



UK Research  
and Innovation



# Building a Green Future

UKRI portfolio review 2024

# Foreword



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**Executive Chair, Natural Environment Research Council**  
**and UKRI Building a Green Future SRO**

We know, better than ever, the scale and severity of the challenges facing climate and nature across the planet. The climate is changing, causing temperatures to rise, risking global tipping points such as ice sheet or rainforest collapse and making extreme events – heatwaves, floods, crop failures – more likely. Climate change causes shifts in ecosystem biomes, disrupting food webs and habitability. This, combined with habitat loss and other environmental damage from human activity, means that biodiversity is under threat. Addressing these linked crises must be the global mission of our times.

But this is also an opportunity. As we remove carbon and protect nature we can rethink how our economy and society works, recognising that growth does not have to come at the cost of our environment, but can be sustainable and equitable. If we can achieve this, the green transition can benefit our country and its people: providing them with warm, secure homes, protecting them from extreme weather and pollution, bringing the jobs of the future to places across the UK and linking our country together with clean, efficient transportation.

To maximise outcomes for both the planet and our society we will need world-class research and innovation. Recognising this need, and the scale of this opportunity, UKRI has developed a significant portfolio across all areas of the green transition.

Currently standing at over £800 million per year, this funding covers everything from blue-skies, curiosity driven research which unlocks knowledge and provides the capability for future breakthroughs, to challenge-focused research and innovation to roll out and scale up the low-carbon technologies and services which are needed now.

To ensure UKRI can deliver on this national priority we have created the cross-UKRI Strategic Theme of *Building a Green Future*. Through this theme we amplify the work going on across the organisation, generating the interdisciplinary, solutions-focused research and innovation necessary to tackle the complex challenges of reaching Net Zero. The Theme also supports UKRI in closer working with government, providing a collective voice and mechanism to collaborate in addressing policy priorities.

Green technologies, industries and services are growing now, and will be the engines of global growth in the coming decades. We must continue to innovate and scale up our ambition in next-generation manufacturing, renewable energy, retrofit, carbon capture, financial services and many other industries which will create jobs and boost local economies all over the country. Research and innovation, backed by cross-government mission-driven working will cement the UK's global leadership and place us at the forefront of the new

technologies and services which we can export all over the world. A cleaner, greener, economy benefits us in other ways too, for example improving our health through reducing pollution, insulating us from excessive heat and cold with more comfortable buildings and cityscapes, and reducing risk from extreme events such as fires and floods.

UK emissions in 2024 are almost half their 1990 levels. Some decarbonisation has been achieved by replacing carbon-intensive processes and materials with low-or-zero-carbon alternatives, for example replacing fossil fuels by switching to renewable energy, or electrified transport – and these have provided other benefits such as energy security and reduced running costs. But we need to go further, and faster, so there are more complex choices and trade-offs ahead. Sectors such as food production and distribution, waste, and buildings, will need a multifaceted approach in which technologies, services, policy and people all align if we are to continue driving down emissions while improving the lives of our citizens.

Decarbonisation is necessary, but not itself sufficient, to build a greener future. Achieving Net Zero should not come at the cost of the rest of the environment, for example through pressure on raw materials such as lithium and cobalt, or tree planting which impacts water systems or existing landscapes and native species. We will need to

make choices informed by the whole system of the environment in the UK, and its interaction with our lives and livelihoods.

Through *Building a Green Future*, in partnership with government and international funders, we have already invested in interdisciplinary programmes that take systems approaches to clean energy, land use, sustainable living, health and adaptation to climate change. For example, with government departments in all four nations of the UK we have established the ‘Transforming Land Use for Net Zero, nature and people’ programme, bringing researchers, policy and industry together to accelerate policy development in land use, soil health and farming. And our planned ‘Accelerating the Green Economy Hubs’ will catalyse inward investment in green technologies in regions across the UK, building clusters of research and industrial excellence rooted in regional economies.

This document sets out for the first time the full breadth of UKRI’s investment in mitigation, adaptation, and environmental net gain. Across key sectors of the economy it shows the enormous difference that research and innovation can make to decarbonisation, the health of our environment, and the day to day lives of people across the UK. These investments are all underpinned by environmental and social data and modelling, our talent pipeline and our support for commercialization, ensuring

we have the information and the people to drive this work forwards.

There is much more to do, but through *Building a Green Future* we will deliver progress on the pathway to Net Zero alongside our other national missions, helping to build a prosperous, healthy, and resilient UK.



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## UKRI Portfolio

**£823m** invested  
2023-24

**4,250** active grants

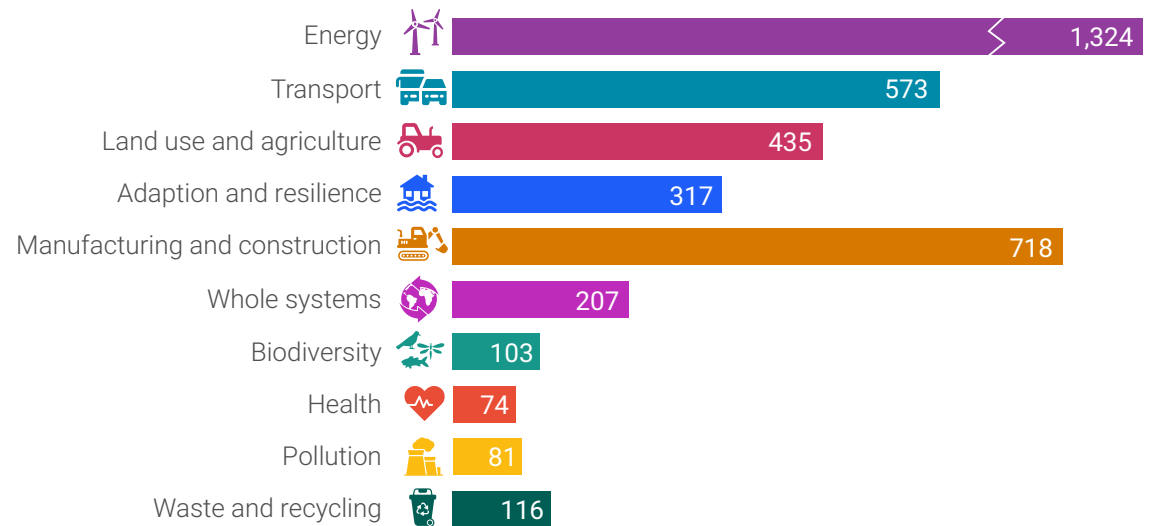
Working with **774** partner organisations

leveraging over **£400m** from our investments

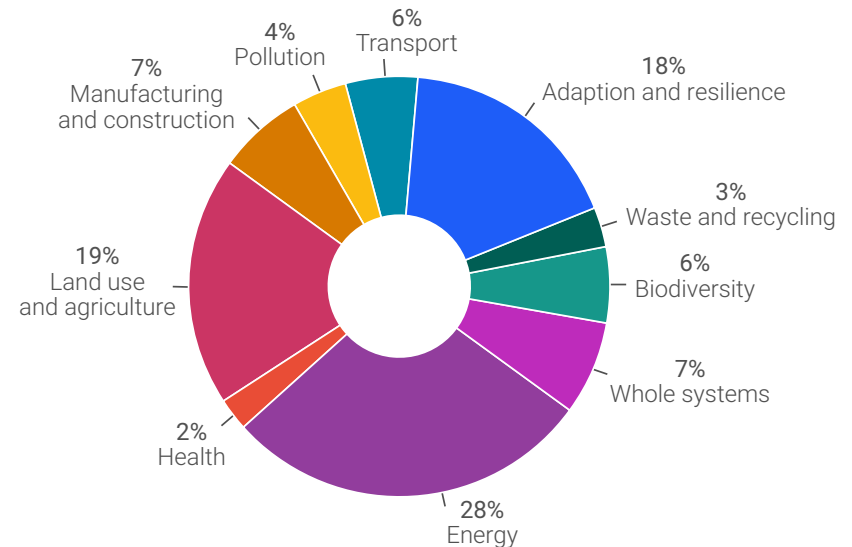
### Top 10 Partners 2023-24

- |                                |                           |
|--------------------------------|---------------------------|
| EUROfusion                     | Shell Global Solutions BV |
| UK Seabed Resources            | Rolls-Royce UK            |
| Jaguar Land Rover              | Tata Group UK             |
| Dynamic Meteorology Laboratory | Shell Research UK         |
| First Light Fusion             | Met Office                |

### Investment 2020-24 (£M)

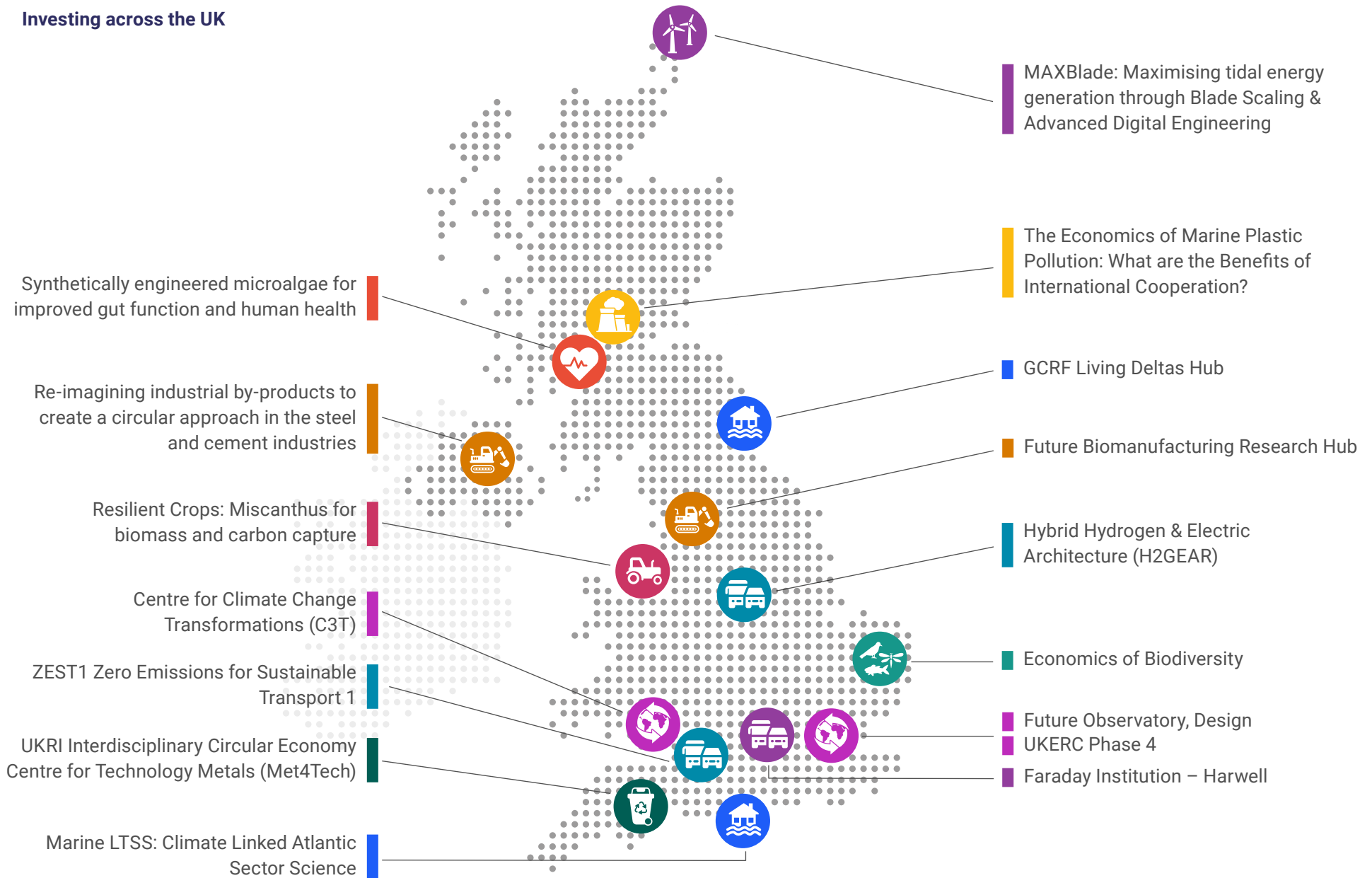


### Proportion of grants 2020-24



# Building a Green Future

## Investing across the UK



# UKRI Building a Green Future

*Building a Green Future* is one of UK Research and Innovation's five strategic themes set out in our five year strategy 'Transforming Tomorrow Together: 2022 – 2027'. The Themes are targeted at significant national (and international) challenges. They are designed to co-ordinate and amplify funding across UKRI, ensuring a collective voice and agreement on research and innovation strategy, and an agile process which supports the co-development of programmes to deliver on shared priorities of national importance. Working across the breadth of UKRI, the Themes are well placed to co-create with government, ensuring solutions-focused research and innovation programmes aligned to government priorities and policy needs.

*Building a Green Future* is helping the UK mitigate and adapt to climate change and improve the quality of our environment. The research and innovation supported through the theme provides solutions essential to achieving Net Zero by 2050, while unlocking growth across the UK. The Theme has three focus areas:

- **Accelerating the green economy:** addressing the near-term costs of transition to a low-carbon economy, by unlocking solutions focusing on genuine partnerships between public and private sector investment.

- **Targeting national priorities:** working in partnership with government to co-create research and innovation programmes that address strategic priorities and kick start green growth in the UK.
- **Achieving the last 20%:** research and innovation focused on the hardest to decarbonise sectors, essential for achieving reduced emissions beyond 2030.

The investments we are making, in partnership with government departments and international funders, support transdisciplinary research and innovation to help accelerate the UK's transition to a sustainable, green economy. We support energy security, sustainable agriculture and ensure that our work benefits people through highly skilled jobs, improved health, and better connected communities in all parts of the UK. In this way we ensure that places across the UK feel ownership and share the benefits from the transition to Net Zero.

## The UKRI Portfolio

*Building a Green Future* builds on and is developing work across UKRI. The UKRI portfolio emerges from a series of choices across the organisation, in individual research councils and Innovate UK, in partnerships between those bodies, or through dedicated collective funding such as the Industrial Strategy Challenge Fund or International Science Partnerships Fund.

To help co-ordinate across this portfolio and design our interventions we have identified the parts of the portfolio relevant to *Building a Green Future*. To do this, we have split our investments across ten categories. These are based on the Committee on Climate Change reports, Net Zero R&I Framework, and the International Energy Agency categorisation.

This approach means we can target our portfolio to the challenges and opportunities in these sectors, including UK and international policy.

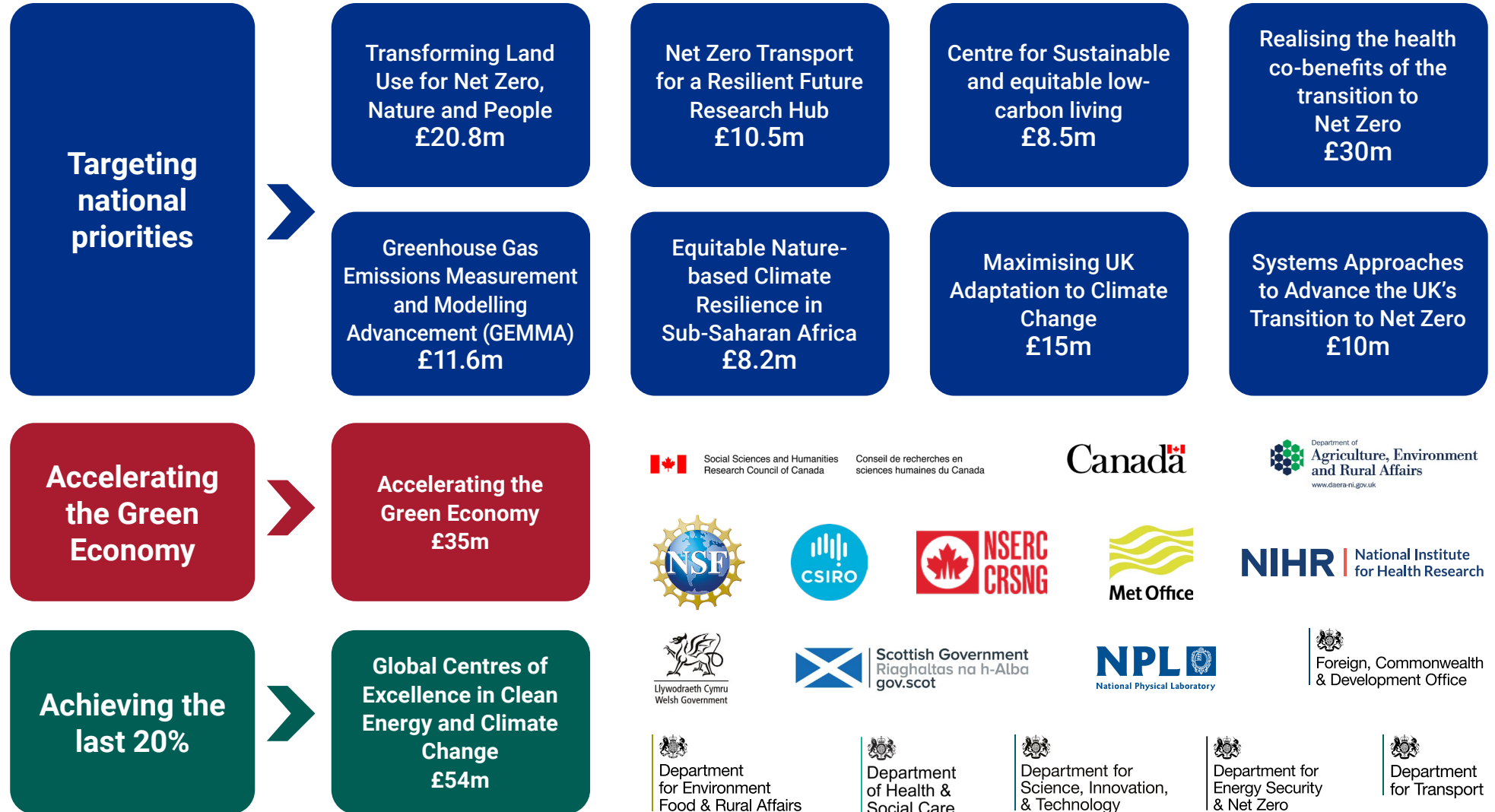
## What has been funded through the theme to date?

As part of our growing portfolio tackling this global challenge, UKRI has committed £116 million over five years through *Building a Green Future* into specific areas demanding a fresh interdisciplinary approach. The theme draws on the power of UKRI to convene the whole R&I system to tackle complex problems, working across disciplines, with government and other external partners. We have built ten programmes, clustering in a further investment of nearly £90 million in areas of national priority. The Investment Portfolio schematic illustrates areas of focus, investment, and partners to date.

# Investment portfolio

## Areas of focus

## Investing into



# Energy

The energy sector has been a critical part of the UK's progress towards Net Zero, with emissions reducing by approximately 75% against 1990 levels.<sup>1</sup> This has largely been driven by technological advances in renewable energy within a clear policy framework, such as the phasing out of coal. Together, these have derisked the clean energy sector, allowing the investment and innovation which means Britain now generates most of its electricity from zero-carbon sources.<sup>2</sup> UKRI's long-term support for R&I in renewable energy has helped to grow these key industries, securing inward investment, UK leadership, supply chains and skilled jobs. The offshore wind industry, for example, now supports over 30,000 jobs across the UK.<sup>3</sup>

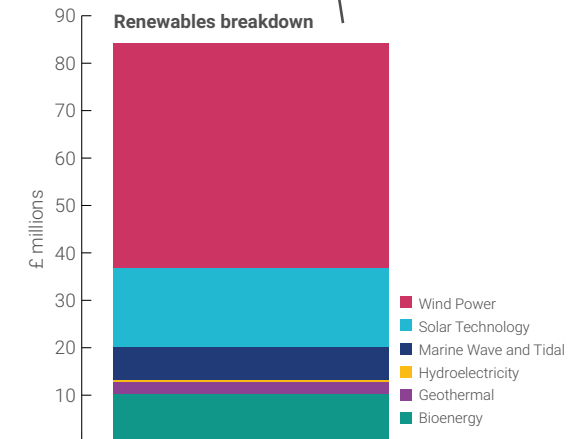
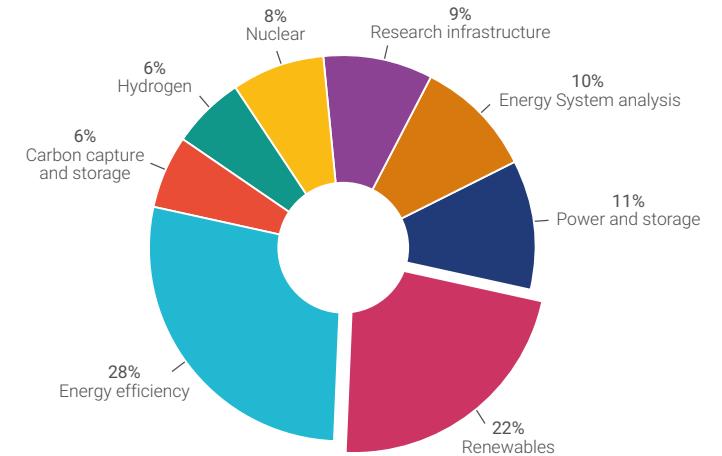
In recent decades UKRI has created and maintained a wide portfolio of investment in renewable technologies. Key among these are wind, solar and marine wave & tidal, with significant investment in research and innovation to improve the efficiency of these technologies, reduce the costs of generation equipment, and improve options for locations, for example with floating offshore wind or 'solar glass' for buildings and vehicles. The breadth and longevity of our portfolio in renewables and nuclear energy has enabled early-stage innovation in a range of technologies. This approach to investment has helped to keep options open for Britain's zero-carbon energy mix and provided the R&I capacity to respond to policy and market drivers as technologies mature.

## Impacts from the UKRI Energy Programme

UKRI has invested £1.1 billion supporting extensive collaboration with project partners, including industrial partners. In 2005 project partners generated £233 billion in UK revenues and employed 1.1 million people; by 2018 the employment figure had almost doubled, and UK revenues had increased to c.£500 billion. In 2019 spin-out companies from these investments generated known UK revenues of £28.9 million and employed 180 people. Since 2010, 13 spin-out companies have secured a total of £49.3 million of investment.



UKRI energy spend by categories 2023-24





### ISIS 'super microscopes' deliver huge benefits for affordable energy and sustainable growth

In 2017, the ISIS Neutron and Muon Source Lifetime Impact Report was published, highlighting three decades of significant achievements.

The ISIS Neutron and Muon Source, renowned for its advanced 'super-microscopes,' produces beams of neutrons and muons that enable scientists to examine materials at the atomic level. Each instrument is meticulously optimized for studying different types of matter.

This cutting-edge research facility has played a crucial role in promoting affordable energy and sustainable growth. Notably, EDF Energy utilized ISIS to predict the lifespan of welds, which facilitated the extension of

15 nuclear reactors' operational lives. This extension saved EDF Energy £3 billion in decommissioning costs, provided low-carbon energy to two million homes, generated £650 million annually in contracts for predominantly UK-based businesses, and safeguarded 2,000 jobs in the nuclear power sector.

The Impact Report revealed that ISIS was on track to deliver at least £1.4 billion in net economic impact, based on past achievements, with an additional £0.4 billion anticipated by 2025. The facility has already demonstrated a robust Return on Investment of at least 214% and is projected to generate a further £1.4 billion in economic impact by 2030.

Decarbonisation of our energy supply remains critical to the UK's Net Zero ambitions, reducing emissions from generation as well as allowing other sectors to meet their energy needs with clean power. However, electrification across the economy presents challenges for the energy sector, with demand anticipated to double by 2050.<sup>4</sup> This will require significant additional renewable generation alongside improved storage and more sophisticated demand management which can shift consumption to balance the grid.

Beyond renewable energy, there are also challenges for alternative green fuels such as biofuels and hydrogen. These include the need to build up the infrastructure and equipment to collect, store and transport these fuels; technologies and skills to allow retrofitting in transport and manufacturing; appropriate regulation and public acceptability; and costs which (largely) remain higher than fossil fuel alternatives.

Reflecting the importance of this sector, UKRI has invested approximately £1 billion over the past three years in energy research. Around a quarter of this spend helps to reduce demand by improvements in energy efficiency. Integrating technological and behavioural changes can help people and businesses use less energy, saving them money and helping the environment. This includes work to increase flexibility with smart systems and incentives, so use is higher when renewable generation is higher, or taking a place-based approach to retrofitting houses to help uptake and optimise energy advice. Underpinning this work is the recognition that the energy transition



must be equitable, so that moving to Net Zero is an improvement in quality of life, and the benefits are shared across society.

Alongside decarbonisation, UKRI has also supported work to measure and reduce the harmful effects of energy generation on the environment. Bringing researchers together with industry and policy stakeholders, we have helped to ensure that offshore wind has minimal consequences on marine and seabird life; that turbines can be safely recycled, reducing their CO<sub>2</sub> footprint and the demands for rare earth materials; reducing the demands for water in construction and maintenance of energy infrastructure; and improving radioactive waste disposal and environmental remediation.

In partnership with the US, Canada and Australia, *Building a Green Future* and the UK Government's International Science Partnership Fund has invested in four Global Centres in clean energy and climate change to support innovative research to tackle hard-to-decarbonise sectors across the UK economy, accelerating transformative socioeconomic and technological innovation and driving the energy transition to reach the UK's Net Zero targets by 2050.

### Monitoring system helps energy producers operate more efficiently

A Scottish company's cost-saving technology to monitor and protect power networks has attracted £6.5 million from investors for further expansion and to build a new manufacturing plant.

Synaptec had early research support from UKRI when spun out from the University of Strathclyde in 2015.

The technology, originally designed for the oil and gas sector, allows energy companies to quickly isolate network faults, keep power flowing, minimising any fines by regulating authorities.

Data from all sensing locations is available at the speed of light, enabling a wide range of protection, control, and monitoring functions to improve reliability and security, reduce unplanned maintenance while significantly cutting costs.

Synaptec's technology has now been adopted by major international customers, including national power networks across the UK, Europe, India, and the GCC territories in the Gulf.



# Transport

Surface transport and shipping make up around 25% of UK emissions. However, we have the technologies available to cut these emissions sharply, which is why the Committee on Climate Change model a two-thirds reduction by 2035 as part of their balanced pathway.<sup>5</sup> Alongside these necessary technological advancements, UKRI is investing in policy and behavioural shifts to encourage more cycling and walking, and the use of public transport. Well-designed cities are a key part of this, ensuring citizens have what they need locally and have a range of viable options for longer journeys.

Light road transport, particularly cars and buses, have benefitted from sustained investment in new technologies and infrastructure – notably in battery development and charging efficiency. Research and development for the next generation of electric vehicles is already underway, including new lightweight components, improvements in battery capacity (and reducing reliance on rare earth metals such as lithium) and smarter charging.

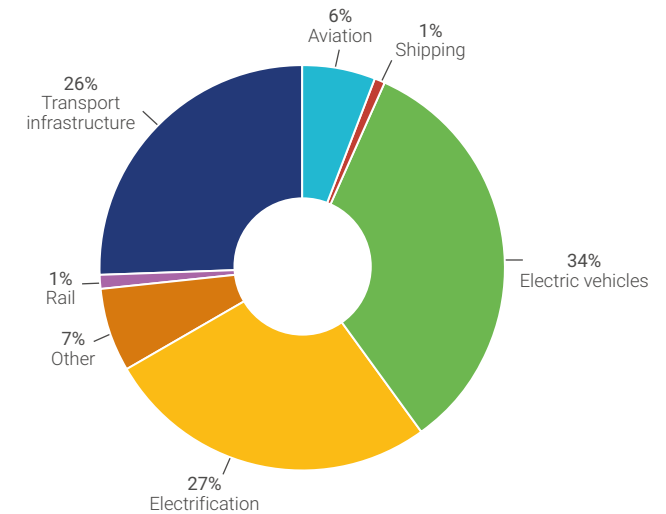
Heavy vehicles need more power for longer and so have been harder to decarbonise. Our portfolio of transport R&D includes a range of options for heavy vehicles, either electrifying them through more powerful ‘engines’ and reducing weight or developing use of alternative fuels such as hydrogen.

Rail freight contributes over £2 billion to the economy each year and is less carbon-intensive than other forms of freight transport. UKRI is

investing in new technologies specifically for the rail industry such as providing auxiliary power for locomotives and system optimisation for freight planning, as well as innovations in electrification and alternative fuels which have applications across a number of transport options.

Low-carbon fuels in shipping are complex, and have significant additional costs and volatility in comparison to fossil fuels. UKRI is therefore investing in further development of these low-carbon fuels such as ammonia, hydrogen and biofuels, making production cleaner, bringing down prices and allowing them to be retrofitted to more ships.

Proportion of UKRI spend on transport by sub-sector



## Research centre boosts road freight’s delivery of carbon cuts

In 2019, heavy goods and light-duty vehicles were responsible for 8.5% of the UK’s greenhouse gas emissions.

In response, supermarket chain Waitrose has introduced 120 new aerodynamic trailers to its road fleet. These trailers, developed by the Centre for Sustainable Road Freight in partnership with the road freight industry, have shown a 7% reduction in fuel consumption during trials, thanks to their innovative aerodynamic design.

Additionally, the Centre has launched a smartphone app for freight drivers. The app uses data on vehicle speed, weight, position, and terrain to issue alerts advising drivers when to ‘prepare to coast’ and ‘start coasting’ on normal terrain, downhill slopes, and approaching roundabouts and intersections.

This technology aims to maximize fuel efficiency and reduce emissions, with trial data indicating a potential improvement in fuel efficiency of 7-10%. A widescale rollout of the app is planned.



### Research spurs cycling uptake across the UK

Researchers at the University of Westminster have identified evidence-based measures to encourage more cycling across the UK.

Their findings empowered city planners to influence changes in Transport for London and national infrastructure design guidelines. The team also provided the foundation for expanding and investing in London's £90 million 'mini-Holland' scheme, which has significantly increased cycling rates through measures such as segregated lanes, cycle hubs and re-designed town centres.

Early studies revealed that residents in target areas were 24% more likely to have cycled in the past

week compared to those in areas without such improvements.

A 2013 grant led to the Propensity to Cycle Tool (PCT), an open-source online system for sustainable transport planning. Further funding in 2017 helped develop tools to estimate the health impacts of transport policies, including changes in physical activity, road traffic injury risk, and air pollution exposure.

These tools have since informed the development of health impact pathways, underpinning the expansion and investment in cycling initiatives across the UK.

For shorter-range maritime transport like ferries we are supporting innovations in autonomous sailing and electrification (including wind/electric hybrids), placing the UK at the forefront of this emerging industry.

Aviation shares some of the problems of shipping since weight and aerodynamics restrict the application of current battery technologies. Overcoming the interrelated engineering problems to deliver hybrid-electric and all-electric flight is a significant growth opportunity for the UK's high-value manufacturing sector. As with other modes of transport, we are continuing to invest in hydrogen fuel cells and green hydrogen infrastructure as a replacement fuel. We are also looking at ways to shift demand, for example developing drone technology (and control infrastructure) for freight and other short-range services currently provided by diesel aircraft.

The infrastructure that supports our transport must keep pace with the shift to low and zero carbon alternatives and be designed or adapted to provide resilience to a changed climate. This includes physical infrastructure such as roads and rails, as well as an integrated energy system that has the flexibility to respond to changing needs and growing demands for electricity.

Through *Building a Green Future* and in partnership with the Department for Transport we have launched the Net Zero Transport for a Resilient Future research programme. This national research hub will help upgrade and decarbonise the UK's complex and interconnected transport infrastructures to meet Net Zero targets by 2050 while protecting our economy.



# Land use and agriculture

Agriculture contributes around 12% of UK emissions, and the food system as a whole (including imports) is responsible for 35% of UK greenhouse gas emissions.<sup>6</sup> This is the largest contribution from any single sector to the UK's total emissions. Although there has been some progress in reducing emissions across the sector, this has been driven by shifts in supply chains and consumer behaviour, and underpinned by decarbonisation of the energy supply, rather than agricultural practices.<sup>7</sup> With 70% of the UK's land used for agriculture, the sector has huge potential to deliver on Net Zero, reduce pollution and reverse biodiversity decline, while protecting our food security. Across UKRI we have made significant investments in R&I on crops, farmed animals, soils, and microbes.<sup>8</sup> Our work helps to improve the yield and robustness of plants and farmed animals and protect them from pests and disease while also benefiting the environment through efficient, biodiverse, and sustainable agricultural practices.

The mix of climate pollutants produced from agriculture (including CO<sub>2</sub>, methane, and nitrous oxide) along with natural carbon sinks in some environments presents unique challenges and opportunities for Net Zero agriculture.<sup>9</sup> The complexity of this system, which needs to tackle sustainability and carbon neutrality in a way which also balances land supplies and healthy, affordable food, requires whole-system approaches to manage

## Research provides new ways to reduce carbon footprint in livestock farming



White clover forage mixes can significantly reduce the carbon footprint of cattle and sheep farms by decreasing the need for nitrogen fertilizers, research at the North Wyke Farm Platform (NWFP) has demonstrated.

This approach also boosts earthworm populations and biodiversity. Legumes like beans, peas, alfalfa, and clover contribute to sustainable agriculture through nitrogen fixation by bacteria in their root nodules. Data from the farm platform demonstrated that multispecies forage with legumes reduces greenhouse gas emissions compared to mineral nitrogen fertilizers, while maintaining or increasing forage yields.

The NWFP has expanded to an international network of 16 research farms across five continents.

A new carbon footprinting method for pasture-based cattle production, developed by researchers from the University of Bristol and Rothamsted Research, assesses the environmental impact of individual

animals rather than aggregate farm statistics.

This method highlights that poorly performing animals produce disproportionately large amounts of methane through enteric fermentation. These findings are crucial for minimizing the negative impacts of agricultural production and producing high-quality protein.

Research on stress memory in forage quality revealed that pre-exposure to drought or acute flood decreases digestibility and increases methane production. This suggests that breeding future forage varieties should focus on tolerance to acute stress rather than long-term climate changes.

Researchers at IBERS, Cardiff University, and Queen's University Belfast found that acute flood and drought consistently decrease digestibility, linking this to post-ingestion stress responses during rumen fermentation. This indicates that efforts to breed forage varieties for reduced gut fermentation should target acute stress tolerance.

trade-offs and optimise outcomes.

Fertilisers are critical to agricultural yields but are carbon intensive to produce. Overuse or run-offs can lead to nitrogen and phosphorous pollution, impacting soils, air and water. Given how much of the world's food relies on synthetic fertiliser, this Net Zero need is also a growing market, and UKRI is investing in development of innovative new products like biofertilisers as well as nutrient management techniques to replace and reduce our dependency on existing fertilisers.

Our portfolio of agricultural research is helping to reduce other inputs such as heat or water needed to produce food, such as 'vertical' farming techniques. We are exploring new approaches to the food system which can boost productivity and relieve pressure on natural resources, including cultured meat and cultivating insects for animal feed.

Pressures on land across the UK are growing, with multiple competing needs including agriculture, housing and energy production and storage. Our investment in land use frameworks helps to guide decisions for this finite resource, ensuring we manage the UK's natural capital to deliver climate solutions such as afforestation and sequestration and protect our food security and rural economies.

The *Building a Green Future* 'Transforming Land Use for Net Zero, Nature and People' programme, is working in partnership with UK government, devolved administrations and industry, to drive Net Zero through action in UK land sectors, focusing on three interlinked themes of soil health, agricultural systems, and land use change.

### Enabling farmers to improve environmental outcomes whilst increasing food production

The AgZero+ programme's free tool, E-planner, is revolutionising farming by helping farmers balance production with environmental enhancement.

It identifies optimal locations for environmental management options like pollinator habitats, woodland creation, and water resource improvement. E-planner maps are accessible via commercial software, including Land App, which boasts 21,000 UK users covering 9.5 million hectares, about 40% of the UK's land area.

Co-designed with farmers, E-planner integrates complex environmental data—such as soil type, slope, and proximity to water resources—into user-friendly,

interactive maps. AgZero+, led by the UK Centre for Ecology & Hydrology and Rothamsted Research, has partnered with Land App and Sainsbury's to enhance biodiversity across the Sainsbury's supply chain.

AgZero+ builds on the earlier Achieving Sustainable Agricultural Systems (ASSIST) programme, designed to make strides in developing innovative farming systems that boost productivity and resilience while minimizing environmental impact. Researchers examined the effects of agricultural intensification and combined ecological and biotechnological solutions for sustainable farming.



# Adaption and resilience

Nearly half of the world's population already live in areas highly susceptible to climate change. Between 2030 and 2050, climate change is expected to cause approximately 250,000 excess deaths per year.<sup>10</sup> UKRI has delivered programmes across the globe to build resilience to climate change, especially among communities which are disproportionately affected, helping to manage vulnerable ecosystems like river deltas and mangrove forests so they continue to provide resilience and sustain livelihoods.

The impacts of extreme weather in the UK highlight the urgency of adapting to climate change.

Record-breaking temperatures seen in summer 2022 brought unprecedented numbers of heat-related deaths, wildfire incidents and significant infrastructure disruption.<sup>11</sup> UKRI is supporting health policy by linking environmental and health data to identify markers of risk and resilience to heat in the population, and target interventions to high-risk groups like the elderly, pregnant women and infants. Alongside human health, we are working to mitigate the effects of extreme heat on plant life and microorganisms which sustain our ecosystems.

The UK also suffers from hydrological extremes (droughts and flooding). We are developing a range of programmes to improve water monitoring, predict the frequency and intensity of flooding to protect homes and businesses, and bring together environmental, social and physical scientists and planners with the water industry to find sustainable approaches to managing water supplies.

## Reducing the costs of flooding

Flooding can have less of an impact on public infrastructure, businesses and international communities thanks to a high-resolution flood modelling tool based on UKRI-funded research.

The University of Bristol commercialised the tool in 2013 via spinout company Fathom Ltd. Avoided losses, reduced risk to populations, better asset management and the creation of numerous jobs in the hazard risk analysis sector have all followed.

Fathom itself now employs 50 people, has an annual

turnover of c.£4 million and was acquired in 2023 by international reinsurance company Swiss Re.

Fathom's customers include Microsoft's cloud infrastructure, used by over 400 million people, Google, who used the Bristol research to develop their own flood forecasting model, The UK Foreign & Commonwealth Development Office, supporting African countries in strategic planning, and The World Bank, helping 10,000 users per month to assess risk to new infrastructure projects.



### Sphagnum moss could become the UK's first 'carbon crop'

Sphagnum moss could play a leading role in restoring degraded peatland and replacing peat-based composts.

Having supported years of research and commercialisation with Manchester Metropolitan University, UKRI has recently funded a collaborative project to produce Sphagnum moss at scale for commercial processing into sustainable growing media.

Beadamoss®, based near Loughborough, will work with industry partners to ensure rapid commercialisation of the UK's first 'carbon crop', with the wider horticultural sector aiming to achieve the UK target of eliminating peat-based composts by 2030.

Peatlands cover 3% of global land surface but store around 33% of soil carbon and twice as much carbon as all the world's forests. Degraded peatlands are responsible for a disproportionate 5% of global anthropogenic carbon dioxide emissions.



Without adaptation solutions to climate extremes, our economy and food security is under threat. The increased frequency of heatwaves and droughts in 2021 was associated with 127 million more people globally experiencing moderate or severe food insecurity compared with 1981–2010.<sup>12</sup> UKRI is helping the food system prepare for a changing climate with programmes to breed new, more resilient strains of crops, adapt to new or shifting pests, and protect and restore soils. To protect livelihoods, we are working with people in areas such as coastal communities which are particularly vulnerable to climate change impacts, helping to build understanding of local consequences of a changing climate and co-develop solutions to protect tourism, marine resources and the coastal environment.

Through *Building a Green Future* we are working with the Department for Environment, Food and Rural Affairs on the Maximising UK Adaptation to Climate Change programme to develop scalable solutions to increase the resilience of people, ecosystems and infrastructure at both local and national scales in the UK to cascading climate impacts.

Because our ability to predict climate is fundamental to adaptation and resilience, within this category we include the significant investments UKRI makes in understanding environmental processes to support climate analysis and modelling. These models provide the basis for understanding and preparing for environmental change, guiding adaptation decisions for maximum environmental impact while helping deliver a just transition for citizens. They also underpin services including spatial planning and risk management for other sectors such as agriculture, planning and transport. As part of this portfolio, *Building a Green Future* alongside the Department for Energy Security and Net Zero is supporting the 'Greenhouse Gas Emissions Measurement and Modelling Advancement' programme to provide accurate ongoing measurement of greenhouse gas emissions.



# Manufacturing and construction

Emissions from industry have decreased by around two thirds against 1990 levels. In recent years reductions in emissions from industry have come through reduced fuel consumption, especially in iron and steel.<sup>13</sup> The manufacturing sector has perhaps the greatest scope for quick decarbonisation, with rapid progress in the 2020s driven by fuel switching and deployment of carbon capture technologies being key to the sector reaching Net Zero by 2040.<sup>14</sup>

Research and innovation is crucial to helping the UK's manufacturing base decarbonise, especially in foundation industries (cement, metal, glass, chemicals, paper and ceramics). UKRI is supporting the integration of new fuels such as hydrogen, as well as finding ways to run industrial processes at cooler temperatures to lower energy inputs. We are also investing in industrial carbon capture and utilisation techniques such as biological fixation and carbon-absorbing materials.

Alongside these investments in decarbonising industrial processes, we have built a significant portfolio in boosting efficiency, producing more from each unit of raw materials, and reducing waste heat, water, pollutants, and other industrial by-products. We are supporting manufacturing and construction with development of alternatives to critical minerals and new bio-based materials which place less of a burden on natural resources, and shifting to more circular practices, including finding ways to reuse materials such as steel and aluminium, which is less energy intensive than fully recycling.



## Innovative green technology revolutionises chemical manufacturing

A groundbreaking environmentally-friendly technology, developed with long-term support from UK Research and Innovation (UKRI), is set to transform the chemical manufacturing industry.

HydRegen Ltd, a spinout from the University of Oxford, has pioneered a method that eliminates the need for toxic heavy metals as catalysts in chemical production, which are notoriously harmful to the environment.

Instead of relying on these hazardous metals, HydRegen's technology employs enzymes as catalysts. What sets this innovation apart is its use of hydrogen as an energy source to regenerate 'co-factors'—biological molecules essential for enzyme activity.

This cutting-edge technology not only enhances

product purity but also significantly boosts the sustainability and efficiency of fine chemical manufacturing. Key benefits include:

- Reduced dependence on toxic catalysts
- Decreased waste generation and disposal needs
- Lower energy consumption, leading to cost savings and reduced carbon emissions
- Enhanced agility and efficiency in chemical production, thanks to its continuous-flow operation capability

HydRegen's innovation marks a significant step forward in making chemical manufacturing more sustainable and environmentally friendly.

Improvements in efficiency reduce the carbon intensity of manufacturing as well as reducing costs, making industrial sectors more sustainable in the long term.

To further drive efficiency across the sector, we are supporting smart design and logistics to make sure manufacturing and construction use minimal inputs and minimises waste. This includes, for example, ensuring that building plans are optimised for efficiency and sustainability (not just cost), and enhancing our ability to track materials through supply chains so that surplus materials can be reused elsewhere in the sector rather than wasted.

Concrete and cement are crucial components of our built environment, but are responsible for a significant proportion of global carbon emissions, with a carbon intensity of approximately 0.6 tonne CO<sub>2</sub> per tonne of cement produced.<sup>15</sup> This is a significant challenge, which UKRI is helping to tackle with investments in novel forms of low-carbon concrete, as well as programmes to find alternative materials and construction techniques such as carbon neutral bricks manufactured using captured CO<sub>2</sub> which have the potential to revolutionise how we build.

### Sustainable British leather production

Grady & Robinson, backed by funding from the Business of Fashion, Textiles and Technology Creative Industries Cluster, are pioneering efforts to discover traceable, natural, sustainably produced, and biodegradable ingredients and processes for leather finishing.

Currently, achieving commercial-scale leather finishing with sustainable, natural, and biodegradable ingredients remains elusive. However, this step is vital for determining the material's suitability for various products.

In collaboration with the Institute for Creative Leather Technology at Northampton University, technical trials were conducted. Mulberry contributed by providing feedback, performance testing, and interpreting test results. This creative R&D has led Grady & Robinson to identify promising avenues for further development, potentially revolutionizing leather coloration and finishing with sustainable methods and materials.

Grady & Robinson are also producing the first supply of leather from animals raised on regenerative farms in the UK. Their mission is to offer brands and designers vegetable-tanned leather that is traceable to its farm source, entirely UK-made, and biodegradable at the end of its lifecycle.



# Whole system approach

UKRI supports the deep disciplinary and sector-specific knowledge which is helping industries and households across the UK decarbonise their manufacturing, heating and cooling, transport and food. These challenges are also interlinked, with both technological and behavioural challenges and solutions shared between them. The breadth of UKRI means we can take a whole systems view of these challenges by building and developing cross-disciplinary, cross-sector teams to balance the interplay and trade-offs across these sectors.

Building public acceptance of the measures needed to reach Net Zero is critical. Our work engages citizens in the choices around Net Zero, adapting to wider environmental change and biodiversity challenges, recognising the varied needs of different social groups. Alongside this engagement we are investing in research and innovation to improve the services government provides, such as health and procurement, to ensure they benefit people and the environment. This includes tracking 'what works', assessing the effectiveness of policy and programmes, and building the evidence base for interventions through demonstrators, living labs and pilots.

To support this work, the *Building a Green Future* Sustainable and Equitable Low Carbon Living Centre will enable UK decision makers to identify the most cost effective and socially feasible options for supporting the public, government, and businesses

## Delivering a better Net Zero future through smart local energy systems

UKRI's Prospering from the Energy Revolution (Pfer) programme has showcased the transformative potential of smart local energy systems. By integrating energy supply, storage, and usage within communities, the initiative has enabled new user services, enhanced efficiency, and reduced emissions and costs.

The programme has validated investable business models through the funding of over 90 projects, encompassing comprehensive energy systems research, demonstrators, designs, and tools. These efforts have delivered integrated solutions across power, heat, and mobility, attracting more than £850 million in private finance alongside £104 million from UKRI.

Key findings from the programme include:

- **Cost-effectiveness:** Smart local energy systems can deliver system-wide benefits worth approximately £1.7 billion annually.

- **Decarbonisation:** With 82% of UK emissions within the influence of local authorities, these systems accelerate the decarbonisation process.
- **Community engagement:** The transition to smart energy systems involves and benefits local communities.
- **Economic growth:** These systems create thriving business environments, opening up markets and generating jobs worth billions across the UK.
- **Social and economic benefits:** They deliver significant social and economic advantages to various regions in the UK.
- **Energy security:** Enhanced UK energy security is another critical benefit.

The findings underscore the urgent need for a policy framework to support local Net Zero delivery.



in transitioning to low-carbon living and adapting to wider environmental change and biodiversity challenges.

The move to a resilient, sustainable Net Zero economy needs high quality environmental and social data. UKRI maintains significant, long-term datasets covering terrestrial, marine and geological environments; animal, plant and human health; and financial, social and administrative data. Through investment in data analytics and skills, and targeted programmes to collect, maintain and manipulate this data, we unlock insights for a whole range of business, planning and policy needs.

The *Building a Green Future* 'Systems Approaches to Net Zero' programme will help embed systems thinking, funding two centres focused on solutions which stretch across sectors, balancing technological, economic, political, social, and environmental considerations to drive the realisation of a just, prosperous, sustainable, and resilient Net Zero transition.

Many Net Zero related fields of research and innovation – manufacturing and the circular economy, carbon capture, greenhouse gas removal, biotechnology and the food system – stretch across the whole of the UK. UKRI supports hubs and networks to boost integration across these sectors, identifying shared challenges and solutions and connecting researchers with innovators, businesses and policymakers.

The *Building a Green Future* Accelerating the Green Economy programme will support co-created centres of excellence with researchers, businesses, local authorities and other partners. They will

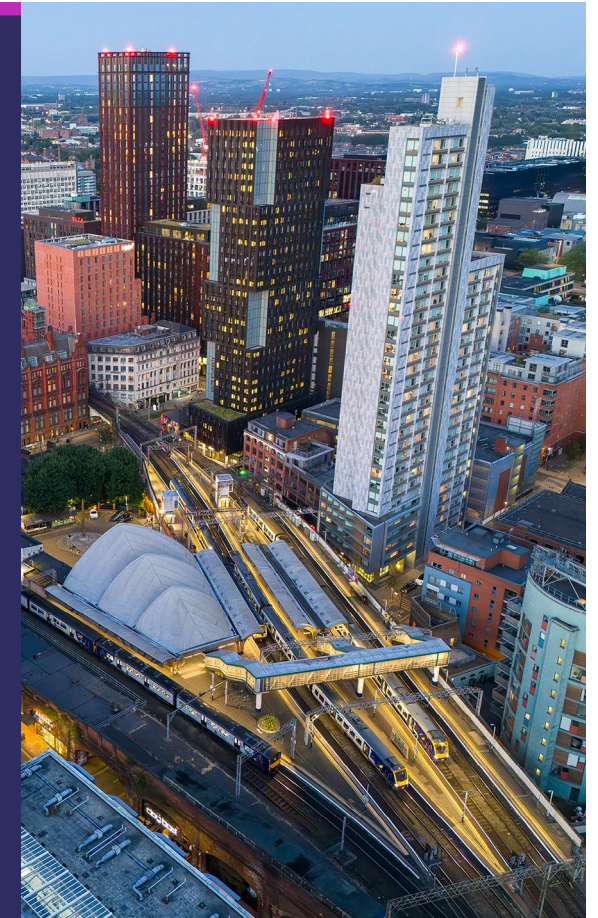
### Carbon budgeting tool prompts £millions of investment in climate change action in the North West

Regions across the UK are advancing more ambitious climate change strategies, driven by practical carbon budgeting tools that have empowered 250 local authorities to contribute to global climate goals. Immediate emission reduction actions are now a priority for local authorities serving 18% of the UK population.

For instance, the Greater Manchester Combined Authority has revised its target from an 80% carbon reduction by 2050 to achieving zero emissions by 2038. This shift has led to public buildings in Greater Manchester producing over 7,000 tonnes less CO<sub>2</sub> equivalent annually and reducing energy use by over 43 million kWh, resulting in savings of more than £2 million per year across the city-region. Similarly, the West Midlands Combined Authority, Sheffield City Council, and Leeds City Region are also updating their climate change policies and practices.

These carbon budgeting tools, developed with expertise from the Tyndall Centre for Climate Change and funded by UKRI translate global carbon budgets to local scales. They enable regions, local authorities, and both commercial and public sector organisations to align their policies with the 2015 Paris Climate Accords.

bring in private co-investment to tackle specific, emerging industry-led research and innovation priorities to support the scale up and adoption of green solutions at the local, regional and national level. The investment will accelerate the translation and commercialisation of these market-informed solutions to support skills, jobs and drive green economic growth for the UK.



Local solutions will drive Net Zero, building on regional strengths and dealing with the specific challenges and opportunities of particular environments. UKRI has a range of place-based investments, such as living labs or the translation of knowledge into policy to help cities and regions find sustainable approaches to delivering for their citizens.

# Biodiversity loss

In the UK, and across the world, biodiversity is being depleted at an alarming rate: overall, there has been a 69% decrease in global wildlife populations since 1970, with freshwater systems showing the greatest relative decline.<sup>16</sup> Drivers of biodiversity loss to date have been human activity – unsustainable use of natural resources like forests and water, habitat fragmentation, and pollution – rather than climate change. As the world approaches 1.5°C of warming, and critical habitats such as forests, wetlands and coral reefs come under increased pressure, the biodiversity crisis will only deepen.<sup>17</sup>

Our economy depends on nature, from foundational resources like clean air, water and land, to complex systems like food and manufacturing which start with environmental inputs. Damage to nature thus has a cumulative slowing impact on GDP which is greater than that of the global financial crisis of 2008. If left unchecked, this continued degradation could lead to GDP being 6% lower over the next decade, or up to 12% (greater than COVID-19) if combined with a zoonotic disease outbreak.<sup>18</sup>

The UK has recognised the need to act, pledging in 2023 to protect 30% of the land and sea for biodiversity by 2030. UKRI is investing in programmes to inform decision-making and support natural solutions for, habitat protection, restoration and creation in a variety of environments, including forests, rivers, soils, farms and cities. Our research is developing our understanding of the complex

## Improving our understanding of biodiversity health

With biodiversity health at risk across the world, new AI-enabled sensing technology is delivering data at unprecedented scale and detail, saving money and enabling more effective action.

One such device is the Automated Monitoring of Insects (AMI) device, developed by the UK Centre for Ecology & Hydrology (UKCEH). Autonomous, continuous and unbiased, AMI is enabling government, businesses, communities and scientists to make better informed decisions on biodiversity.

For example, AMI devices are measuring the biodiversity impacts of different peatland restoration

and agri-environment interventions in real-time, providing detailed evidence to inform the journey to Net Zero.

UKCEH and the Alan Turing Institute are deploying AMI, with additional sound recognition capability, to baseline small animal populations (e.g. insects, bats, birds) in Africa, Asia and South America.

Similar technology, working with Keen AI Ltd, is making trackside vegetation management cheaper and safer, identifying invasive and diseased plants from moving trains for Network Rail, one of the UK's biggest landowners.



interactions between landscapes, the communities that live in them, and the ecosystem services they provide. With this knowledge, data analytics, and harnessing new technologies like digital twinning, we can inform nature positive developments such as tree planting or rewilding.

Underpinning this work is our investment in long-term environmental data including, for example, the Biological Records Centre (which has been recording UK soil, animal and plant life since 1964), now supplemented with cutting edge satellite and analytical technology enabling us to count wildlife and measure forest coverage from space.

The drivers of biodiversity loss, and the opportunities to arrest and reverse it, are closely linked to the ways in which we value nature (economically, socially and politically).<sup>19</sup> Finding ways to appropriately value nature will help shift business practices and investment to greener options, with associated gains in human capital and employment.<sup>20</sup> UKRI has recognised this growing market and policy need with a series of programmes to better represent the complex values of the environment and ecosystem services in economic terms, and translate that environmental data into effective and sustainable decision-making by businesses and financial services. Environmental data is a growing market,<sup>21</sup> and the UK is well placed to benefit from this demand through its globally significant financial sector.

The *Building a Green Future* 'Equitable nature-based climate resilience in Sub-Saharan Africa (SSA)' programme will enhance understanding of the contextualisation, scalability and community-driven

### Embedding climate and biodiversity in finance

UKRI is investing over £20 million in research projects to integrate biodiversity and climate considerations into financial decision-making. The Integrating Finance and Biodiversity for a Nature Positive Future (IFB) programme is developing the skills and tools to incorporate biodiversity-related risks and opportunities into planning, reporting and investment decisions for the finance and business sectors.

The Resilient Planet Data Hub is a collaboration between IFB and another UKRI programme, the UK Centre for Greening Finance and Investment. Launched at COP28 by the Global Resilience Index Initiative (GRII) and UN High Level Champions, with partners like Google, the Hub helps countries, financial institutions, and investors quantify and manage climate risks using advanced data and modelling tools.



governance of nature-based solutions in SSA. It will identify how effective nature-based solutions are increasing resilience to multiple climate change-

induced risks, their wider impacts and how they can be monitored and improved to enhance equitable outcomes for local environments and people.

# Health

Climate change has significant implications for human health. The World Health Organisation considers the climate crisis the 'single biggest health threat facing humanity'.<sup>22</sup> Many of the indirect causes of disease and mortality are addressed specifically by other sectors in this review (for example extreme heat or pollution), with this section focused on those interventions which specifically integrate environmental and health concerns.

Interventions which mitigate climate change while addressing pollution – for example the shift to green transportation – have the potential to positively impact human health as well as address Net Zero targets. However, such measures are often not direct replacements, and require shifts in behaviours, policy, and designing the built environment. For transport this would include charging infrastructure, changing traffic flows and speeds, a different mix of road vehicles, and even construction of new infrastructure such as light rail. UKRI is therefore also investing in research to optimise transport choices, as well as identifying any unintended consequences in, for example, the types of particulate matter in the air or different forms of injury in road traffic accidents. Deteriorating environmental quality due to pollution or overexploitation of natural resources has significant impacts on human health. In the UK, nearly 40,000 people die early every year due to diseases caused by outdoor air pollution.<sup>23</sup> Long-term exposure to air pollution can cause chronic conditions such as

## Avoiding wildlife disease outbreaks

COVID-19 showed only too starkly how devastating the health and economic consequences of spillovers of wildlife diseases into human populations can be.

Research linking emerging wildlife diseases (zoonoses) with land use and climate change indicators, has provided insight into the transfer of such diseases into human populations. This has guided policy priorities at international bodies including the United Nations, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and WWF, as well as the UK government – informing zoonotic risk evidence in HM Treasury's Dasgupta Review, and the UK Foreign and Commonwealth Development Office's (FCDO) Ebola response planning.

The research also prompted major investments globally into pandemic prevention, such as FCDO's Zoonoses and Emerging Livestock Systems programme, tackling disease emergence via livestock systems, and the US Government invested \$1.5 billion in aid to countries at high risk of emerging diseases.



cardiovascular and respiratory diseases as well as lung cancer, leading to reduced life expectancy. The total estimated cost (2017-25) to the NHS and social care system of fine particulate matter and nitrogen dioxide in the air we breathe will be £1.6 billion.<sup>24</sup>

Exploitation of natural resources and resulting changes in the environment such as deforestation or depleted water resources can drive animal species to seek new habitats and alter their typical behavior, bringing them closer to human settlements. As this happens, the risk of transfer of disease from animals to humans (zoonosis) rises, which may increase outbreaks of known diseases such as Ebola or Plague, or create the conditions for diseases to transmit to humans for the first time. UKRI is investing in research programmes to identify and track species such as mosquitos, ticks and rats which spread zoonotic diseases, and to drive positive change in agricultural and land management practices to mitigate this risk.

Through *Building a Green Future* we are collaborating with the National Institutes of Health Research (NIHR) on the 'Realising the health co-benefits of the transition to Net Zero' programme. This programme will establish transdisciplinary research hubs that will provide policy-relevant evidence and deliver high impact, solutions focused research to protect and promote the physical and mental health of the UK population as part of the UK's transition to Net Zero.

### Making cities healthier through air pollution research

In 2019, air pollution caused 40,000 deaths in the UK, with 4,000 in Greater London. Globally, it leads to 4.2 million deaths annually from conditions like stroke, heart disease, and respiratory diseases.

UKRI has a significant portfolio of air quality research, including the SPF Clean Air Initiative which draws in the environmental, physical, social and life sciences alongside the arts and humanities to take a holistic approach to this complex problem. Scientists at the Centre for Environment and Health are leading research on air pollution policies, including the Ultra Low Emission Zone (ULEZ) in London, and how this might aid other UK cities in developing clean air zones.

Initial ULEZ results showed only a slight reduction in air pollution, but long-term improvements were significant. From 2016 to 2020, the number of Londoners in areas with illegal nitrogen dioxide levels dropped by 94%.

New air pollution monitoring technologies have also spurred local clean-ups, generated over £50 million in revenue, and boosted job growth for UK companies.

Leicester-based SME Earthsense has tackled local pollution hotspots, created numerous jobs, and aided property sales with air pollution risk reports for conveyancers. The company produces high-resolution air pollution maps, from national to street level, and develops sensors. Earthsense's MappAir® powers the BBC Pollution Postcode Checker, and its Zephyr® sensor is used by 17% of UK local authorities.





# Pollution

The economic impact from air pollution – including hospital admissions, longer-term sickness, and work days lost – in the UK is estimated at £20 billion every year.<sup>25</sup> Air quality is highly variable across the UK, with inner city air especially polluted due to concentrations of industry and transport. This, combined with other related factors such as modes of travel, means that the impacts of air pollution are not evenly spread across the population, but rather concentrated on low-income or otherwise vulnerable groups.

Outdoor air pollution is a mix of gases such as ammonia, nitrogen dioxide and sulphur dioxide and fine particulate matter. UKRI has built a substantial portfolio of air quality research and innovation, including air quality monitoring and modelling to identify sources of pollution, their interactions, and the effectiveness of policy and public health interventions in air quality. Much of this research intersects with our investments under 'health', addressing the respiratory and cognitive diseases associated with air pollution, and identifying the socioeconomic drivers and consequences of pollutant exposure.

Indoor air pollution adds biological and chemical sources to the outdoor air that enters the home, with the intensity and consequences of pollution often compounded by the effects of heating and ventilation. Our research into indoor air pollution thus focuses on the particular toxicology of indoor spaces, as well as the airflows at the indoor/outdoor boundary for improved ventilation.

Only 14% of rivers in England have a good ecological status and none has a good chemical status.<sup>26</sup> Rivers carry pollution from many different sources, including agricultural and industrial waste, urban pollution and wastewater. Our water pollution portfolio contains programmes addressing these distinct forms of pollution, as well as comprehensive approaches focused on the consequences to freshwater ecosystems and human health of mixing pollutants. We are also developing modelling to predict the ability of freshwater to cope with a changing climate, for example changes in water temperatures or runoff from more frequent and higher intensity storms, so that appropriate protections can be developed.

Plastic pollution is a growing problem, with the amount of plastic waste entering the ocean projected to triple to 23-37 million tonnes per year by 2040, unless we change how we produce, use and dispose of plastic.<sup>27</sup> UKRI has supported research to track plastic pollution in the ocean, air and in our food system and identify its impacts on biodiversity and health. To help prevent pollution, we have also made investments across the whole lifecycle of plastics, aiming to replace plastics with biodegradable and recyclable alternatives, and to manage plastic waste so that it does not leak into the environment.

UKRI also makes significant investments in addressing the causes of pollution – cleaner transport and improved chemicals to reduce air

## Turning the tide on plastic pollution

Plastic pollution in marine environments poses significant risks to marine life and has economic impacts on society.

Scientists at Plymouth Marine Laboratory were the first to discover that microplastics, which are plastics smaller than 5mm, harm zooplankton. Zooplankton are the most abundant animals on Earth and play a crucial role in oceanic food chains.

Their groundbreaking research led to the UK's ban on microplastic beads in wash-off cosmetics, preventing 4,000 tonnes of plastic from entering the oceans annually. This research has also influenced similar bans in other countries and contributed to discussions on an EU-wide restriction on intentionally-added microplastics.

Additionally, it supported the introduction of the 'plastic bag tax' in the UK, which started at 5p per bag and later increased to 10p, reducing plastic bag usage by 86% between 2011 and 2015.

pollution, or approaches to farming and industry that reduce runoffs into water. These investments fall primarily in other sectors, and so are discussed there more fully, but the efforts we make through the full span of our portfolio to reduce waste and pollution at source is an excellent example of our cross-cutting approach to Net Zero and environmental gain.

# Waste and recycling

Recycling rates are increasing in the UK, but so is the population. We are producing more goods and using more natural resources and yet we are still sending high volumes of waste to landfill. The UK generates approximately 40 million tonnes of commercial and industrial waste each year.<sup>28</sup> The Environment Act sets out a commitment to halve residual waste per person by 2042.<sup>29</sup> To address this, we must get better at preventing waste and find new ways to re-use and recycle, which will require a mix of new technologies and different business practices combined with structural changes in our economy and behaviours.

Our investments in addressing waste include reducing inputs for manufacturing and finding novel uses for by-products of current processes. Optimising the design of manufacturing systems and improving the efficiency of industrial processes, for example by recapturing scrap or using low-temperature catalysers, helps to reduce the need for raw materials and energy. Many processes also create waste because they cannot use 100% of the materials they need. We are backing innovative companies finding alternative uses for these products, such as producing calcium carbonate from discarded eggshells or composites from waste woods to support construction and manufacture.

To tackle the problem of waste our economy must move to a more circular model, with material at the end of its life in one use being repaired, reused elsewhere or recycled. Currently less than 1% of

clothing can be recycled, so we are finding ways to reclaim fibre, even when it has been mixed or dyed, and supporting development of new fibres (including bio-based fibres) that are easier to reuse and recycle. We are investing in similar ways across a whole range of products and sectors, including electronics, glass, medical devices and even wind turbine blades.

Under half of household waste is currently recycled, although this does include 63% of packaging waste.<sup>30</sup> We are addressing hard (or impossible) to recycle items such as plastic packaging for food (packets, sachets and bottles), mixed metals or electronic waste such as silicon chips and batteries by developing recyclable alternatives. Biotechnology is a key part of this effort, creating and combining biologically renewable raw materials (biopolymers) which allow for recyclable or biodegradable products.

For the remaining waste that cannot (yet) be returned to the economy, UKRI is supporting research and innovation focused on minimising environmental harm. This includes, for example, bioengineering to allow micro-organisms to break down specific forms of pollution like chemicals or plastics, and technology to enhance the waste value chain by identifying and tracking high-value materials which can be extracted for reuse.

## **Innovative use of paper pulp waste: Transforming lignin into bioplastics**

In a groundbreaking development, waste from the paper pulp industry is being repurposed into bioplastics.

Lignin, a robust structural material derived from plants and typically burnt as fuel in paper manufacturing, is now at the forefront of this transformation. A team of researchers and innovators has pioneered a biological method to extract valuable chemicals from lignin, converting them into plastic.

This research has led to a significant collaboration with Biome Bioplastics, one of the UK's leading bioplastic developers. Together, they are demonstrating that lignin digestion products can be produced on a commercial scale for bioplastics production.

Plastic production is a major industry in the UK, generating over £20 billion in revenue and exporting more than £8 billion worth of plastic products annually. With existing global market connections, the UK's world-leading engineering biology sector, and the government's goal to eliminate avoidable plastic waste by 2042, the bioplastics industry is poised to redefine plastic production in the UK.

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