investments. As such, government action can play a key role in setting standards for carbon offsets, providing reassurance to businesses and ensuring that investments lead to credible emissions reductions.

1080. **The space for offset standards is fragmented, to the detriment of the emerging carbon market.** There are various standards for offsets and their longevity set by organisations internationally. This has created a fragmented investment environment where it is difficult for businesses looking to invest to know the exact offset of their investment, as well as for businesses looking to attract investments and as such support emissions reductions and removals:

> *"The market for purchasing UK offsets is currently fragmented, inconsistent, and lacks regulation and verification mechanisms. Addressing this would support the reduction of emissions from land use and the use of land for carbon sequestration in the UK."* – UK Centre for Ecology & Hydrology[771]

1081. The lack of transparency/regulation in the emerging carbon market has led to a prevalence of low-quality offsets. Offsetting will not succeed in delivering net zero ambitions and emissions removals where associated claims are not based on scientific evidence.

1082. This is particularly important in the light of previous offset schemes having lacked transparency, which has led to the risk of greenwashing where companies would buy cheap offsets that did

not necessarily provide the emissions reductions claimed. This has previously led to a lack of confidence in the integrity of offsets, which makes businesses less likely to invest in credible offsets. The roundtables held by the Review highlighted examples of so-called 'greenhushing' where companies invest in the voluntary market, but do not want to make this public due to the risk of being accused of greenwashing. This leads to less investment despite businesses being keen to lead on decarbonisation efforts.

1083. **Government can mitigate this by putting in place guidance for businesses looking to purchase offsets and endorse international standards** to ensure the transparency and integrity of carbon offsets while avoiding VCMs becoming a substitute for businesses to reduce their own greenhouse gas emissions. There is potential to harness voluntary carbon markets in the UK for delivering both nature-based greenhouse gas removals, building on the UK's "leading examples of good governance with the Woodland Carbon Code and the Peatland Code", and engineered GGRs, building on the Government's Green Finance strategy and GGR programme.

1084. **Government should endorse a set of international standards for offsets**. The UK Government has welcomed the work of the Voluntary Carbon Markets Integrity Initiative (VCMI) and the Integrity Council for Voluntary Carbon Markets (ICVCM) to ensure that voluntary markets for carbon have integrity are accessible for all globally. However, the Government has yet to endorse a set of standards for offsets.

1085. **Nature-based solutions need to be considered as part of wider approaches to ecosystem markets.** Nature-based solutions will be a key part of the 'net' in net zero, and voluntary carbon markets can leverage private investment to massively scale up efforts in this space. As set out in ***Pillar 3***, government has a role to play in ensuring there are readily investible nature-based solutions projects in the UK. More broadly, government should ensure that private investment in nature-based solutions for climate is not considered in isolation from other natural capital and habitat restoration. Upcoming work undertaken by Defra will set out the development of high-integrity ecosystem markets including markets for nature-based carbon sequestration and abatement as well as other ecosystem services (such as biodiversity and nutrient pollution mitigation) to ensure a coherent and sustainable approach.

6.5.2 Mobilising UK investments

Government should set up a **programme for offsets and carbon credits**, providing **guidance to businesses** looking to invest in carbon credits and offsets, for businesses looking to **provide carbon credits and offsets**, and explore the opportunities to create a market in the UK for **offsets through energy efficiency measures.**

1086. **With 60% of FTSE100 companies committed to a Science Based Target in 2021,[772] there is considerable scope for businesses to invest in offsets**, and the Review has heard from numerous stakeholders showing a keen interest in investing in the VCMs. Similarly, the value of the global VCMs increased more than fivefold from 2018 to 2021.[773]

1087. This shows the potential for the VCMs to mobilise considerable investments in emissions reductions, particularly if those investments are channelled to credible and transparent credits and offsets.

1088. **VCMs could support accelerated emissions reductions in areas that have not had sufficient public investment need increased financial flows, such as ecosystem restoration and engineered GGRs.** Whilst VCMs have the benefit of providing financial flows from developed to developing countries,[774] providing investors with credible greenhouse gas removals or efficiency gains in the UK could also attract investments into the UK.

1089. **VCMs can provide a model for UK investments.** VCMs have not had much deployment in bringing investments into the UK, but there is potential for VCM investments in the UK to work as a model for inward investments in nature-based and engineered GGRs as well as energy efficiency measures if the Government endorses sufficient standards of transparency for investors.

1090. **Government needs to explore a regulatory framework for nature-based removals**. On nature-based GGRs specifically, the release of land to net zero consistent use choices could provide opportunity for private green investment in enhancing natural capital in the UK. Natural England highlighted to the Review that businesses are looking for places to invest, with low risk, and have found that challenging.[775] Government needs a regulatory framework that sets standards for carbon removals to drive innovation across industry as well as improve the credibility of companies' net zero claims, promoting market confidence. As the Wildlife Trusts commented in the Review's Call for Evidence:

> *"Almost all aspects of carbon and other environmental markets could benefit from regulation of quality and resulting impact on both the demand (for claims made by buyers) and supply side (for credit-generating projects), or at least a form of standard accreditation (for schemes themselves)."*[776]

1091. **The Government should endorse international VCM standards as soon as possible and consult on formally adopting regulated standards for VCMs and setting up a regulator for carbon credits and offsets by 2024.** Voluntary carbon markets can have an essential role to support the UK to decarbonise, creating financing tools for innovation and nature-based solutions both in the UK and abroad. Ensuring these markets are credible is essential, providing investors with more certainty and confidence in VCMs and driving investments.

1092. **The Government should set up a programme for offsets** providing guidance to businesses looking to invest in carbon offsets, for businesses looking provide carbon credits and offsets, and explore the opportunities to create a market in the UK for offsets through energy efficiency measures.

6.6 International trade

Government should establish **baseline environmental and climate protections in Free Trade Agreements (FTAs)** and for removal of trade barriers to environmental goods and services

1093. **Trade can support economic growth opportunities by increasing the availability of green technologies and low-carbon goods.** By eliminating tariffs and non-tariff barriers on, for instance, certain clean energy technologies and energy efficiency products could increase their trade volume by 14% and 60% respectively.[777] Working with other governments to increase the trade of environmental goods and services would send a positive signal to markets and could support emerging technologies by providing access to markets overseas. Green trade can contribute to the growth of the UK economy by securing critical imports to build the capability of green businesses in the UK, lowering the cost of green technology, accelerating the transition by exporting green products overseas and through this create green jobs across the UK.[778]

1094. **Since leaving the EU, the UK has negotiated new Free Trade Agreements (FTAs) with the EU, Australia and New Zealand, as well as transitioning existing EU agreements with more than 70 partners.** In new agreements, the Government has included an 'Environmental Goods and Services' article with a high-level commitment to promote and facilitate trade and investment in environmental goods and services. While these articles serve to signal the Government's support for trade in green goods and services and create a mechanism to identify and remove barriers to it, only few have included definitions or prioritised addressing barriers to trade in specific goods or services.

1095. The FTA with New Zealand went a step further by including an illustrative list of environmental goods – such as wind turbine towers and blades and solar panel cells– on which tariffs are set at zero. Alongside renewable energy, clean transport and energy efficiency and storage, the list includes goods aimed at transitioning to a more circular economy and pollution abatement. The agreement encourages parties to address non-tariff barriers, including, on an ongoing basis, through an Environment and Climate Change sub-committee. The agreement also includes text encouraging parties to transition towards a circular economy, including by cooperating to facilitate and promote trade in used and remanufactured goods. Nonetheless, beyond the New Zealand FTA, there is a missed opportunity to further trade in environmental goods[xliii] which could expand UK exports in these goods.

1096. **Promoting environmental goods and services should be a top priority for the Government.** In recent years there has been growing momentum on this issue at the WTO as a way to support meeting international climate commitments, despite previous multilateral discussions on this subject having been met with some resistance. The Government should continue to advocate at the WTO on improving market access and facilitating trade in green goods and services, through both liberalisation and addressing non-tariff barriers. This would further facilitate reducing trade barriers to environmental goods, providing further export opportunities for UK producers. Within the Trade and Environmental Sustainability Structured

[xliii] The World Economic Forum report referred to above suggests this should include alternative refrigerants, goods needed for renewable energy and energy efficiency, materials and technologies improving energy efficiency of buildings, low-carbon fuels, electric vehicles and trains, and carbon capture and storage technologies. See World Economic Forum (2022), 'Accelerating Decarbonization through Trade in Climate Goods and Services, Insight report', https://www.weforum.org/reports/accelerating-decarbonization-through-trade-in-climate-goods-and-services/

Discussions (TESSD), the Government should proactively engage WTO members to work towards launching a wide, plurilateral negotiation, pushing for substantive outcomes as soon as possible.

1097. **In order to maximise the potential of FTA to make a positive difference for the net zero transition and remove the barriers to trade in climate change products and services, the Government should establish a minimum threshold for the environmental provisions which all new FTAs should adhere to.**

1098. **Finally, minimum climate provisions in FTAs can help create a more even playing field between domestic production and imports, reducing climate action disparities,[779] and such the risk of carbon leakage (see above on carbon leakage).** From this perspective, it is an issue that the in vast majority of FTAs the UK has concluded since leaving the EU, the environmental and climate provisions are not subject to the same dispute mechanisms as in the rest of the agreements. Having created weak incentives to comply, increases the risk of non-compliance[780] and as such the risk of UK businesses complying with UK regulation to become uncompetitive.

6.7 The UK and the global climate agenda

Government should **conduct a strategic review of the UK's international climate leadership** and ensure the **2030 Strategic Framework on Climate and Nature provides practical direction** for the UK's international climate and nature leadership.

1099. **As described elsewhere, an unstoppable drive to decarbonise is reshaping the global economy. The UK can only capitalise on the opportunities for investment and collaboration with a serious and renewed commitment to international partnership.**

1100. **The UK has had a leading role in global climate action over the last decade**. Our roles as COP26 President and recent G7 Presidency put us in a natural position to lead the way for increased ambitions globally, showing leadership and setting the direction for decarbonisation. We now need to retain this position without these platforms, remaining a key player in the global debate. This will enable us to promote UK solutions globally - creating economic growth and investment in the UK economy.

1101. **International action is key to bringing down costs of green technologies**. Green technologies are increasingly becoming more competitive, but this could fall even faster with international action. For example, costs for critical low carbon technologies such as electrolysers and batteries are set to decrease by more than 40% by 2030 if the green transition picks up pace globally.[781] That can happen even more quickly if countries collaborate to grow global markets and compete to fill them.

1102. **Prioritising development of UK R&D and technologies for net zero provides opportunity to demonstrate global leadership and collaboration in these areas.** Moreover, research and innovation attendees at the Royal Society-hosted roundtable were confident that there were emerging opportunities in the international decarbonising technologies market for the UK to participate in or mirror, such as the partnership recently built between Canada and South Korea to deepen cooperation on critical mineral usage in electric vehicle batteries. The UK has played a leading role in the international Missions Innovation, a global initiative to accelerate public and private investment in clean energy innovation, work and should strive to participate and lead similarly in other relevant international fora.

1103. **The UK's global leadership on standards can help facilitate global cooperation on emerging technologies**. Standards are crucial to the net zero transition, ensuring new forms of energy generation and low carbon technologies can be integrated into the grid, are interoperable, digitally-enabled, safe and secure by design. Globally accepted standards can also provide rigour and credibility to green claims and accelerate the adoption of innovation. BSI, the UK's national standards body, is a leading member of the 'International Organization for Standardization' and has led a number of international efforts on net zero, e.g. the new international Net Zero Guidelines at COP27.[782]

CASE STUDY: The Industrial Deep Carbonisation Initiative

The Clean Energy Ministerial Industrial Deep Decarbonisation Initiative (IDDI) is a global coalition of public and private organisations working in collaboration with national governments, to stimulate demand for low carbon industrial materials. Coordinated by the United Nations Industrial Development Organisation (UNIDO), the IDDI is co-led by the UK and India and brings together additional members such as Germany and Canada.

The IDDI's mission is to facilitate the process to consider well-designed policy packages that tackle decarbonising heavy industry such as steel and cement which are key emitting sectors. For instance, if developing countries expand their infrastructure to average current global emissions, the construction sector alone will emit 470 billion tonnes of CO_2 by 2050.

One major focus of the IDDI is on agreeing common standards for low and near zero emissions steel which is important for the UK from a carbon leakage perspective. The IDDI will address missing policy gaps, encourage governments and private sector to buy low carbon steel and cement, source and share data for common standards and targets, and ultimately stimulate a market for decarbonised industrial materials including steel and cement.[783]

1104. **As COP26 presidents, the UK played an instrumental role in securing a broad set of international coalitions in key emitting sectors, in order to keep 1.5°C alive.** This included work to phase out coal, end international public financing for fossil fuels, end the sale of petrol and diesel cars, and halt and reverse deforestation. As part of this, the UK called on political leaders and business leaders to commit to action – including through the Breakthrough Agenda, the Glasgow Declaration on Forests, the Zero Emission Vehicle Declaration and the Coal to Clean Transition Statement.

1105. **The Glasgow Breakthrough Agenda is a key example of the progress brought about by UK leadership.** In line with the UK approach to carbon budgets and tackling high-emitting sectors, the Glasgow Breakthrough Agenda, brought together 45 world leaders committed to working together internationally to accelerate the development and deployment of clean technologies and sustainable solutions needed to meet the Paris Agreement goals. This means delivering clean and affordable technology globally by 2030. These could provide an effective delivery mechanism of the COP26 Pledges and Government should continue to push for delivery and expansion of these agendas. It was supported by 45 leaders covering 70% of global GDP and all regions of the world. The five Breakthroughs cover global clean technology development and deployment in five key sectors of the economy; power, road transport, steel, hydrogen, and agriculture covering a total of 50% of global emissions.

1106. **Government needs to consider how to build on the Breakthrough progress at COP27 with its partners.** At COP27, in response to recommendations in the first annual Breakthrough Agenda report in 2022 from the International Energy Agency, International Renewable Energy Agency and UN High Level Action Champions, signatory countries backed 28 specific coordinated international actions to be delivered by COP28 across these sectors to speed progress towards the 2030 goals. Delivering the first five Breakthroughs could create 20 million new jobs globally and add over $16 trillion across both emerging and advanced economies. The intention to launch new Breakthroughs was also announced at COP27, including a Buildings Breakthrough (by France and the Kingdom of Morocco) and a Cement Breakthrough (by Canada). The Breakthrough Agenda is now the first formal joint project under the joint oversight of the Clean Energy Ministerial (CEM) and Mission Innovation, embedding it firmly in both the clean energy international architecture and the annual COP cycle. The Government

needs to consider how to build on this substantial progress, working with its Breakthrough co-leads to deliver Priority Actions, while encouraging further expansion of the Breakthroughs into other sectors over time, and expanding the list of countries signed up to each 2030 Breakthrough sectoral goal.

1107. **Establishing leadership at a time of uncertainty.** The current context of an increasingly pressured global order exposed to insecurity, slowing growth and constrained energy, food and water supplies means that international attention is often diverted away from delivering on net zero. Combined with fractious international dynamics, there is a risk that international action on net zero will be limited, which will put 1.5°C out of reach with huge economic, social and political consequences.

1108. **Without power as COP president, the UK is no longer the obvious global leader on climate change which presents a challenge to pursuing the UK's interests in the transition to the global low-carbon economy.** However, the UK has over a decade's worth of experience in working bilaterally and multilaterally on climate change, and has a strong track record in the COP negotiations in pushing for ambition, in delivering high quality climate finance with real world impacts, and in using its diplomatic network of climate attachés to great effect.

1109. **The UK also has credibility and influence globally because of its domestic credentials, such as being a first mover on climate legislation and having a strong climate policy and regulatory framework that other countries look to emulate.** Setting an example in the UK's domestic policy context helps promote our position as leaders in a global context. With the UK being a global green finance centre and the UK Government a key player in many international climate initiatives, the UK is in a unique position to pave the way for investments in green technologies and solutions globally.

1110. **The UK's ability to engage and influence net zero globally must be maintained and enhanced,** maximising opportunities to the UK. This also means ensuring that UK's climate diplomacy remains credible and resourced in climate negotiations at G7 and G20 as well as through developing climate knowledge and skills across the FCDO's diplomatic networks and UK trade negotiators.

1111. **UK global leadership can increase demand for UK goods and services.** The UK Government should continue to use levers such as convening power, expertise, strategic relationships, finance and technical support to crowd in a critical mass of actors needed to drive change at speed and scale. The total value of UK low carbon and renewable exports was £6.1 billion in 2020,[784] which is equivalent to around 1% of total UK exports (£609.9 billion),[785] but low carbon goods and services exports are expected to be worth £1 trillion-£1.8 trillion globally in 2030. As such, the UK's international leadership can not only accelerate the transition but shape it in line with UK interests, help put UK business at the forefront and establish strategic relationships with countries which will be at the forefront of the clean energy economy of the future. As such, international leadership and partnerships benefit the UK and help drive domestic economic opportunities. If decarbonisation happens at a global scale this will create markets for low carbon technologies and bring down costs through global demand, ultimately supporting UK domestic objectives of economic growth through the net zero transition.

1112. **Government should conduct a strategic review of the UK's international climate leadership and ensure the 2030 Strategic Framework on Climate and Nature provides practical direction for the UK's international climate and nature leadership.** In the wake of its COP presidency, the UK Government should consider how it will build on this to retain its

role as an international climate leader. This is particularly important in order for the Government to continue to promote and protect UK economic interests, including international collaboration on issues like R&D. The review should address how current activities contribute to these objectives.

Conclusion: Mission Zero

The Net Zero Review was established three months ago to undertake a review into how the UK might meet its net zero commitments in a more affordable and efficient manner, one which is pro- business, pro-enterprise and pro-growth.

This report has set out clearly the international opportunity for future investment and economic growth that net zero presents. This opportunity must be seized however, if the UK is not only to maintain its international leadership on climate action, but also if the UK is to realistically compete with other nations who are making important strategic decisions over their own energy transitions.

There is no denying the fact that, forty-two months on from the UK signing net zero into law, we are now in a net zero race. To stand still, delay or maintain the status quo is not an option. International markets and investors are seeking to make decisions now on where to invest for the future. The UK can either seek to provide the incentives for investment— as outlined in this Review— along with the wider opportunities for job creation and local and regional regeneration, or else these markets will go elsewhere.

There is an active, strategic choice to be made. Does the UK wish to compete in the net zero race, with the chance to lead, or do we wish to simply observe from the sidelines? On the one hand, to lead, and to seek first mover advantage, brings with it the opportunity to attract inward investment, to generate new supply chains and lower the costs of wider deployment of clean technologies and industries. On the other hand, to follow, risks witnessing the opportunities for jobs, infrastructure and investments that could have been onshored in the UK go elsewhere in the world. We have reached a tipping point. The risks of ‘not zero’ are now greater than the associated risks of taking decisive action on net zero now.

The Review has outlined what is needed to effectively ‘deliver’ net zero investments: what must be achieved to deliver the certainty, clarity, and consistency needed from government policy and investment to de-risk the costs of private investment and capital expenditure.

There is a vital requirement for stable, long term, programmes, rather than piecemeal, short term, projects, if the UK is to meet its net zero ambitions in an affordable manner. Long term certainty for investment, allowing for supply chains to be created and secured, will drive down the costs of net zero at the same time as making the UK a more attractive place to invest.

This is why we need a new approach to our *Net Zero Strategy*. One which identifies stable ten-year missions that can be established across sectors, providing the vision and security for stakeholders and investors. This ‘Mission Zero’ approach should set out long term missions across ten years, between 2025 to 2035, with clear mandates or missions to be achieved in this timescale. These Missions must include the infrastructure and governance requirements needed to achieve them, but also set ambitious goals that reflect the reality that by 2025, when the UK should fully launch its ten ‘Mission Zero’ missions, we will be just five years away from our 2030 NDC commitment, ten years away from our 2035 commitments to decarbonise the power sector and end petrol car sales, and ultimately twenty five years from the net zero 2050 target.

The establishment of a stronger, better planned and co-ordinated, long-term delivery for net zero across a core ten-year mission approach, does not prevent this government taking further action immediately, to better deliver net zero and maintain our climate leadership.

There are no regrets policy options that the Review believes the Government should adopt now, that are equally no excuses policy requirements in order to maintain our progress to deliver on our net zero commitments. While reflecting on the importance of creating more informed and accurate decision-making processes, there remains a substantial risk that to delay any further on certain policy requirements only diminishes the UK's ability to act upon and deliver its net zero commitments. The risks of inaction will only damage further the ability of the UK to attract investment and scale up its infrastructure requirements, in the face of growing international competition.

The Review recommends that, alongside the comprehensive prescription of policies across all sectors outlines in the Report, that the Government meet the net present danger of not acting fast enough by taking forward a series of no regrets and no excuses policy recommendations that can be delivered now, as soon as possible. We have termed these the '25 by 2025' that the Government must seek to take forward recognising that there is no time to waste. This is not to suggest that these are the most important recommendations in the report— but to recognise the essence of acting sooner rather than later. The '25 by 2025' set out twenty-five policies that the Review believes that the Government can take forward now, to deliver meaningful change that will have a positive impact on the UK's net zero ambitions. Of course, other recommendations must be taken forwards, but we recognise the need to above all build long term certainty and stability for these measures to succeed. The '25 by 2025' can provide an immediate signal of the Government's intent to deliver on net zero, but also to remove the barriers that are preventing business and industry going further, faster.

Annexes

Engagement Annex

The Review has been grateful for the extensive engagement by individuals and organisations who have given their time to provide evidence. Their evidence and ideas underpin the recommendations throughout the review. Engagement has been in two parts.

1) Call for Evidence
2) Themed Roundtables and evidence sessions

In numbers - In 8 weeks, the review team:

- ❖ Received over 1800 call for evidence responses
- ❖ Met with more than 1000 organisations
- ❖ Engaged in 52 roundtables
- ❖ Heard over 150 hours of evidence
- ❖ Visited over 20 locations

In September 2022 the review launched a call for evidence asking the general public, businesses and other organisations for their views on maximising net zero growth opportunities. The responses were wide ranging, including personal, individualised experiences of net zero; community case studies; evidence from SMEs through to large corporations; as well as original research papers on cross-cutting and specific policy issues. Responses were broadly made up of:

- Individuals - 65%
- Businesses - 12%
- Consortia and consultancy associations - 10%
- Local council and LEPs - 8%
- Other sources including universities and colleges - 5%

The review Chair toured the UK to engage with industries, businesses, academics, trade associations, SMEs, NGOs, and individuals to gather evidence on the key barriers and growth opportunities in the net zero transition. We saw the full capacity of a live nuclear power plant generating enough power for Manchester and Liverpool combined; we visited innovative energy trials showcasing next generation district energy in the community; we travelled on hydrogen buses to experience the future of public transport; and saw the latest innovations in hydrogen-electric aircrafts. Additionally, the Chair attended COP27 in Sharm El Sheikh to learn from and share with the international community.

We wanted this review to be informed by the broadest possible range of experiences. The map shows locations we have visited in the UK.

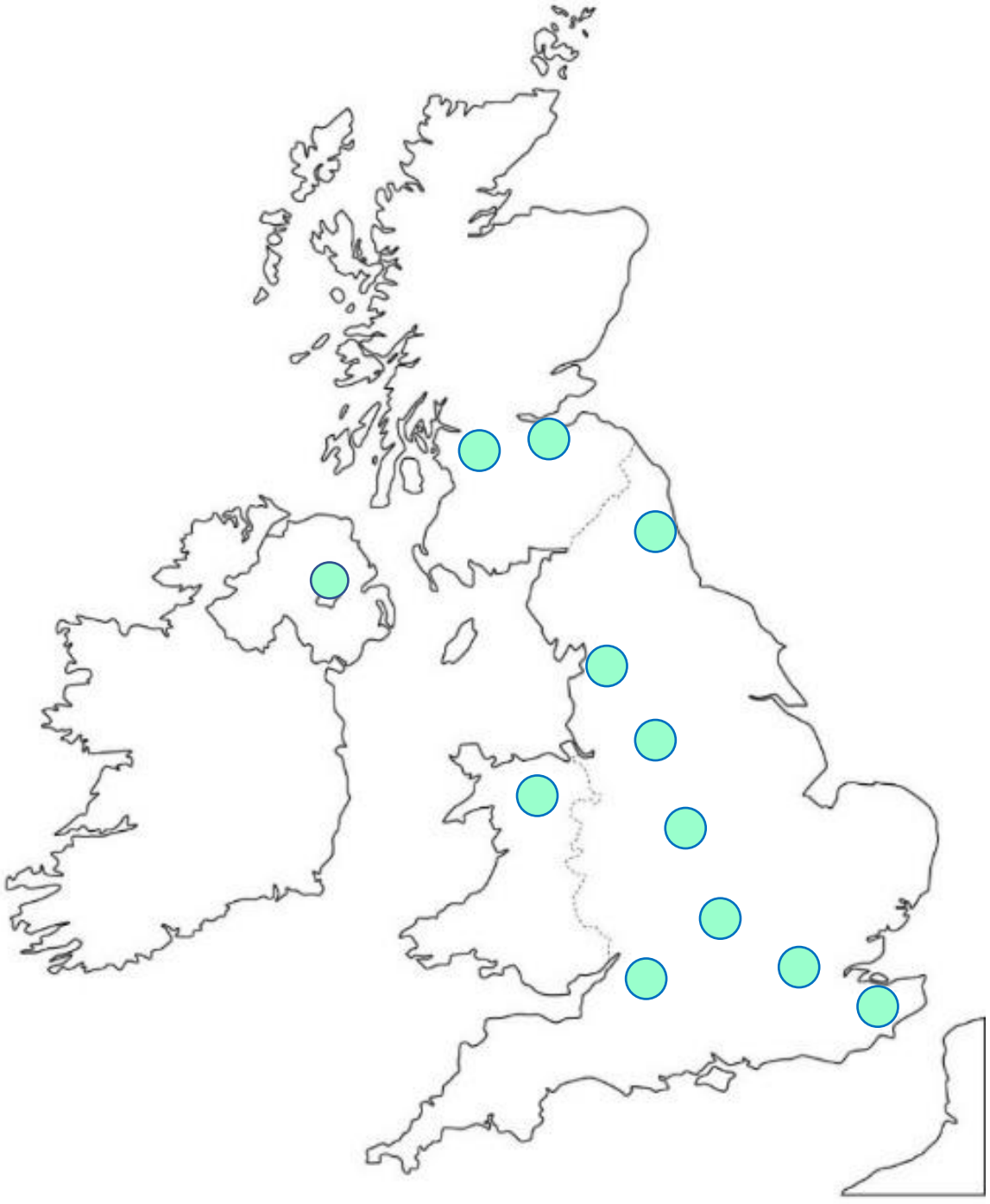


Figure A.1 – *Places visited by the Review*

Table of Recommendations made by Review

#	Area	Owner	Timing	Recommendation
1	Stable environment for business to plan and invest	BEIS/ HMT	-	Government should publish an overarching financing strategy covering how existing and future government spending, policies, and regulation will scale up private finance to deliver the UK's net zero enabled growth and energy security ambitions. This should include setting out the role of UKIB, BBB, BII, and IPA and UKEF in the transition.
2	Long-term funding certainty	HMT	Next SR	At the next Spending Review, government should review options for providing longer-term certainty to a small number of major priorities for net zero – where we know that long-term policy commitment will be essential for success and provide long-term opportunities to save money.
3	Well-designed funding schemes	BEIS	2023	Government to lead a bespoke consultation on funding scheme design – with a ministerial champion – to report on the issues and recommend reforms to government
4	Well-designed smart regulation	BEIS	2023	Government to establish a new forum to coordinate across all regulators on the signals they are sending to businesses and investors across sectors about the net zero transition – including Ofwat, Ofgem, HSE, Environment Agency, Competition and Markets Authority, FCA, and the North Sea Transition Authority
5	Well-designed smart regulation	BEIS/ HMT	2023	Government should conduct and publish, before Autumn 2023, a review of how we should change regulation for emerging net zero technologies to enable their rapid and safe introduction, to support the net zero transition and boost growth
6	Strengthen parliamentary scrutiny	-	2025	New 'Net Zero select committees' should be created in both Houses of Parliament.
7	Strong delivery governance	No10/ BEIS	2023	Government to establish an 'Office for Net Zero Delivery' by Spring 2023, to ensure that the cross-departmental priorities for net zero are properly managed.
8	Strong delivery governance	No10/ BEIS/ DfT/ Defra/ DLUHC	2023	Government to consider the case for creating new separate delivery agencies to deliver long-term decarbonisation programmes.
9	Data	BEIS	2023	Government to significantly expand its public reporting on net zero - potentially either through the ONS's climate portal or developed in partnership with the CCC. This will act as a tool both for public communication and greater scrutiny of government's progress towards net zero. It should set out regular and publicly accessible data on key progress indicators.
10	Data	BEIS/ HMT	2024	Government to review how often it publishes data on UK emissions – and represent this alongside GDP.

#	Area	Owner	Timing	Recommendation
11	Data	HMT	2024	Government should work with OBR and CCC to set out a process for how it will ensure the climate impacts of fiscal decision making are considered. It should commit to publishing the climate impacts of future spending reviews.
12	Data	BEIS	2023	Government to commission the ONS and/or UKRI to lead an engagement exercise with business to define their data needs and develop bespoke recommendations to address these.
13	Clarify UK's competitive advantage and green industrial policy	BEIS/ DIT	-	Carry out competitiveness analysis for clean technologies setting out the UK's export and import strategies and where it intends to develop leadership - and utilise this to clarify for investors and industry the UK's current green industrial policy
14	Incentivise financial disclosures and standards	HMT/ BEIS	2023	Government to endorse and implement the International Sustainability Standards Board (ISSB) standards as soon as possible. The UK should lead by example, launching a formal adoption mechanism as soon as the ISSB standards are published and moving swiftly to assess and endorse the standards for use in the UK. The UK should aim for 2024/25 as the first sustainability reporting cycle for companies in scope, encouraging companies to apply the ISSB's standards voluntarily in 2023/24.
15	Standard setting - transition plans, taxonomy, greenwashing, and stewardship	HMT/ BEIS	2025	UK to continue its pioneering work in transition plan disclosures led by the UK Transition Plan Taskforce, share them internationally, and once more developed, Transition Plan Taskforce standards to be made mandatory for both listed and private firms to ensure comparable disclosure standards across the economy, in line with previous government commitment.
16	Standard setting - transition plans, taxonomy, greenwashing, and stewardship	BEIS, HMT and Defra	2023	To ensure government facilitates sufficient investment in transition economic activity, investors need information on transition pathways to put transition plans into context, as well as common categories and definitions on what economic activities are aligned with the transition to net zero. Government to consider the appropriateness of a transition taxonomy (alongside a green taxonomy) that is simple and proportionate; and work with international partners to ensure the UK approach is interoperable and harmonised with others' approaches.
17	NZ Charter Mark	BEIS	2023	Government to consider the adoption of a Net Zero Charter Mark – a mark to acknowledge "best in class" among firms in terms of their role in the transition to net zero.
18	Robust supply chains	BEIS/ HMT/ DIT	2023	The Government should, by autumn 2023, undertake net zero infrastructure and technology critical supply chain analyses to inform decisions at the next Spending Review on where support akin to the Automotive Transformation Fund could add value.
19	Transmission and distribution	BEIS/ Ofgem	-	Government and Ofgem should work with network companies to facilitate anticipatory investments in grid infrastructure

#	Area	Owner	Timing	Recommendation
20	Regulation and planning	BEIS/ Ofgem	-	Government should update Ofgem's remit to incorporate the Government's net zero target as set out in the 2008 Climate Change Act.
21	Gas networks and fuel distribution	BEIS	2025	Government should develop a long-term cross-sectoral infrastructure strategy by 2025, to adapt and build respectively the distribution of liquid and gaseous fuels, electricity and CO_2 networks over the next decade.
22	Electricity markets	BEIS	2024	Government should commit to outlining a clear approach to gas vs. electricity 'rebalancing' by the end of 2023/4 (depending on the fossil fuel prices), and should make significant progress affecting relative prices by the end of 2024. In outlining this approach, ensure that the distribution of the costs which make up energy bills are passed through to consumers, through their suppliers, in a way which is fair, affordable, and supports competition, decarbonisation and economic growth
23	Electricity markets	BEIS	-	Government should deliver REMA as a priority, to scale up electricity sector investment, unlock the benefits of renewables, reward flexibility and maintain security of supply.
24	Renewable energy	BEIS	2023	Government, regulators and industry should set up taskforces and develop deployment roadmaps for onshore wind and solar respectively in 2023 to reach required deployment levels for 2035 net zero grid, following the example of the offshore wind sector.
25	Electricity generation and transmission/ distribution	BEIS, DLUHC, Defra	2023	Government should work with regulators, devolved administrations, local authorities, industry and key stakeholders to streamline the planning and environmental permitting processes to ensure new power generation can come online as soon as possible.
26	Solar	BEIS	-	Government, regulators and industry should set up a taskforce and deployment roadmaps with clear milestones to reach up to 70GW by 2035.
27	Solar	BEIS	-	Government to assess how low-cost finance options can be provided to households and small businesses
28	Electricity generation and transmission/ distribution	BEIS	-	Government to ensure there is clear guidance to support case-by-case decisions, for example on sensitive issues such as siting and to allow new, innovative solutions, instead of technology-specific restrictions
29	Solar	BEIS	-	Build up UK capability and provide the necessary training and certification.
30	Onshore wind	BEIS	-	Government, regulators and industry to set up a taskforce and develop roadmap with clear milestones for onshore wind to reach required deployment level for 2035 net zero grid.
31	Onshore wind	BEIS	-	Build up UK capability and provide the necessary training and certification.

#	Area	Owner	Timing	Recommendation
32	Nuclear	BEIS	2023	Government should implement reforms set out in the British Energy Security Strategy to double down on achieving the UK's nuclear baseload requirement • Expedite the set-up of Great British Nuclear (GBN) in early 2023, ensuring required funding and skills are in place. • Government and GBN to set out clear roadmap in 2023, including interim targets to reach 2050 ambition. Government to ensure funding is in place. As part of the roadmap, government should assess the possibility to increase the current ambitions supporting the development of supply chain to service a fleet of projects. • Roadmap to set out clear pathways for different nuclear technologies (including small modular reactors) and the selection process. This should consider how to use programmatic approach to deliver further cost reductions in a competitive environment. Government to deliver on siting strategy by 2024.
33	Nuclear	BEIS	-	Government should ensure Office for Nuclear Regulation (ONR) has necessary capacity to progress applications. Government to explore potential to reduce timelines through international cooperation that would allow recognition of approvals by partner countries.
34	Nuclear	BEIS	-	Government should work with GBN and industry on UK supply chain & skills. This includes: • On basis of the roadmap, identify key issues and potential dependencies to address; • Agree commitment to boost resilience of UK supply chain and monitor supply chain; • Build UK capacity and skills, provide the necessary training and certification and explore synergies with other sectors.
35	Nuclear	BEIS	-	Government should ensure continued funding and support for new technologies such as advanced modular reactors (AMRs) and fusion that could play an important role in the future. Government should consider how a programme-approach could be used to drive down costs for AMRs in a competitive setting. Government should also look at the opportunities the nuclear industry provides outside the power sector, for example heat or hydrogen.
36	Flexibility	BEIS	2024	By 2024, government should set a strategy for its market for flexible capacity, including pathways for different technologies to 2035.
37	Flexibility	BEIS	2023	Government should continue to set ambitious targets for the remaining years of the four-year smart meter framework

#	Area	Owner	Timing	Recommendation
38	Flexibility	Ofgem	2024	Ofgem should maintain focus on a timely implementation of its market-wide half-hourly settlement.
39	Hydrogen	BEIS	2023	By the end of 2023, the government should develop and implement an ambitious and pragmatic '10 year' delivery roadmap for the scaling up of hydrogen production. This roadmap should include detail on the plan for Track-2 decisions and should also include clear indication of how much capacity government hopes to procure through each future allocation round, including for electrolytic hydrogen, and how the UK will support growth of the electrolyser supply chain.
40	Hydrogen	BEIS	2023	Government should deliver transport and storage business models as soon as feasibly possible and take a pragmatic approach to support key 'no regrets' transport and storage projects.
41	Hydrogen	BEIS	-	Future System Operator (FSO) should take forward a role in setting out a system plan for hydrogen, considering the interactions between hydrogen storage and balancing renewables for the decarbonised grid. Government, with advice from the FSO, takes decisive leadership on naming priority areas for minimum viable pipeline and storage infrastructure, providing strategic direction that shows how we will link up demand and supply. We need early identification of strategic assets that are critical enablers of other infrastructure and therefore require at risk investment.
42	Hydrogen	BEIS	2023	Government should continue the hydrogen heating community trials, to inform decisions on the role hydrogen can play in heating. Additionally, by the end of 2023, government should update its analysis of the whole system costs of the mass roll out of hydrogen for heating, in order to ensure that the case for economic optimality and feasibility still holds.
43	Biomass and other low carbon fuels	BEIS	2023	Government should publish its Biomass Strategy as soon as possible
44	Oil and gas	BEIS	2025	Accelerate the end to routine flaring from 2030 to 2025.
45	Oil and gas	BEIS/ NSTA	2023	Government should ensure all new oil or gas fields have abatement built in now to avoid backwards engineering when they are electrified
46	Oil and gas	BEIS	2023	Government should ensure the Climate Compatibility Checkpoint is an effective tool to shape policymaking
47	Oil and gas	BEIS	-	Government should consider setting fossil fuel producers operating domestically a 10% storage obligation target to restore carbon dioxide to the geosphere by at least 2035, separate to any investment on nature-based solutions.
48	Oil and gas	BEIS	2050	Government should recognise the importance of geological net zero and work to align international ambitions toward geo zero by 2050, in line with net zero.

#	Area	Owner	Timing	Recommendation
49	Oil and gas	BEIS	2023	The 2023 consultation on the long-term tax treatment of the North Sea must include an option to create a hypothecated net zero fund
50	Oil and gas	BEIS	2026	Dependent on the response to the consultation, by the end of 2026, HMT should set out a long-term plan for replacing the Energy Profits Levy with a 'Net Zero Fund' that clearly ringfences revenue for investment into clean offshore technologies and/or energy efficiency improvements
51	Oil and gas	BEIS/ NSTA	2023	Greater transparency and data from industry on the carbon intensity of oil and gas (O&G) imports, and also from the North Sea Transition Authority (NSTA) and industry on O&G that is produced.
52	Oil and gas	BEIS	2024	Government should publish an offshore industries integrated strategy by the end of 2024 which should include roles and responsibilities for electrification of oil and gas infrastructure, how the planning and consenting regime will operate, a plan for how the system will be regulated, timetables and sequencing for the growth and construction of infrastructure, and a skills and supply chain plan for growth of the integrated industries.
53	CCUS	BEIS	2023	As soon as legislation allows, government must finalise the business models and regulatory frameworks across the value chain, including for industrial CCS, Energy from Waste with CCS and CO2 transport and storage.
54	CCUS	HMT	2023	In 2023, HMT should set out the funding envelope available to support Track-1 clusters
55	CCUS	BEIS	2023	In 2023, government must act quickly to re-envisage and implement a clear CCUS roadmap, showing the plan beyond 2030. As part of the roadmap, government should take a pragmatic approach to cluster selection. This means allowing the most advanced clusters to progress more quickly. The roadmap should include: • Approach to confirming the pipeline of capture projects, at least up to 2030, that will receive future funding, not limited to Track 1 cluster locations. In doing so, it should set out the process and timeline for Track 2 cluster selection; • Greater clarity on planned investment for CO2 transport and storage, including a streamlined route to market for future CO2 storage sites and a plan for making economic licenses more readily available to those that have safety licenses for CCUS acreage already; • The plan for ensuring our supply chain and skills can meet demand
56	CCUS	BEIS	2024	By 2024, government must develop a strategy for the plan for non-pipeline transport and how dispersed sites and mini clusters can connect to the CCS network and what support should be offered for doing so.

#	Area	Owner	Timing	Recommendation
57	GGRs	BEIS	2023	Government should announce, as soon as is possible, its intentions for engineered GGR business models including timings and eligibility. This announcement must clearly outline what standards these business models are expected to require.
58	Tax	HMT	2023	By Autumn 2023 HMT should review how policy incentivises investment in decarbonisation, including via the tax system and capital allowances.
59	Skills	BEIS/ GJDG	2023	Government should drive forward delivery of the recommendations of the Green Jobs Taskforce and the commitments from the Net Zero Strategy. Government to publish an action plan for Net Zero skills that includes a comprehensive roadmap of when, where, and in which sectors there will be skills needs specific to net zero. Government should look to report on progress made to delivering the recommendations on a regular basis, starting by mid-2023.
60	Skills	BEIS/ GJDG	2023	To monitor progress against the just transition, Government should swiftly develop robust regional green jobs statistics (ideally at local authority level, at least for England), breakdowns of green jobs considering protected characteristics, and publish information about salary levels.
61	Skills	BEIS/ GJDG/ DfE	2023	Government and the Green Jobs Delivery Group should explore a variety of targeted options, including: • Increasing the flexibility of the Apprenticeship Levy, and assessing whether the Levy aligns with Government net zero and growth priorities, whether shorter, more intensive courses should be available alongside exploring the role of T levels • Options for retaining talent within businesses and access to international labour
62	Energy efficiency	DLUHC	2025	Legislate by 2025 the minimum energy efficiency rating to EPC B for all non-domestic buildings, both rented and owned, by 2030. Legislate for EPC B rating for all new non-domestic buildings from 2025.
63	Energy efficiency	BEIS	2027	Government to drive the creation of sustainable material supply chains and influence market development through its public procurement standards by 2027
64	Energy efficiency	BEIS/ DLUHC	2023	UK to continue to show leadership through ambitious public sector decarbonisation by conducting its own trials to ensure alignment with the targets in the Heat and Buildings and Net Zero Strategies

#	Area	Owner	Timing	Recommendation
65	SME support	BEIS	2023	Building on the UK Business Climate Hub, Government should launch a 'Help to Grow Green' campaign, offering information, resources and vouchers for SMEs to plan and invest in the transition by 2024.
66	SME support	BEIS	2023	Government should develop an SME role models programme, which provides mentoring for micro businesses and the self-employed by 2023.
67	SME support	BEIS	2023	Government should establish a taskforce of suppliers, small business landlords and business groups to agree on how to cut energy use in rented premises by 2023.
68	Financial services	HMT/ BEIS	2023	Review how the UK can become the most competitive financial centre for green and transition listings, capital raising and project financing; to include reviewing prospectus and listing regimes to encourage integrity and growth in the market for green finance instruments, exploring new opportunities arising for professional services, climate and nature data and analytics and innovative product development.
69	Financial services	BEIS/ HMT	2023	Through its update to the Green Finance Strategy, Government should set out a clear, robust and ambitious approach to disclosure, standard setting, and scaling up green finance – including how it will meet existing commitments to implement Sustainable Disclosure Requirements across the economy; how it will provide a clear, long-term plan for attracting capital to meet net zero ambitions, and how to maintain the UK's position as the leading green finance hub internationally and metrics for success.
70	Manufacturing	BEIS	2024	Government should develop a policy proposal to incentivise on-site generation in Manufacturing by Q2 2024, with options to consult on the funding formula required by the public and private sector to reach the tipping point of adoption.
71	Manufacturing	BEIS	2023	Government should progress its consultation on carbon leakage measures, including a carbon border adjustment mechanism (CBAM) and mandatory product standards by 2023. This will enable Government to implement effective carbon leakage mitigations from 2026.
72	Construction	BEIS	2023	Government to develop a public procurement plan for low-carbon construction and the use of low-carbon materials, by the end of 2023.
73	Construction	BEIS/ Defra	2023	BEIS, DfT and Defra to develop a strategy on the decarbonisation of non-road mobile machinery by the end of 2023.
74	Waste, resources and circular economy	Defra	2023	Deliver urgently on commitments that the UK has already made on collection and packaging reforms, including extended producer responsibility, standardised collection and deposit return schemes. Industry engagement must be central to design and rollout of schemes.

#	Area	Owner	Timing	Recommendation
75	Waste, resources and circular economy	BEIS/ Defra	2023	Launch a task force to work jointly with industry to identify barriers and enablers and develop sector-specific circular economy business models for priority sectors. This should have representation from BEIS, Defra, DLUHC, HMT and DIT, and include the role of extended producer responsibility in promoting reuse, repair, remanufacturing, and rental alongside recycling, in line with the powers under the Environment Act 2021.
76	Waste, resources and circular economy	BEIS/ Defra	2027	End export of UK plastic waste by 2027, and in parallel set an end date for the import of recycled plastic chips, subject to the UK's international legal responsibilities. To drive domestic demand for high-quality recycled materials, ratchet up minimum percentage recycled content targets for a range of products in consultation with industry.
77	Waste, resources and circular economy	BEIS/ Defra	2023	Delivering UK recycling infrastructure capacity in key areas. Areas to consider include: • plastic processing capacity (an additional one million tonnes) • domestic capabilities in the circular economy of critical minerals • the necessary infrastructure to support textile collection and fibre recycling. In doing this, the Government should consider the expected profile of private sector investment in building UK recycling infrastructure - and explore opportunities to further enable such investment if current expectations fall short of domestic need.
78	Waste, resources and circular economy	WRAP (BEIS/ Defra)	2023	Task WRAP with developing a report jointly for the BEIS and Defra Secretaries of State to understand the right role for Government in supporting resource matching across the private sector, learning from e.g. Invest NI and the National Industrial Symbiosis Partnership. This must ensure resource planning to achieve symbiosis rather than just waste exchange.
79	Transport	DfT	2024	Government to swiftly deliver the ZEV mandate, to apply from 2024, while maintaining regulations and funding to support the uptake of electric and other zero emission vehicles, and continuing to drive emission reductions from internal combustion engines
80	Transport	DfT	2023	Government to publish the Low Carbon Fuels Strategy in 2023 and the necessary legislation for the sustainable aviation fuels (SAF) mandate to apply from 2025. Recognising that an adequate price stability mechanism is vital for investments in SAF, government to set out evidence for barriers to SAF investments and options to address this.

#	Area	Owner	Timing	Recommendation
81	Transport	DfT	2024	Government to set out options for further legislative steps by 2024 and take a leading role in International Maritime Organization (IMO) negotiations to decarbonise the maritime sector.
82	Transport	DfT	2024	Government should continue to work with industry to set out a clear programme by 2024 to accelerate decarbonisation of the wider freight sector through modal shift and deployment of new technologies, building on the Future of Freight Plan
83	Transport	DfT	-	Government to reduce delays to anticipated reforms by bringing forward the delayed Future of Transport Bill this Parliament.
84	Food, agriculture, nature and land	Defra	2023	Government to publish a Land Use framework as soon as possible, and by mid-2023.
85	Food, agriculture, nature and land	Defra	2023	Government to publish full details of all Environmental Land Management Schemes and future plans by the end of 2023 - with a particular focus on how participants can take advantage of both public and private finance
86	Food, agriculture, nature and land	Defra/ UKRI	2025	By 2025, Government to ensure that 50% of UK-based food and drink businesses measure and report their scope 3 emissions against a government- and industry-agreed standard. Defra and UKRI research should prioritise innovations that support on-farm measurement and processes to accurately collect the remainder by 2030.
87	Food, agriculture, nature and land	Defra/ Natural England	-	Deliver accurate monitoring of carbon across broader range of ecosystems, with a view to bringing more habitats into the inventory to drive habitat creation and restoration efforts
88	Food, agriculture, nature and land	Defra (and delivery bodies)	2023	In line with wider thinking on voluntary carbon and ecosystem markets, ensure a pipeline of investable nature-based solutions projects is available
89	Tech and digitisation	BEIS/DIT/ DCMS	2023	BEIS to work with DCMS and DIT to develop a campaign by Q2 2023 to promote digital technologies, including AI, robotics, digital twins, and autonomous systems, as a solution to industry's energy efficiency needs in the short term and their role in wider decarbonisation for the long term.
90	Tech and digitisation	BEIS	2023	BEIS to include digitisation and the related energy demand change forecasts in Energy and Emission Projections by 2023.
91	Local and regional	BEIS/ DLUHC	2023	Central government should introduce a statutory duty for local authorities to take account of the UK's net zero targets, based on a clear framework of local roles and responsibilities.

#	Area	Owner	Timing	Recommendation
92	Local and regional	DLUHC/ HMT/BEIS	Next SR	Central government should simplify the net zero funding landscape for all local authorities by the next Spending Review. This should include consolidating different funding pots, reducing competitive bidding processes, giving longer lead-in times where bidding remains and providing funding over the medium- rather than the short-term.
93	Local and regional	BEIS/ DLUHC	2023	Central government should establish local net zero missions in 2023 for a number of key policy areas to encourage places to go further and faster.
94	Local and regional	BEIS/ DLUHC	2023	Central government should establish core principles for future net zero devolution and ensure that all devolution deals agreed between now and 2030 have a strong net zero element.
95	Local and regional	BEIS/ DLUHC	2023	Central government should fully back at least one Trailblazer Net Zero city, local authority and community, with the aim for these places to reach net zero by 2030.
96	Local and regional	BEIS/ DLUHC	2023	Central government should provide guidance, reporting mechanisms and additional capacity and capability support to enable local authorities to better monitor and report their net zero progress.
97	Local and regional	BEIS /DLUHC	2023	Central and local government should work together to convene an annual Local Climate Summit that helps to share best practice, attract green investment and provides an opportunity for areas to update on their Locally Determined Contributions.
98	Local and regional	BEIS/ DLUHC	2023	Central government should reform the local planning system and the NPPF now. Have a clearer vision on net zero with the intention to introduce a net zero test, give clarity on when local areas can exceed national standards, give guidance on LAEP, encourage greater use of spatial planning and the creation of Net Zero Neighbourhood plans, and set out a framework for community benefits.
99	Local and regional	BEIS/ DLUHC	2023	Government should undertake a rapid review of the bottlenecks for net zero and energy efficiency projects in the planning system, and ensure that local planning authorities are properly resourced to deliver faster turnaround times.
100	Community	BEIS	2023	Government should commit to the Local Electricity Bill and publish a Community Energy Strategy that addresses regulatory, legislative, funding and capacity barriers in the sector. The Strategy should also consider what support should be given to innovative projects such as community purchasing and community energy sharing and storage.
101	Individuals (general)	BEIS	2023	Government to publish a public engagement plan for England by 2023, to ramp up public engagement on net zero.
102	Individuals (general)	BEIS	2023	Government to run a competition to create a Carbon Calculator to inform consumers of the carbon intensity of different choices, in 2023.

#	Area	Owner	Timing	Recommendation
103	Individuals (general)	Defra/BEIS	2025	Government to pursue ecolabelling to help consumers make more informed purchasing decisions, by 2025.
104	Affordability	BEIS	2023	Government should develop the distributional analysis of net zero policies started by the Review in 2023.
105	Individuals (general)	DfT	2024	Government should amend the regulatory framework to incentivise transport providers to increase demand and improve services, and that it works with them on this vision, by 2024.
106	Transport	HMT	2024	Government to equalise VAT on public and private electric vehicle charging in 2024.
107	Energy efficiency	BEIS	2025	Government should regulate through a suite of measures to create the conditions for sustained growth of new markets for low-carbon heat, so that at least 600,000 heat pumps are installed each year by 2028, and up to 1.9 million by 2033. The Government should implement the off-gas grid regulations that envisage the end of new and replacement fossil fuel heating systems in the mid-2020s.
108	Energy efficiency	BEIS/ DLUHC	2023	Government should bring forward all consultations and work to mandate the Future Homes Standards by 2025 to prevent further delays by ensuring the standard applies to all developments. This should include a consultation on mandating new homes to be built with solar and deliver the Net Zero Homes Standard, ensuring that the planning system (discussed in ***Pillar 4***) is flexible enough to enable this.
109	Energy efficiency	BEIS	2030	Government should ensure the right policies are in place to achieve the UK's demand reduction targets, building on the 2022 Autumn Statement announcement, with interim targets and milestones to hit this goal. Noting the UK's 2050 net zero ambitions the government should publish clear analysis of which mix of policy measures gets the UK to the 15% target and assure future funding for those policies.
110	Energy efficiency	BEIS	2023	Government should expand its energy efficiency advice service in 2023, ensuring that it helps consumers to access qualified traders and providers in local areas.
111	Energy efficiency	BEIS	2025	Government should support establishing retrofit hubs by 2025 to bridge the gap between households and suppliers. These could enable installers to seek training and impartial advice and could connect households to suitable installers.
112	Energy efficiency	DLUHC/ BEIS	2023	Government should mandate that EPCs are updated on a regular basis, using a new metric which better reflects current relative costs of heat pump and accounts for wider benefits from low-carbon heating systems. Under this new metric, EPC ratings could become a more holistic Net Zero Performance Certificate (NZPC), giving consumers more detailed information about the heating technology used in the property and its associated financial and social effects.

#	Area	Owner	Timing	Recommendation
113	Energy efficiency	BEIS	2024	Government should provide certainty by 2024 on the new and replacement gas boiler phase out date to drive industry and investor confidence. The Review recommends bringing the proposed date of 2035 forward and legislating for 2033. Government should set a legislative target for gas free homes and appliances by 2033, to contribute to a gas free grid in future. Government should legislate for all homes sold by 2033 to also have an EPC rating of C or above in line with the aforementioned NZPC, with exclusions around certain properties (e.g. listed properties, on grounds of affordability). Government should also mandate landlords to include 'average bill cost' alongside the EPC (and possible future NZPC) rating, when letting a property out. This will help renters understand what costs to expect, while also helping to put a premium on energy efficient homes.
114	Energy efficiency	BEIS/ DLUHC	2023	Government should consider options to support homes to include roof solar panels installation as part of its retrofit provision to support homes reaching the Net Zero Homes Standard.
115	Energy efficiency	BEIS	2023	Government should include an Energy Efficiency Taskforce workstream on green finance products to report by end of 2023. This should help to support those in low EPC rated properties to carry out green home upgrades and should identify opportunities to crowd-in private finance, alongside public funding.
116	Energy efficiency	BEIS	2028	Government should deliver the Heat Pump Investment Accelerator to catalyse private investment for at least two major heat pump factories in the UK.
117	Energy efficiency	BEIS	2023	Government should choose from multiple options which could help increase heat pump efficiency: 1. Suppliers say this could be done via a mandate stating the minimum efficiency which needs to be achieved by all installations. Government should test whether this could be done by most major installers for most properties. 2. Set up a heat pump coefficient of performance competition, run for example by the Energy Efficiency taskforce. This will show the state of the art technologies with higher efficiencies and allow others to replicate these. 3. Quality of the installation matters; training and installation standards need to be accelerated to support this.

#	Area	Owner	Timing	Recommendation
118	Energy efficiency	BEIS	2028	Government should extend the Boiler Upgrade Scheme to 2028 and consider whether grant levels should be increased in light of inflationary pressures, before being scaled down over time. This should happen alongside efforts to increase awareness of government support. Support for those unable to afford the upfront costs associated with improving energy efficiency and moving to low carbon heating systems should be continued and expanded, namely through the Home Upgrade Grant (HUG), Social Housing Decarbonisation Fund (SHDF) and other existing schemes for low-income households.
119	Energy efficiency	BEIS	2023	Government should set the policy framework and supportive investment environment to encourage reskilling and greater training opportunities in the heat pump sector and work to encourage adoption of standards to increase firms able to take up existing schemes.
120	R&D landscape	BEIS	2023	Government should create a roadmap, by Autumn 2023, which details decision points for developing and deploying R&D and technologies that are critical for enabling the net zero pathway to 2050.
121	R&D landscape	BEIS, HMT, OSTS	2023	By Autumn 2023, Government should review how to incentivise greater R&D for net zero, including considering the role of clarity on research priorities and government support, tax credits, greater ring-fencing of R&D spend, and enabling regulations.
122	R&D landscape	BEIS, HMT, OSTS	2023	Government should establish up to three new R&D demonstrator projects, out to 2035, aligning with the ten-year missions set out by this Review. These should be considered when creating the overarching R&D and technology roadmap.
123	R&D landscape	BEIS, OSTS, GOS	2023	Government should include in forthcoming work from OSTS how regulators can provide more opportunity for demonstrations for net zero technologies.
124	Carbon leakage	BEIS/ HMT	2026	Government should progress with the consultation on carbon leakage measures and speed up decision-making to enable Government to implement effective carbon leakage mitigations from 2026.

#	Area	Owner	Timing	Recommendation
125	Carbon markets	BEIS, HMT	2024	By 2024, Government should work within the UK ETS Authority to develop a pathway for the UK ETS until 2040. This pathway should: a) Set out a vision on the future design and operation of the ETS b) Set out a timeline for expanding the coverage to the rest of the UK economy, as well as sectors consulted on including maritime and waste. c) Address inclusion of GGRs to incentivise early investment in new technologies and potentially nature-based solutions. d) Provide reassurance to businesses around how the Government will mitigate the risk of carbon leakage as a result of expanding the ETS.
126	Carbon markets	BEIS	2024	Government should endorse international VCM standards as soon as possible and consult on formally adopting regulated standards for VCMs and setting up a regulator for carbon credits and offsets by 2024.
127	Carbon markets	BEIS	2024	Government should set up a programme for offsets and carbon credits, providing guidance to businesses looking to invest in carbon credits and offsets, for businesses looking to provide carbon credits and offsets, and explore the opportunities to create a market in the UK for offsets through energy efficiency measures
128	International trade	DIT	2024	Government should establish baseline environmental and climate protections in Free Trade Agreements (FTAs) and for removal of trade barriers to environmental goods and services
129	International leadership	BEIS/ DIT/ FCDO/ Defra	2023	Government should conduct a strategic review of the UK's international climate leadership and ensure the 2030 Strategic Framework on Climate and Nature provides practical direction for the UK's international climate and nature leadership.

Endnotes

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