Innovate UK

Net Zero

Annual Review 2020–21

Contents

Facts and figures

In 2020-21, Innovate UK has invested £273 million in net zero innovation, creating value, jobs and growth as we move to net zero.

Energy
£68,475,700

Transport
£93,014,773

Industry
£89,253,449

Buildings and infrastructure
£7,675,765

Agriculture and land use
£15,405,703

856
organisations supported (commitments in 2020-21)

£2.1bn
valuation of companies supported by Innovate UK

£786m
private investment raised by organisations we have supported up to and including 2020-21

- East Midlands: £21,039,328
- East of England: £25,859,508
- London: £27,782,137
- North East: £16,820,266
- North West: £16,815,995
- Northern Ireland: £6,023,014
- Outside UK: £804,299
- Scotland: £32,694,441
- South East: £31,572,682
- South West: £17,441,133
- Wales: £7,162,499
- West Midlands: £30,578,429
- Yorkshire and The Humber: £39,231,654

Executive summary

Indro Mukerjee,
CEO, Innovate UK

Innovate UK is the UK's innovation agency. We drive productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class scientific research base.

We work **to inspire** innovative businesses to create value through innovation. We work **to involve** talented organisations and people to create a vibrant and successful innovation ecosystem. We work **to invest** in innovation to make a clearly tangible positive impact on the UK's economy and society.

This is the Innovate UK Net Zero Annual Review 2020-21 and it summarises the work we have been doing over the past year to support the UK's net zero commitments.

Net zero presents both a vital commitment and a call to action for all of us, as well as an opportunity for business growth through innovation.

UK businesses can grow through the creation of new products, services and processes that help the UK and wider world to decarbonise and minimise other adverse environmental impacts.

Innovate UK programmes can help realise opportunities for innovation across the main related sectors of the UK economy: energy systems, agriculture and food production, transport, industry and the built environment.

In 2020-21 Innovate UK committed to invest £273 million in projects related to net zero, and this review highlights the potential for impact from these projects and related programmes. Our funding helps support new, innovative ideas, and we work hard to ensure that the private sector co-invests with us. To date net zero-focused organisations supported by us have raised a further £786 million in private investment to take these innovative ideas to market.

This review has been developed in the run up to COP26. COP provides a renewed emphasis and imperative to tackle the climate crisis. Innovate UK is playing an active part in COP, showcasing innovators and innovations, and helping to communicate how these will help build our net zero future.

This is a future we are strongly committed to.

Indro Mukerjee
Chief Executive Officer
Innovate UK

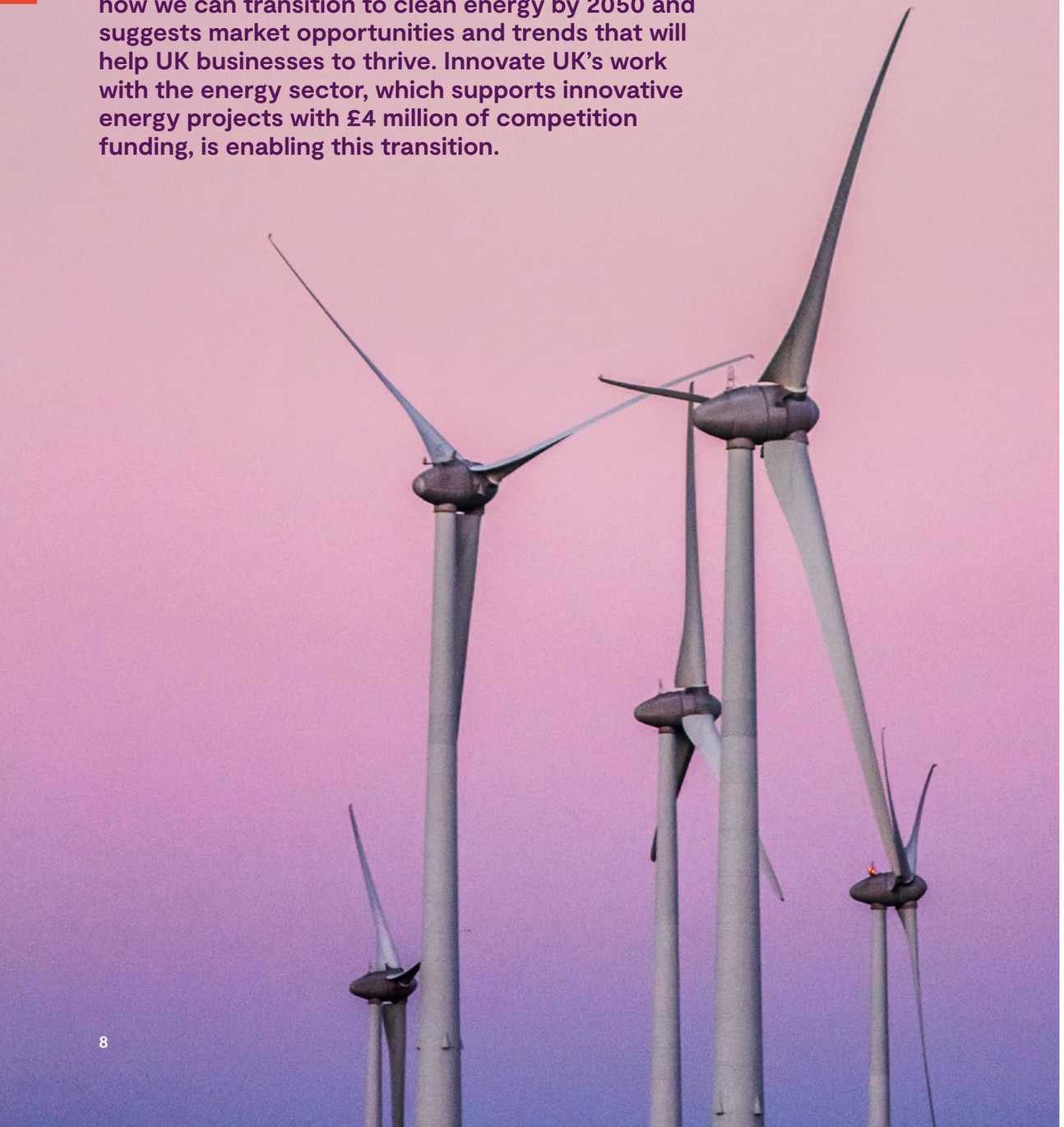
A low carbon future

Innovation is key to developing the green technologies needed to tackle climate change. We work to provide funding that accelerates the commercialisation of low-carbon technologies, systems and business models in energy, buildings, agriculture, transport and industry.

To achieve net zero we must combine the talents and capabilities of the UK's world-class scientific research base with those of the UK's innovative businesses, catapults and other centres of expertise. This review presents these partnerships and collaborations, including several Industrial Strategy Challenge Fund programmes that address some of our biggest net zero societal challenges.

Energy

The government's Energy White Paper[1] examines how we can transition to clean energy by 2050 and suggests market opportunities and trends that will help UK businesses to thrive. Innovate UK's work with the energy sector, which supports innovative energy projects with £4 million of competition funding, is enabling this transition.



Prospering from the Energy Revolution Challenge

This challenge drives innovative smart local energy systems to provide clean, affordable energy while attracting investment and creating high-value jobs across the UK.

Intelligent local energy systems can provide cleaner, cheaper and more efficient energy. However, setting them up can be complex, integrating heat, power and transport services, requiring innovation in areas from energy storage to data management.

The **Prospering from the Energy Revolution (PFER) Challenge** aims to show how society can build a foundation for net zero by combining the best existing technologies into smart local energy systems – providing cleaner, cheaper, joined-up energy services that local people want to buy.

Smart local energy systems

Smart local energy systems (SLES) are how we combine national systems with local knowledge and networks to unlock the best of each to achieve net zero delivery.

With funding on net zero activities for the challenge reaching £28.2 million in 2020-21, SLES activity covers:

- demand on the grid
- creation of local skilled jobs
- reduction in fuel poverty
- reduction in CO_2
- increase in resilience.

Key achievements over 2020-21 have been:

- overseeing the start of the build-out of the demonstrator's asset base, including 50 megawatts of world-leading hybrid battery installation in Oxford
- launching 10 new local area design projects around the country, bringing plans together between technology and infrastructure to benefit local citizens
- funding 12 businesses to develop the next generation of digital infrastructure and applications from energy data, including **Icebreaker One Limited** and **Siemens PLC**
- securing £32 million to date of co-investment en route to the challenge target of £95 million
- 228 participants, including small/micro and large businesses, local authorities and academic institutions
- 117 new jobs created
- 31 new products and services developed.

The challenge is funding 15 projects to research and develop key technology components that could make SLES more efficient and effective.

Net zero impact

To date, the challenge has invested £16.3 million in three large-scale demonstrators:

- **Energy Superhub Oxford:** a transmission-connected network of rapid electric vehicle charging, hybrid battery energy storage, low-carbon heating and smart energy management technologies that reduces stress on local grids
- **ReFLEX Orkney:** a first-of-its-kind integrated virtual energy system linking local electricity, transport and heat networks
- **Project LEO (Local Energy Oxfordshire):** a local energy marketplace that actively balances generation with demand for power, heat and transport, enabled by an intelligent local grid.

Alongside these demonstrators are more than 50 other projects developing designs, concepts, technologies and data approaches that will help such systems become reality.

The programme is funded by UK Research and Innovation and delivered by Innovate UK and the Engineering and Physical Sciences Research Council. It is already seeing evidence that these approaches can offer efficient and sustainable ways of investing for net zero, acting as lighthouse projects for others to follow.

£32m
private investment secured

228
participants in the programme

117
new jobs created

31
new products and services developed

Low-Cost Nuclear Challenge

The Low-Cost Nuclear Challenge aims to develop a compact, standardised nuclear power station product based around a UK-designed Small Modular Reactor, using modern mass production methodology. These units, in the future, will provide low-carbon energy to help the UK reach net zero.

470MW

of low-cost, low-carbon electricity each small power station will produce each hour for up to 60 years

1m

homes and 62,000 electric cars can be powered by each SMR

200

high-value jobs created within the consortium of companies connected to the LCN

£18m

in ISCF awards to the Phase 1 consortium (a further £18 million of matched funding was raised from industry)

£258m

in private funding being finalised for the next phase of the development (to be matched by £210 million of government funding as part of its Ten Point Plan for a Green Industrial Revolution[4])

800

jobs could be supported by the next phase of the programme

The **Low-Cost Nuclear (LCN) Challenge**, funded by UK Research and Innovation and delivered by Innovate UK and the Economic and Social Research Council, is developing a nuclear power station design that can be built quickly by the UK supply chain.

This innovative programme, led by Rolls-Royce Small Modular Reactor (SMR), will enable new SMRs to be deployed in the UK by the early 2030s. These units will be capable of producing cost-competitive low-carbon electricity, creating significant export opportunities for UK businesses.

Success in partnership

Nuclear programmes are complex, exacting and need a wide range of technical competencies. The LCN programme has brought together a consortium of leading UK-based companies who have successfully delivered the first phase (during which a concept reactor design was produced), gained confidence, and are now creating a new standalone company to commercialise SMRs.

In the past year, there has been growing recognition that nuclear will form part of the net zero energy mix to underpin future renewable power generation. Additionally, the LCN Challenge aligns with the Nuclear Sector Deal[2] and government's Advanced Nuclear Technologies framework[3], which provides the supporting policy framework for encouraging new nuclear technologies.

Sort and Segregate Nuclear Waste competition

This Small Business Research Initiative competition is delivered by Innovate UK on behalf of the Nuclear Decommissioning Authority and targets the net zero agenda.

The aim of the **Sort and Segregate Nuclear Waste competition** is to develop an autonomous and integrated toolkit to sort and segregate radioactive waste generated by nuclear decommissioning activities. This will reduce the level of waste requiring disposal, increase productivity, reduce costs and improve safety.

The £3.9 million competition awarded Phase 1 contracts in February 2021.

Decommissioning and optimisation

The competition's objectives align with the Nuclear Decommissioning Authority's aspirations to reduce human decommissioning activities by 50% and to reshape and optimise the way nuclear waste is dealt with by 2030[5].

Phase 1 supported 14 projects in total, with £840,000 of Small Business Research Initiative funding.

CASE STUDY

NuSORT

This project uses machine vision and robotics control to sort and segregate nuclear waste.

With £59,354 of funding, the NuSORT project used lead organisation NUVIA Ltd's radiometrics instrumentation, data processing and software currently used on nuclear waste management applications around the world. It combined these with the latest innovations in industrial automation, machine vision and robotics used on a commercial basis in the oil and gas, agricultural and food processing sectors.

These factors resulted in NUVIA performing waste sorting and segregation operations on several UK nuclear licensed sites. It also optimised recycling and free release potential to minimise waste disposal costs.

To deliver a feasibility study, NUVIA will now be collaborating with Peacock Technology Ltd (PTL), an engineering consultancy and research incubator specialising in electronics, automation, robotics and machine vision.

PTL has been successful in applying the latest innovative technologies to invigorate old ways of working and improve conventional and environmental safety and productivity.

Together, NUVIA and PTL will investigate and optimise the process flow required to achieve high-quality LLW/ILW product streams.

The study will analyse methods for:

- integrating and automating the processes for materials handling
- physical and radiological characterisation
- object and materials recognition
- optimisation of waste container packing
- data management
- production of package records.

Driving the Electric Revolution Challenge

This challenge brings together the UK's Power Electronics, Machines and Drives community to accelerate innovation, build partnerships across industries, and help ensure the UK can develop capabilities fit for the future.

The Driving the Electric Revolution Challenge is investing £80 million in electrification technologies, including Power Electronics, Machines and Drives (PEMD).

The investment supports the UK's push towards a net zero carbon economy and contributes to the development of clean technology supply chains, worth £80 billion in gross domestic product by 2050[6].

The investment will accelerate the UK's ability to deliver:

- hybrid aircraft – hydrogen and fully electric
- industrial drives
- low-carbon construction and agriculture equipment
- low-carbon maritime and rail
- next generation electric vehicles
- renewable energy
- robotics
- smart grids.

The challenge focuses on growing the UK's PEMD supply chains and manufacturing capability through three areas of activity:

- industrialisation centres
- collaborative innovation funding
- talent and skill development.

Continued success

2020 posed many challenges to the world as a whole and to the PEMD community. However, the Driving the Electric Revolution Challenge demonstrated continuing success in moving towards a net zero carbon economy via:

- a £33 million investment in four national centres of excellence in PEMD, based at existing areas of expertise in Strathclyde, Sunderland, Nottingham and Newport. These centres support research and development in net zero technologies by enabling businesses and researchers to develop and scale new PEMD technologies and manufacturing processes
- in response to COVID-19, the Catalysing Green Innovation: Advancing PEMD Supply Chains competition was conceived and delivered, and resulted in 21 collaborative R&D projects and £5.75 million of investment.

As part of the Industrial Strategy Challenge Fund, the Driving the Electric Revolution Challenge is funded by UK Research and Innovation and delivered by Innovate UK and the Engineering and Physical Sciences Research Council.

CASE STUDIES

WIND Electric Revolution (WINDER)

This project is part of a plan to bring the manufacture of large generators for offshore wind to the UK.

Sheffield-based Magnomatics has partnered with the Offshore Renewable Energy (ORE) Catapult to further trials of its Compact, High-Efficiency Generator (CHEG), in addition to exploring more efficient scale-up concepts.

This 500kW pseudo direct drive (PDD) generator combines a magnetic gear with a permanent magnet generator to replace the traditional turbine generator and gearbox, and therefore has the potential to increase reliability and decrease maintenance when scaled up to wind turbine sizes.

Magnomatics is developing computer-based modelling software that can be used to design robust pole piece rotors (PPRs), including dynamic modelling of the pole piece loads to predict wear and possible erosion.

These methods have been tested and validated by ORE Catapult's 1MW drivetrain test rig. A virtual product validation will also be performed on concept designs in order to ensure the PPR achieves the expected product lifetime of over 25 years.

Wind turbine generator unit volumes could reach 800 units per annum therefore it would be essential to manufacture the PPR cost effectively. The University of Sheffield's Advanced Manufacturing Research Centre – part of the High Value Manufacturing Catapult – is providing Design for Manufacture input and support to Magnomatics.

Energy Catalyst

Energy Catalyst accelerates the innovation needed to end energy poverty, focusing on how the international landscape will be crucial to achieving net zero targets.

1.1 billion people globally go without access to modern energy services, and a further billion experience intermittent access. Through financial and advisory support, and by building strategic partnerships and uncovering new insights, Energy Catalyst helps bring to market technologies and business models that can improve lives in Africa and Asia.

Energy Catalyst works towards combating energy poverty through climate mitigation and Sustainable Development Goal 7 (SDG7). SDG7's aim is to deliver universal access to energy by 2030.

Energy Catalyst aims to achieve this through:

- **acceleration** – a springboard for innovators to de-risk, accelerate and demonstrate their solutions for ending energy poverty
- **network** – maximising the potential for commercialising new technology and business models by building partnerships across the energy access ecosystem
- **impact** – innovators are pioneering new ways to create economic opportunity and improve lives in Africa and Asia
- **knowledge** – by testing and demonstrating innovation, Energy Catalyst benefits the wider energy access ecosystem by contributing knowledge, case studies and lessons learned.

The programme is co-funded by partners, including the Engineering and Physical Sciences Research Council, the Foreign, Commonwealth & Development Office, the Department for Business, Energy & Industrial Strategy and the Global Challenges Research Fund.

Challenges and successes

Despite the challenges COVID-19 has placed on international collaboration during 2020-21, the programme managed to help 56 businesses, with funding of £6.5 million committed to tackle the net zero challenge. Successes include:

- the total projected CO_2 emission reductions for Energy Catalyst Programme projects are between 30,000 and 150,000t of CO_2
- Energy Catalyst support has progressed technology readiness levels (TRLs) for businesses on average by 1.5+ TRLs during the project. This has increased to 2.1+ TRLs when including any post-project progress attributed to Energy Catalyst support
- the Energy Catalyst programme has created 7,386 end-user energy connections, with a total of 174,000 people positively affected
- due to COVID-19 we utilised online rather than face-to-face brokerage events and reached over 1,000 businesses. This helped achieve the programme's highest ever application numbers, with a 100% scale-up on submissions for Round 8 versus Round 7 (Round 7 saw 200 applications; Round 8 saw 400 applications)
- the programme created 350 sustainable long-term jobs
- £35 million in private finance was leveraged on the back of Energy Catalyst funding.

CASE STUDIES

Mobile Power

Supplying cleaner, cheaper energy off-grid and championing gender equality in Africa.

Mobile Power has supplied power to 15 remote villages in Sierra Leone, using a pay-per-charge battery pack service. MOPO Batteries are charged at solar charging stations then rented directly from a hub. Customers can also hire packs from distribution agents, who are paid on commission and travel up to 10km from the hub to provide off-grid energy to households.

The MOPO Battery provides sufficient power for a household's daily use. It can be used to run fans, TVs, MP3 players or its built-in 500lm light. The battery can also charge eight to 10 mobile phones at a cost 75% cheaper than using gasoline generators, as is common in parts of Africa.

Mobile Power has received £1,067,554 of Innovate UK funding, starting with a pilot to prove the project's viability. In December 2020 the company raised £2 million in a Series A funding round.

Since the project began, 18 women have become MOPO agents and received training and support from Energy Catalyst's Gender Equality Support Officer.

Bilateral programme: USA and UK offshore wind

This R&D programme partners research teams across two countries to develop offshore wind innovations that help drive down costs and achieve net zero goals.

As part of the **Clean Growth and Infrastructure** UKRI Fund for International Collaboration, the Bilateral UK and US offshore wind R&D programme has invested £1.3 million in four UK projects to collaborate with four separately funded US projects.

This UK programme leverages $40 million of funding provided by the US National Offshore Wind Research & Development Consortium. The projects will:

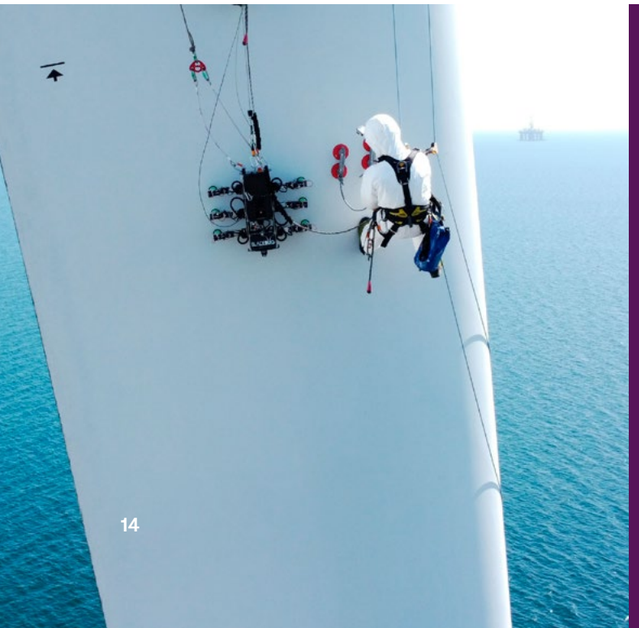
- work collaboratively with a US consortium
- reduce the technical barriers faced by offshore wind developers, original equipment manufacturers and the supply chain
- focus on reducing barriers that stop the use of offshore wind technologies, including cost.

Twenty challenge areas were identified that aimed to reduce the cost and risk of offshore wind development projects throughout the US.

Other decarbonisation and net zero initiatives

A number of other initiatives were delivered in support of our clean growth and net zero ambitions:

- extending the **KTN Innovation Exchange (KTN-iX)** programme for a further three years, from 2020 to 2023 (the focus of the KTN-iX is on finding low-carbon solutions or novel propositions to net zero challenges raised by challenge sponsors)
- managing a portfolio of 60 grant-funded projects focused on accelerating low-carbon and renewable energy technologies
- co-chairing the Department for Business, Energy & Industrial Strategy net zero international working group and helping refocus its mission and active participation
- developing further UK-US collaboration opportunities, including a potential R&D competition with several US states
- supporting the Global Incubator Programme launch and selection of first cohort of cleantech start-ups
- follow-on projects have resulted from two separate grant-funded projects, including BladeBUG joining with EchoBolt for a successful follow-on submission to the Robotics ISCF.



Robots for a Safer World Challenge

Making work environments safer in sectors like offshore wind will help the UK achieve its emissions targets.

The Industrial Strategy Challenge Fund's Robots for a Safer World Challenge focuses on research and innovation in advanced robotics and autonomous systems (RAS) to create a safer working world. Many of these new technologies are operating in extreme and challenging environments that can be dangerous to work in or hard to reach, such as nuclear power, offshore energy and space-based activity.

BladeBUG and Echobolt

In spring 2021, BladeBUG and EchoBolt joined forces to develop a robotic solution for ensuring the integrity of the millions of bolts that hold wind turbines together. The move was described as essential to the expansion of offshore wind – and the world's net zero future.

The project, announced by the Offshore Renewable Energy Catapult and funded by Innovate UK, brings together the six-legged BladeBUG inspect-and-repair robot for turbine blades and EchoBolt's ultrasonic bolt inspection device.

The collaboration will expand BladeBUG's capabilities, allowing the robot to crawl turbine structures and test bolt integrity using ultrasonics. Leading turbine developer GE Renewable Energy, which plays a supporting role as technology advisor, estimates that the companies' technology fusion will unlock cost savings of 75% in bolt maintenance and repair bills. The potential market ahead of the solution's developers is estimated at £150 million per year by 2030.

MIMRee

Multi-Platform Inspection, Maintenance and Repair in Extreme Environments (MIMRee), a two-year project funded by UK Research and Innovation, demonstrates how autonomous 'mother ships' and robotic crews can replace humans in dangerous offshore inspection and repair work, so technicians can be deployed in safer, highly skilled roles onshore.

ORE Catapult estimates that the MIMRee system could reduce the lifetime operational costs of an average wind farm by £26 million. By reducing turbine stoppage time, it could increase revenue generation by £1.1 million. Both savings represent a significant step in the industry's drive to reduce the cost of energy to consumers.

Offshore Renewable Energy Catapult

The Offshore Renewable Energy Catapult is the UK's leading technology innovation centre for offshore wind, wave and tidal energy – creating a significant impact on net zero targets.

With bases in Glasgow and Blyth, Northumberland, the **Offshore Renewable Energy (ORE) Catapult** is home to a dynamic, creative team of experts who each play an important role in helping achieve the Catapult's goals.

Key areas of focus include:

- next-generation turbine technology
- floating offshore wind
- marine energy
- smart and sustainable operation and maintenance of wind energy systems
- energy system integration
- UK growth and levelling up.

Net zero agenda

With net zero ambitions to increase offshore wind capacity by 2050 to some seven to 10 times of that installed today, tackling UK market challenges in this sector is of the utmost importance.

The climb is a formidable one: the UK's skills, infrastructure and funding gaps still create barriers to innovation, supply chain growth and manufacturing opportunities.

To meet the challenge, ORE Catapult operates at the centre of the offshore renewables sector as a unique partner to industry, innovators, academia and government. Since 2013, ORE has been:

- instrumental in driving the innovation agenda
- building capacity to develop and commercialise technology
- sparking strategic collaboration and expanding business support opportunities.

All of these aspects are required to unlock the huge potential of the UK's natural energy resource to generate gross value added (GVA), jobs, regeneration and carbon reduction.

102
new collaborative projects initiated in 2020-21

190
SMEs that made their first engagement with ORE Catapult in 2020-21

54
UK companies entered into a project or collaboration with ORE Catapult

Energy Systems Catapult

This centre of excellence accelerates the transformation of the UK's energy systems and ensures UK businesses and consumers capture the opportunities of clean growth on the way to net zero.

Success figures

The **Energy Systems Catapult (ESC)** has contracted or partnered with 132 businesses during 2020-21, an increase of 25% since the previous year, making it ESC's most successful to date.

Other key success figures include:

- seven live international projects: Power Forward – Qbots (Canada), Energy Launchpad International (in both India and Thailand), Innovating for Clean Air (India), International UK PACT, ISGAN and CELCEP (China)
- Energy Launchpad, a collaborative meeting place for UK innovators transforming energy markets, has engaged with 74 SMEs through ESC's Universal Support, Assisted and Incubation/Acceleration activities
- three challenge calls were launched and completed in 2020-21. Previously, another two were launched in 2019-20 and completed in 2020-21.

Next phase

The next phase of ESC activity will continue to support the achievement of net zero targets.

The programme aims to deliver a total of £22.4 million of activity in 2021-22, and to leverage £13 million of match-funded investment from the 90 or more businesses it aims to work with during the year.

One of the highlights of the activity and impacts from work supported by the ESC core grant includes further investment into Living Lab.

Living Lab is a real-home test facility. It helps innovators test new products and services with consumers in over 250 real-world homes that are all connected to a cloud-based digital integration platform.

In July 2021, ESC announced plans to add 50 new homes with disabled consumers to Living Lab to boost inclusive innovation[7].

CASE STUDY

AirEx

The company's intelligent air brick lowers household energy bills.

AirEx has developed a smart ventilation control – an intelligent air brick – that automatically regulates air flow using sensors to monitor temperature, humidity and air quality.

AirEx believes up to 40 million homes across Europe could benefit from an intelligent air brick. However, with its initial target market being UK social housing, the obvious beneficiary is the tenant rather than the landlord.

ESC is helping AirEx accelerate its innovation to market with product validation via:

- test and demonstration
- exploiting data from the trial for further product development
- support with business planning
- extending the monitoring period in the Living Lab to a larger scale.

Transport

UK government has set in law the world's most ambitious climate change target: cutting emissions by 78% by 2035 compared with 1990 levels[8]. In 2021, the UK's sixth Carbon Budget[9] will incorporate the nation's share of international aviation and shipping emissions. From rail and road to air and sea, transport is a sector packed with low-carbon commercial opportunities for UK businesses.

Rail innovation

Innovate UK supports projects delivering green innovation via competitions that focus on decarbonisation of the railways and low-emissions transport.

Innovate UK delivers innovation programmes on behalf of the Department for Transport (DfT), including competitions that focus on both decarbonisation and delivering a low-emissions railway.

Specifically, we provide support to projects across the railway industry, including:

- activities delivering greener railway technology
- enhancing customer experience
- improving the resilience of the railway
- reducing noise
- enhancing station security
- supporting gauging and infrastructure examination
- benefiting the environment
- supporting rail freight.

Achieving net zero

In 2020-21 Innovate UK supported companies to demonstrate the UK's first hydrogen-powered train and low-emissions maintenance vehicles.

Sourcing new green innovation through competition has also played a key role. The **First of a Kind 2021 rail innovation competition**, has low-emissions and a greener railway as a theme, and opened in February 2021.

This competition has funded the first prototype of a zero-emissions version of the **Trac Rail Transposer (TRT-e)**, launched by Unipart Rail and McCulloch Group, which takes conventional rail engineering equipment and replaces the motor with a battery-powered electric substitute.

TRT-e will eliminate up to 80kg of CO_2 on a typical operating shift and, as a first-of-its-kind solution, places Unipart and its partners in a favourable position for sales in both the UK and international markets.

CASE STUDY

HydroFlex

The UK's first hydrogen-powered train represents a vital step in decarbonising the rail network.

In September 2020, the first ever hydrogen-powered train ran on the UK mainline in what marked a big step forward towards the UK's net zero targets.

Supported by Innovate UK, the trials of the train, known as **HydroFLEX** , follow almost two years of development work and more than £1 million of investment by both **Porterbrook Leasing Company Limited** and the **University of Birmingham**.

Unlike diesel trains, hydrogen-powered trains do not emit harmful gases, instead using hydrogen and oxygen to produce electricity, water and heat.

The ground-breaking technology behind the trains will also be available by 2023 to retrofit current in-service trains to hydrogen. This will help decarbonise the rail network, making rail journeys greener and more efficient.

As part of the innovation, **Tees Valley** is set to become a trailblazing Hydrogen Transport Hub. It will bring together representatives from academia, industry and government to drive forward the UK's plans to embrace the use of hydrogen as an alternative fuel. It also has the potential to create hundreds of jobs, as well as seeing the region become a global leader in the green hydrogen sector.

The next stages of HydroFLEX are already underway. The University of Birmingham is developing a hydrogen and battery-powered module that can be fitted underneath the train, which will allow more space for passengers in the train carriages.

Faraday Battery Challenge

Conceived as a 10-year investment to enable UK battery manufacturing to grow and build to a self-sustaining model, the Faraday Battery Challenge remains a key part of the overarching net zero agenda.

The **Faraday Battery Challenge** is funded by UK Research and Innovation and delivered by Innovate UK and the Engineering and Physical Sciences Research Council. The challenge aims to support development of world-class science, technology and manufacturing scale-up capability for vehicle batteries in the UK.

The challenge is focused on developing cost-effective, high-performance, durable, safe and recyclable batteries to capture a growing market. It initially addresses eight present-day limitations of automotive battery technology, which allows the UK to realise its commitment to move to full electrification and zero-emissions vehicles. The challenge is also looking to address other sectors including aerospace and rail.
It comprises three stages to market:

- research
- innovation
- scale-up.

To date, the challenge has funded £127.8million across 81 collaborative R&D projects, with £90 million of the total in innovation funding and £36.4 million from industry.

There have been four competitive funding rounds since July 2017. These had increasing numbers of applications as UK companies began to pivot and work together successfully, rising from 34 to 80 applications across the four rounds of the competition.

To date, the funding round projects have involved 134 organisations, of which:

- 42% are micro and small companies
- 24% are large companies
- 20% are academic
- 9% are medium companies.

Net zero-led centres

As part of the drive towards net zero, two flagship Faraday Battery challenge centres have been set up: **The Faraday Institution** and the **UK Battery Industrialisation Centre (UKBIC)**.

The £108 million Faraday Institution is the UK's independent institute for electrochemical energy storage research, skills development, market analysis and early-stage commercialisation. It brings together research scientists and industry partners on projects with commercial potential that will reduce battery cost, weight and volume, improve performance and reliability and develop whole-life strategies including recycling and reuse.

The £130+ million UKBIC is a battery manufacturing development facility providing manufacturing scale-up and facilitating upskilling in the battery sector. This publicly-funded facility welcomes manufacturers, entrepreneurs, researchers and educators, and can be accessed by any organisation looking to scale battery technologies – if that technology will bring green jobs and prosperity to the UK.

CASE STUDY

Li4UK

This project aims to develop a sustainable domestic lithium supply chain.

Li4UK (Securing Domestic Lithium Supply Chain for the UK) is a £500,000 feasibility project, led by mining consultant Wardell Armstrong International and involving the Natural History Museum and Cornish Lithium Ltd.

The overall objective of the Li4UK project is to demonstrate the feasibility of producing battery-quality lithium compounds from sources of lithium found in the UK, both hard rock sources and geothermal waters.

In light of the COVID-19 international pandemic, the need to secure reliable supply chains for critical materials such as lithium has grown in prominence – and the opportunity to establish domestic supply chains where possible has grown in importance.

The Li4UK project has been fundamental in increasing awareness in both local and national government about the vital role that minerals will play in underpinning the UK's Clean Growth and Future of Mobility Grand Challenge ambitions.

Cornish Lithium Ltd received a further government investment through the Getting Building Fund for a £4 million project to build a pilot lithium extraction plant at the United Downs Deep Geothermal Project, in partnership with Geothermal Engineering Ltd. This will significantly accelerate Cornish Lithium's route to commercial production of low-carbon lithium.

Zero emission transport

The adoption of ultra-low-emission vehicles will bring significant benefits to the UK in improved air quality, decarbonisation and economic growth.

In July 2018 the government launched its Road to Zero strategy[10]. Its ambitions are:

- for at least 50% (and as many as 70%) of new car sales and up to 40% of new vans to be ultra-low emission by 2030
- to support the development of one of the best electric vehicle infrastructure networks in the world
- to set the stage for market opportunities in zero-emission transport.

Vehicle-to-grid

Vehicle-to-grid (V2G) technology enables electric vehicle (EV) batteries to store energy and send it back to the electricity grid when it's most needed.

Connecting millions of EVs and coordinating their charging and discharging could minimise the costs of EV battery charging, while allowing the grid to integrate high levels of variable renewable energy sources.

Zero emission transport

To meet the goals of the Paris Agreement, we need all new car sales to be zero emission by 2040[11].

Together with the **Office for Zero Emission Vehicles**, in March 2021 Innovate UK launched the Transitioning towards Zero Emission Vehicles and Niche Vehicle Network programmes focusing on the transition to ZEVs by 2030.

The aim of this competition is to fund innovative on-vehicle solutions that support the transition to zero emission vehicles.

Among the winning projects[12], announced in June 2021, were:

- an onboard plug-in device that provides drivers with data on battery health to improve the experience of buying secondhand EVs
- a kinetic battery that will provide a temporary power boost for charging the next generation of ultra-fast EVs at peak times in rural areas
- a zero emission ambulance with a hydrogen range extender designed from the ground up
- the development of a solar-powered refrigeration unit for small commercial vehicles.

CASE STUDY

Sciurus

How one million electric vehicles could deliver as much energy as a nuclear power station.

V2G technology in homes could be a valuable source of energy for the UK's national grid, helping the UK achieve zero emission targets.

Sciurus, the world's biggest domestic trial of V2G, found that EV batteries make energy supplies more resilient and cheaper. Under the two-year project, which was funded by Innovate UK, 320 Nissan Leaf owners had their cars fitted with V2G two-way charging technology linked to their domestic energy supply.

The platform imports energy to the car overnight and at off-peak times, when energy is cheap, and exports it back to the grid when demand is high and energy is expensive.

Alfred Ireland, Sciurus project lead and EV Commercial Manager with domestic energy supplier OVO, which provided the V2G platform, says the project was a huge success: "The trial proved that the technology could be rolled out at scale. A million EVs could contribute three gigawatts to the grid, equivalent to one nuclear power station."

Connected Transport

Connected Transport mobilises innovative technologies to leverage smarter, greener and more sustainable future mobility systems for the efficient movement of people and goods around the world.

Decarbonisation drives everything the Connected Transport team does: from reducing congestion; making travel efficient, informed and safer; to wayfinding and smart ticketing; freight and cooperative, intelligent transport systems; and using geospatial data in transport.

Connecting local to national and national to international, this is about enabling the seamless movement of people and goods. It is not only from the start of a journey, but from the point people think about and plan their journey.

Net zero and decarbonisation

The net zero agenda runs through all aspects of the Connected Transport remit, particularly towards decarbonisation. The Connected Transport programmes target the key sections of the net zero agenda to reach net zero emissions by 2050 by:

- supporting low-carbon alternatives, such as active travel and promoting shared options
- using technology to reduce carbon impacts of vehicles, such as traffic light management
- enabling passengers with informed choice to make better decisions when it comes to travel.

During 2020-21, a funding commitment of £10 million was made via competitions, in addition to an ongoing portfolio commitment of £20 million. £2 million of funding was also allocated to support the Niche Vehicle Network.

Two key competitions driving towards net zero goals with support from the Connected Transport team were for the Geospatial Commission and Highways England.

CASE STUDIES

Geospatial Commission

A project to accurately estimate a train's location uses innovative real-time image processing.

The objectives of the geospatial competition were to identify innovative geospatial solutions to current transport challenges and enable the future of mobility.

The Small Business Research Initiative competition was funded by the Geospatial Commission, part of the Cabinet Office, with substantial support from the Connected Transport team.

One such funded project is Geospatial Position Accuracy Improvement proposed and led by Reliable Data Systems International Ltd. It fulfils the net zero theme of increasing capacity, and partners with One Big Circle Ltd (sub-contractor), Network Rail (challenge owner), and Porterbrook Leasing Company Ltd (partner).

This project looks at accurate train positioning, a concept that is key to Network Rail operations, and will augment GPS with camera vision technology to achieve geospatial accuracies within 1m.

Going forward, location data such as this will help the UK build back greener and reach our net zero target.

Highways England

The organisation is tackling transport challenges by changing the way roads are designed, managed and used.

Highways England funded 15 pilot and development projects via Innovate UK through the Developing Digital Roads and Improving Air Quality competition, which was part of the Connecting the Country strategy.

Aimsun Ltd was part of one such project, which was entitled Network Emissions/Vehicle Flow Management and fulfilled the air quality net zero theme.

The project investigates the impact of different traffic management tactics in real-time on the Oxford road network (within the ring road) and their implications on the A34 and A40.

ATI Programme

The ATI Programme represents a £3.9 billion joint government and industry investment to accelerate innovation and grow the UK's competitive position in civil aerospace design and manufacture.

Innovate UK coordinates and manages this programme in partnership with the Department for Business, Energy & Industrial Strategy and the Aerospace Technology Institute. We work in close collaboration to deliver a coherent portfolio of projects to meet the objectives and priorities of the UK Aerospace Technology Strategy[13].

The Programme is addressing large-scale technology and capability challenges, including technologies for more energy efficient and sustainable aircraft. Since 2013, it has invested over £1.6 billion in grant funding for 338 projects with a total portfolio value of £3.1 billion.

The flight path to net zero

At the 2019 Paris Air Show, seven of the world's largest aerospace companies recommitted to neutral carbon growth in aviation from 2020[13], along with the 2050 ACARE environmental goals[14]. Meanwhile, passenger traffic continues to grow at a rate of 3% to 4%[15] annually, adding to the challenge.

Despite the current climate the aerospace sector finds itself in as a result of the COVID-19 pandemic, there remains a strong commitment from UK industry to invest in R&D relating to more energy efficient and sustainable aircraft in order to grow and ensure future competitiveness.

During 2020-21, the ATI Programme has supported a number of projects that focus on net zero and zero emission aircraft technologies. Such projects include:

- AEPEC: Addressing electrical power systems and energy usage for future aircraft, in particular, generation, control, starter-generator function and electric actuation
- H2GEAR: Developing a liquid hydrogen propulsion system for sub-regional aircraft that could be scaled up to larger aircraft configurations of up to 100 passengers
- InCEPTion: Developing a novel all-electric propulsion module that is safe-by-design, scalable, modular and enables the combined use of batteries and fuel cells in electric aircraft (of up to 30 passengers)
- HEPBAS: Developing electric drivetrain (motor and controllers) and propulsion battery systems to address the requirements of more energy efficient and sustainable aircraft
- AEDD: Developing a prototype smart-diagnostic charge device for the eVTOL aircraft battery using cutting-edge electrochemical methods.

CASE STUDY

HyFlyer II

This ATI Programme-funded project is developing a hydrogen fuel cell powertrain for commercial aviation.

ZeroAvia's HyFlyer II project follows the company's world-first flight of a commercial-grade hydrogen-electric aircraft – the Piper Malibu M350 six-seater plane – at Cranfield Airport in Bedfordshire in September 2020.

Previous to this, in June 2020, ZeroAvia conducted the first electric-powered flight in the UK with the same aircraft.

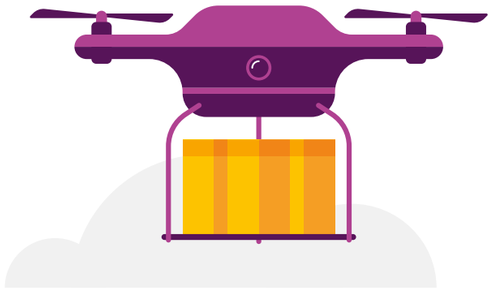
With the HyFlyer II project, ZeroAvia is developing a market-ready 19-seater 600kW hydrogen-electric powertrain for 2023.

The organisation hopes to have a version with 50 to100 seats ready by the end of the decade, bringing zero emission commercial flights closer to reality.

ZeroAvia is partnering on this project with The European Marine Energy Centre and Aeristech, a leading developer of power-dense and efficient air compressor solutions.

Future Flight Challenge

The Future Flight Challenge aims to stimulate the development and application of new aviation technologies in the UK to create new modes of air travel and capability within the net zero agenda.



The **Future Flight Challenge (FFC)** is investing up to £125 million (matched by £175 million from industry) to develop greener ways to fly by advancing electric and autonomous flight technologies.

One of the challenge's aims is to bring together technologies in electrification, aviation systems and autonomy to create new modes of air travel and capability. It will:

- create the aviation system of the future
- increase mobility, improve connectivity and reduce congestion for people across the UK
- advance electric and autonomous flight technologies to help reach the net zero target
- drive technology investment to the UK by increasing UK manufacturing and service opportunities.

A challenge in three phases

The FFC is being run in three phases. Phase 1 (Concepts) launched in 2019, Phase 2 (Development) launched in 2020, and Phase 3 (Demonstration) opened in September 2021.

Achieving net zero outcomes

During 2020-21, the FFC committed funding to 230 applicants in Phase 2, with 34 projects being taken forward to Round 3 – more than expected given COVID-19's impact on the aviation industry. A key driver for projects is to incorporate net zero into their solutions.

Projects funded by FFC under Phase 2 include:

- Project SATE (Sustainable Aviation Test Environment) is creating the UK's first low-carbon aviation test environment based at a licensed island airport. If successful, this project should stimulate inward investment and local supply chain business opportunities in Orkney
- HyStYRIAA (Hydrogen Storage to Energise Robotics in Air Applications) 2.0 is carrying out a feasibility study for a hydrogen energy storage system for flight. The system is initially for smaller aircraft (such as large drones) but is potentially scalable to large aircraft
- 2ZERO (Towards Zero Emissions in Regional Airline Operations) is developing a six-seater and 19-seater point-to-point hybrid electric aircraft, and is demonstrating the possibility of regional air transport operating models, increasing flexibility by creating viable routes from smaller airports.

Phase 3 of the challenge will focus on ambitious, real-world case demonstrations of the new aviation systems and support the move towards net zero aviation. The FFC will continue to engage with the wider hydrogen initiatives led by the Innovate UK Energy team, including the use of hydrogen for net zero transport solutions.

There are also 10 drone delivery and inspection projects. Electric drones transport parcels and medication, and survey infrastructure in hard-to-reach places, which is more environmentally friendly than using road transport.

The programme is funded by UK Research and Innovation and delivered by Innovate UK, the Engineering and Physical Sciences Research Council, and the Economic and Social Research Council.

Connected Places Catapult

The Connected Places Catapult is the UK's innovation accelerator for cities, transport and places with the goal of reducing emissions.

Given the interdependencies between the way we live, work and travel, emissions reduction targets will not be achieved by taking a sector-by-sector approach. Instead, this is a system-level challenge, where place, energy, infrastructure, industry and people all influence each other. The **Connected Places (CP) Catapult** is at the forefront of this integrated change.

Optimising existing systems

To achieve net zero aspirations, the CP Catapult looks holistically at how current assets operate, how they relate to other parts of the system, and identifies new technologies to reduce emissions.

This includes:

- net zero ports – creating multi-modal energy hubs moving to decarbonisation
- net zero airports – as well as aircraft, airports need better connectivity with public transport networks, plus a public desire to change habits
- recognition that building back is not enough – looking at the critical case for retrofit, solar use and challenging conventional methods of construction.

Reducing demand

While we can achieve some impact on reducing emissions by improving the operation of existing systems and infrastructure, it is also necessary to change behaviours and reduce underlying demand.

The CP Catapult works on this around the critical areas of:

- mobility as a service – focusing on customer convenience and how to make travel more carbon-efficient
- making better decisions through data-driven integrated place planning
- active travel – increasing the number of journeys made on foot and by bike.

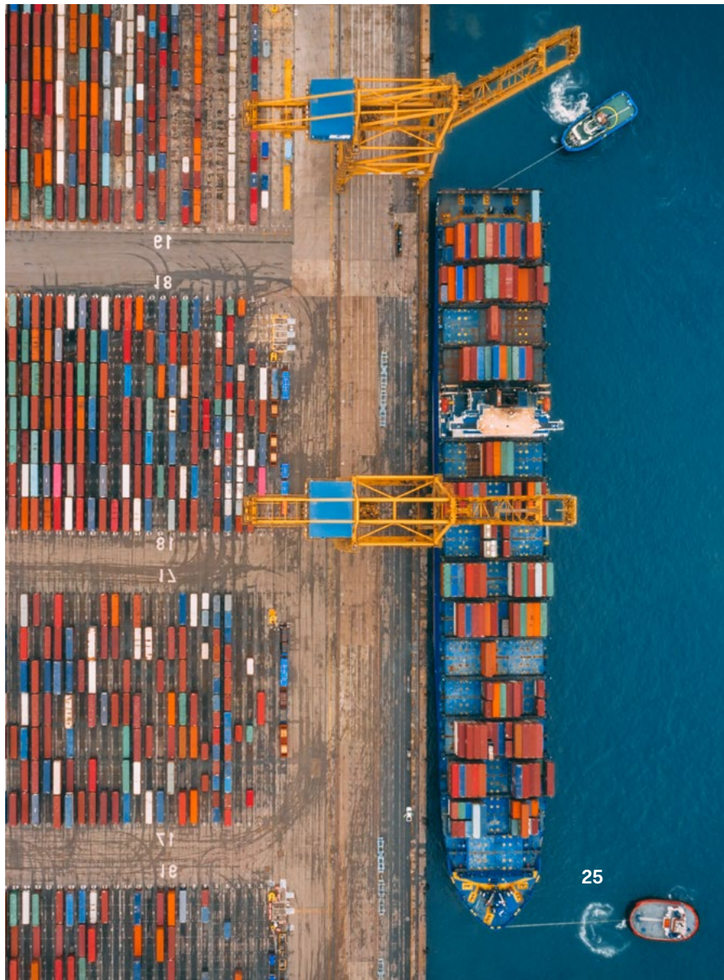
New technologies

Emerging technologies have a transformative impact on the ways people and goods travel.

Deploying them at the scale needed to deliver net zero will require significant innovation in the planning and development of our towns, cities and national infrastructure, all of which represent market opportunities.

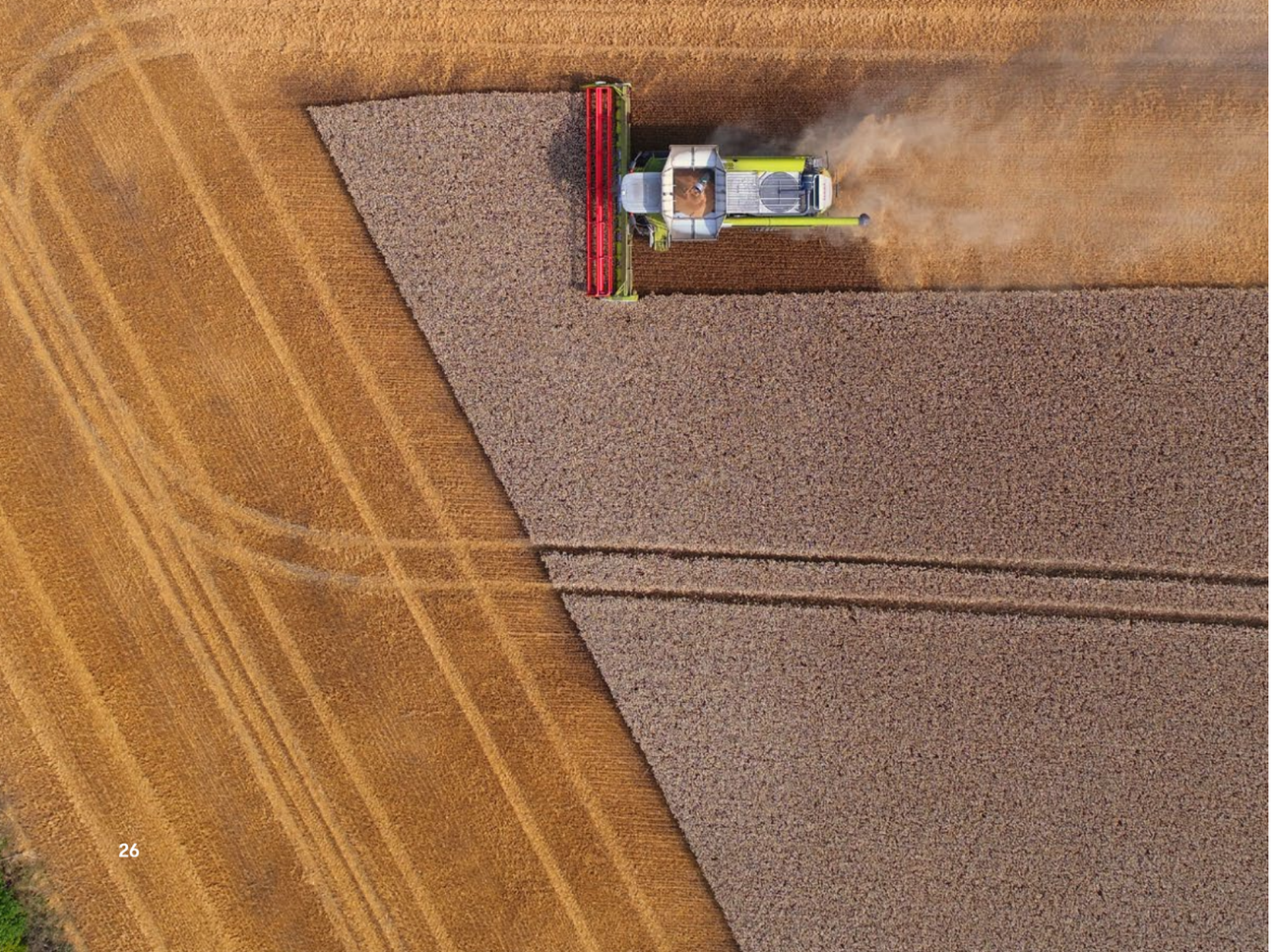
As part of this, the CP Catapult is focusing on:

- transitioning road freight to net zero
- drones and the electric aircraft revolution
- home delivery services.



Agriculture and land use

There is an opportunity for the UK to lead the way in developing climate-friendly farming systems and land use for the mutual benefit of people, the environment and our shared prosperity. Through diverse collaborations (for example, between areas such as carbon storage, fuel and electricity), we can tackle the challenge of how to produce enough food and feed stocks to sustain an evergrowing world population while protecting the planet.



Transforming Food Production Challenge

This wide-reaching challenge supports new ways to produce food that reduce emissions and pollution, and contribute to feeding a growing world population.

It has been predicted that 70% more food will be needed worldwide by 2050 in order to feed the increasing global population[16]. To do this, we need to be able to produce resilient and sustainable food more efficiently. This will reduce emissions and pollution, minimise waste and improve soil.

The **Transforming Food Production (TFP) Challenge** is investing up to £90 million of funding to help businesses, researchers and industry transform food production, meet growing demand and move towards net zero emissions by 2040.

Funding is invested in:

- future food production systems
- science and technology into practice
- international opportunities
- investment ecosystems.

47
new projects added to the TFP Challenge portfolio during 2020-21

290+
organisations supported

80+
live projects, ranging from SMEs through to universities/RTOs

£36m
committed to be awarded in competition grants to projects with a net zero focus

As of December 2020, a TFP Challenge survey has identified the following benefits experienced by businesses participating in the projects:

49
new customers secured

5
new business established

£10m
in UK and international private investment raised

150
jobs created or retained

Investment competition success

Launching the Series A investment competition through the Investor Partnership Scheme has proved a successful route for the TFP Challenge.

£5 million of grant funding has been earmarked to support late-stage R&D for UK companies. These companies are expected to leverage at least a 2:1 ratio from a pool of lead investors, providing up to £15 million of support.

The scheme addresses a specific gap pertinent to the UK agri-tech sector, with a lower rate at which business proposals and investment pitches are being received (deal flow) at this Series A stage compared with international competitors.

The TFP Challenge funding (which comes via UK Research and Innovation and is delivered by Innovate UK and the Biotechnology and Biological Sciences Research Council) will support UK businesses that have a food production focus that aligns with a net zero agenda. Specifically, the aim is to help these firms transition to commercial-scale production and revenue generation.

CASE STUDY

LettUs Grow Ltd

The company's patent-pending aeroponics technology is used for sustainable vertical farming.

The TFP Challenge awarded £498,000 to project lead LettUs Grow Ltd, with project partner ECH Engineering Ltd, to develop a vertical farming project designed to reduce water usage in agriculture.

The development uses aeroponics technology, which uses 95% less water than traditional agriculture, needs no pesticides and can be deployed anywhere in the world from cities to deserts.

Based in Bristol, LettUs Grow started operations in 2015 and now employs 30 staff. The business receives up to 60 commercial enquiries a year from a wide range of customers looking to grow a variety of crops.

It is currently seeking a Series A investment deal and saw its first major revenue sales in 2020, with more sales expected through 2021.

The LettUs Grow team has applied for two patents with one more in the pipeline.

Industry

From cutting emissions in their supply chains to opting for sustainable business practices, it is vital that businesses take action to achieve the UK's 2050 goals. Funding delivered through Innovate UK, such as the Transforming Foundation Industries Challenge, Industrial Decarbonisation Challenge and Industrial Energy Transformation Fund, encourages businesses to reduce their emissions though the use of innovative technology. The focus is on designing, manufacturing, selling and using products that deliver more value during their lifetime, with minimal environmental impact and increased sustainability.

Transforming Foundation Industries Challenge

This challenge is supporting innovation across the metals, glass, paper, ceramics, cement and bulk chemicals sector in a drive to make them more sustainable and internationally competitive.

The Transforming Foundation Industries (TFI) Challenge is developing innovative technology, new business models and supporting training to reduce energy and resource use within the foundation industries (glass, metal, paper, cement, chemical and ceramic sectors).

As part of the Clean Growth Grand Challenge, the challenge aims to help businesses across the foundation industries, their technology providers and supply chains to develop innovative solutions to increase their sustainability and remain internationally competitive.

By working together to solve common resource and energy efficiency challenges, the costs of technology development can be shared, speeding up development and making real-world impacts sooner.

Key achievements of the challenge include:

- 5,000 jobs forecasted to be created in the sector within 10 years of starting the TFI
- private equity attracted is estimated to reach £72 million within 10 years
- a survey of projects indicates 80 new IP claims will be filed
- the challenge has supported 53 SMEs so far
- the TFI Investor Partner Programme offers £6.5 million of grant funding aligned with investors, ranging from £500,000 to £2 million.

This programme is funded by UK Research and Innovation and delivered by Innovate UK, the Engineering and Physical Sciences Research Council, and the Economic and Social Research Council.

CASE STUDY

Glass Futures Ltd pilot facility

A new pilot facility in St Helens will provide a centre of excellence for the sustainable manufacture of glass.

The Transforming Foundation Industries Challenge has contributed £15 million of the £54 million total cost of the construction of a new pilot facility with Glass Futures Ltd.

Due to open in 2023, the facility will be set up in St Helens to accelerate the development of promising clean technologies. Other contributing partners are Liverpool City Region and St Helens District Councils, with a £20 million industry contribution.

The 30 tonnes per day furnace and associated processing equipment will enable members from the glass and other high-temperature sectors to undertake process improvement experiments at a highly instrumented pilot facility.

The facility in St Helens is on a former glassworks site historically occupied by United Glass.

Business Secretary Kwasi Kwarteng said: "This new funding will build on our commitment to cut emissions across heavy industry, create green-collar jobs on Merseyside and help us to build back greener."

£149m
to be invested in total by the TFI Challenge to ensure sectors make improvements to their energy and resource efficiency

£66m
to be invested in direct projects by the challenge (match-funded by £83 million from the private sector)

500,000
skilled jobs in 31,400 firms in the foundation industries, mainly in areas outside of London and the South East

Manufacturing and materials sector

The UK Manufacturing and Materials processing sector is essential for economic growth and competitiveness, vital to achieving environmental and sustainability targets, and key to improving the resilience of UK supply.

High Value Manufacturing Catapult

Joining industry and academia to reduce emissions.

The High Value Manufacturing Catapult (HVMC) connects businesses to academia, providing access to research and development facilities and expertise. It tackles climate change by supporting the development of products and processes that reduce emissions.

Working as part of a consortium developing Small Modular Reactors (SMRs), HVMC is creating jobs in nuclear energy – around 6,000 roles are expected to be filled by 2025.

In transport, HVMC's National Composites Centre has reduced the weight of parts of the Ford Transit van's suspension system by 40%. The result is that each van will be 30kg lighter, making the Transit more fuel efficient with lower emissions.

In production, the Advanced Forming Research Centre has demonstrated an alternative way of forging that reduces waste by up to 40% – in a sector where material wastage can be as much as 80%.

Manufacturing in the UK accounts for approximately 8% of jobs and 10% of economic output, yielding an impressive 42% of UK exports and 65% of UK research and development spending[17].

Manufacturing and materials also contributes an important proportion of UK CO_2e territorial emissions. Different studies suggest a range from 12%[18] to 16%[19] of total CO_2e emissions are attributable to manufacturing within the 'factory gate'.

These territorial emissions, however, exclude the energy (and thus emissions) that go in to processing and manufacturing the materials, components and goods that are imported into the UK, equivalent to approximately 40%[20] of our domestic, 'national' emissions.

The broad impact of design and sourcing decisions relating to manufactured products and the associated production and supply chains is very significant indeed.

Our vision for the UK Manufacturing and Materials sector is as a sustainable, safe, thriving and resilient system to make the goods and provide the services that enhance people's lives in a clean, productive and efficient way.

This system will maximise UK-based design, innovation and deployment, with industry providing high-quality and skilled employment across all regions of the UK and a major contributor to UK GDP.

Made Smarter Innovation Challenge

By pioneering the development and integration of digital technologies, this programme will support the transformation of the UK's manufacturing industry.

The Made Smarter Innovation Challenge aims to deliver a flexible, more productive and sustainable UK manufacturing sector. So far, it has supported more than 250 organisations.

The Made Smarter Review[21] has set the goal that by 2030 the UK will be a global industrial leader in creating, adopting and exporting advanced digital technologies.

It focuses on four priority areas: skills, adoption, leadership and innovation. From this, the SMART objectives for the challenge are:

- to increase total gross value added for the manufacturing sector by up to £2.3 billion
- increase the number of industrial digital technology skilled jobs by up to 4,000
- increase productivity by up to 30%.

In addition, there are a further two objectives with a specific net zero focus:

- decrease carbon emissions (in the businesses we support) by up to 4.5%
- decrease waste emissions by up to 25%.

The challenge aims to achieve the review's net zero goals through process efficiency improvements as well as introducing a sustainability requirement into all new competition offerings[22].

It is also supporting the development of artificial intelligence technology that will help the UK achieve an early abatement of its emissions by 2030. This is critical as emissions saved now have a much greater effect on limiting warming to 1.5ºC than those later in the 2050 window.

This programme is funded by UK Research and Innovation and delivered by Innovate UK, the Engineering and Physical Sciences Research Council, and the Economic and Social Research Council.

Industrial Decarbonisation Challenge

The Industrial Decarbonisation Challenge supports the delivery of significant emissions reduction in the UK by accelerating the cost-effective decarbonisation of heavy industry.

The **Industrial Decarbonisation Challenge (IDC)** is a key part of the government's Industrial Decarbonisation Strategy[23]: to have four of the UK's major industrial regions linked up to the necessary decarbonisation infrastructure by 2030 and capturing 3MtCO_2 of industry emissions each year.

The challenge is funded by £210 million from UK Research and Innovation and delivered by Innovate UK, the Engineering and Physical Sciences Research Council, and the Economic and Social Research Council. This is matched by £261 million from industry. It aims to:

- develop and deploy low-carbon technologies such as carbon capture and storage and hydrogen fuel switching
- reduce the carbon footprint of heavy and energy-intensive industries in the UK, such as iron and steel, cement, refining and chemicals
- increase the competitiveness of key industrial regions
- contribute to the UK's drive for clean growth
- harness the scale of the industrial clusters to create opportunities to work together to find cost-effective solutions to decarbonise.

New infrastructure

The competition to develop decarbonisation infrastructure ran through the second half of 2020. Projects were expected to demonstrate the regional and national significance of their proposals and how net zero could be delivered in their region by 2040, supporting the UK target of net zero by 2050.

The nine winning deployment projects secured a share of £172 million and include:

- three offshore storage sites for CO_2 (in the North West, North East and Scotland)
- CO_2 capture and/or hydrogen production projects in the North West, Scotland, Teesside, Humberside (two projects) and South Wales.

The projects aim to deliver significant reductions in industrial CO_2 emissions in industrial clusters by 2030 through development of offshore storage and onshore infrastructure, as well as providing the opportunity for jobs and increasing the global competitiveness of industry in these areas.

Cluster plans

Six projects have secured a share of £8 million in funding as part of the drive to create the world's first net zero cluster by 2040, covering key industrial regions of the UK:

- South Wales
- The Black Country (West Midlands)
- Teesside
- North West
- Humberside
- Scotland.

The projects bring together industry and public sector bodies to devise a comprehensive route for changes to industries, products and supply lines to reach net zero emissions in each region.

Industrial Decarbonisation Research and Innovation Centre

The **Industrial Decarbonisation Research and Innovation Centre (IDRIC)** is a £20 million investment to carry out multidisciplinary research in cross-cutting areas of technology, policy and economics. It started in April 2021 and will:

- deliver a programme of knowledge exchange activities and stimulate cross learning between industrial clusters
- provide a strong evidence base to enable policy makers to make informed decisions about future decarbonisation options, policies and institutional reforms.

Outcomes

The challenge is delivering the foundation for decarbonising industry while also enhancing regional productivity and creating new jobs in low-carbon industries.

This is already unlocking multi-billion-pound investment from industry, private investors and government to ensure that the UK's ambition of developing the world's first net zero industrial cluster by 2040 is met.

Clean air to safeguard health

Over the past year, indoor and outdoor air quality and its effect on health has been a key priority, with a competition remit for greenhouse gas removals and hydrogen production.

Air quality, and its effect on health, is a strategic priority for UK government[24]. Action to reduce the health impacts of air pollution have tended to focus on outdoor sources, notably emissions from vehicles.

At the same time, indoor levels of air pollution are less well understood, and many end up in the external atmosphere and can be detrimental to health.

Clean Air Strategic Priorities Fund

As part of a UKRI **Strategic Priorities Fund Clean Air** programme, Innovate UK has launched a range of innovation pilots to drive forward developments in critical technology needed for a green industrial revolution that improves indoor and outdoor air quality.

The Clean Air Programme overall is investing £42.5 million across its lifetime in order to deliver the research and innovation to reduce the 40,000 early deaths and £20 billion per annum cost to health services and business that result from air pollution[25].

Among the associated projects is Clean Air Gas Engine (CAGE), led by OakTec. CAGE is an ultra-low emission technology that uses clean gas and biogas fuels to replace diesel power in construction, agriculture and non-road mobile machinery. It is being trialled by HS2 at Euston to cut carbon on construction sites.

Elsewhere, AutoAlign, led by RL Capital, is a wheel alignment fault detection system that detects, measures and communicates misalignment issues in real-time. It contributes to a reduction in air pollution caused by excess tyre wear and fuel consumption.

CASE STUDY

Hubl CoolRun Pod

Hubl provides an alternative to polluting diesel-fuelled refrigeration units.

The Hubl CoolRun Pod (CR Pod) is an innovative new product to reduce harmful non-tail-pipe emissions from transport refrigeration units.

It combines existing and emerging technologies to create the world's first non-diesel, last-mile, independently monitored refrigerated delivery system.

The Cool Run system optimises the handling of food through a novel insulated pod system, which controls the temperature of individual unit loads. The system reduces vehicle cold air losses through door openings and retains the refrigerated air during multiple drops on the last-mile delivery run. Retention of product integrity and security, along with handling efficiencies, also contributes to the commercial viability.

CoolRun has the potential to reduce emissions from mobile refrigeration units, vehicle brakes, road surfaces and overall emissions relating to urban transport for last-mile deliveries. These combined technologies will enable urban delivery networks to operate in a significantly more efficient manner.

Industrial Energy Transformation Fund

By offering support to energy efficiency and deep decarbonisation projects, the Industrial Energy Transformation Fund is strengthening government support in the net zero agenda.

The UK's business and industrial sectors currently account for around a quarter of UK emissions.

Although emissions have fallen significantly since 1990, there is still more to do if the UK is to achieve its ambition of meeting our net zero target by 2050.

The **Industrial Energy Transformation Fund (IETF)** is a £315 million Department for Business, Energy & Industrial Strategy fund. It aims to help companies with high energy use to cut their bills and reduce carbon emissions, with £289 million to invest in England, Wales and Northern Ireland, and £26 million for investment in Scotland.

In 2020-2021 we awarded 39 projects with £31 million of funding on behalf of the IETF.

Net zero objectives

Working towards the net zero agenda, in line with the policy objectives of energy efficiency, the key aims of the IETF programme are to:

- reduce energy costs and emissions for industry, particularly for energy intensive companies in the near term
- bring down costs and risks of deep decarbonisation technologies by demonstrating those technologies.

One of the key barriers to industry uptake of energy efficiency and decarbonising technologies is the capital cost of installation and the lengthy payback periods of some of these technologies.

Therefore, cutting energy costs and emissions in the near term will help UK industry across the nation to remain competitive. Reducing costs and risks of deep decarbonisation technologies will help the IETF team achieve its net zero emissions target.

The IETF will continue to provide direct grants to incentivise businesses to invest in energy efficiency and deep decarbonisation.

Current mapping of existing support for industry also identifies a gap at the deployment stage for energy efficiency and deep decarbonisation projects. The IETF helps fill this gap.

CASE STUDY

Tate & Lyle Sugars Ltd

Tate and Lyle Sugars Ltd (TLS) is leading a consortium to carry out a study of deep decarbonisation of a sugar refinery, which will test feasibility, engineering and wider replicability of this technology. The project will undertake a front-end engineering design study on a process to reduce greenhouse gas emissions by 90% from the Thames Refinery site based in Silvertown, London, and operated by TLS.

Essar Oil (UK) Ltd

Essar Oil (UK) Ltd will upgrade a major distillation unit with a new net zero ready furnace. The new furnace will be designed for 100% hydrogen firing and ready to utilise carbon-free hydrogen from the planned HyNet project. This will reduce site CO_2 emissions by 11% each year.

Smart Sustainable Plastic Packaging Challenge

This challenge will establish the UK as a leader in smart sustainable packaging and support a reduction in waste entering the environment.

Sustainable plastic packaging is a vital component of achieving the net zero agenda. Reducing plastic demand can reduce carbon emissions, while recycling plastic waste could help prevent a several-gigatonne increase of carbon emissions by 2050[26].

The **Smart Sustainable Plastic Packaging (SSPP) Challenge** is funding up to £60 million to support academic-led research into sustainable plastic packaging solutions. SSPP underpins landmark reforms being driven by the four UK governments to boost packaging recycling and fight plastic pollution. It is funded by UK Research and Innovation and delivered by Innovate UK and the Natural Environment Research Council. SSPP will additionally support industry-led collaborative research and the development of new technologies, which will matched by £149 million from industry.

The challenge aims to:

- tackle the environmental impact of plastic packaging through the development of a more sustainable plastic packaging supply chain in the UK
- drive research and innovation to develop more sustainable plastic packaging materials and designs, and enable new recycling processes and infrastructure
- encourage collaboration and innovation in integrated circular supply chains using insights into consumer behaviour in order to reduce the environmental impacts of plastic packaging.

Projects so far

Funded projects and achievements include:

- £20 million funding for four cutting-edge recycling plants
- £8 million for research projects designed to reduce plastic packaging and increase reusable packaging
- £235,000 for projects developing solutions to deliver a more circular economy for plastic packaging
- £175,000 for feasibility studies that are intended to lead to larger scale projects for future plastic packaging solutions
- 69.5 full-time equivalent jobs created.

2021 has seen two funding opportunities:

- SSPP demonstrator Round 2 (opened February 2021) provides funding of up to £12 million per project for large-scale commercial demonstrator projects.This includes first-of-a-kind infrastructure or large-scale commercial trials of new packaging technology or systems
- SSPP business-led research and development competition will provide funding of up to £4 million per project.

CASE STUDY

ReNew ELP

An advanced plastic recycling solution is set to save difficult-to-recycle plastics from landfill and incineration.

ReNew ELP is developing the world's first site to use the hydrothermal upgrading process HydroPRS™ (Hydrothermal Plastic Recycling Solution).

An advanced plastic recycling system, HydroPRS™ can convert any plastic – even plastic packaging formats that are difficult to recycle such as flexible and multi-layered films – into shorter chain hydrocarbons that form the building components for new plastics and other products.

This offers an alternative end-of-life for flexible and multi-layer plastic packaging, which no longer needs to be incinerated or sent to landfill and can instead be recycled. Recycling these plastics back to hydrocarbons means they can then be used for food-grade packaging, a limitation for most mechanically-recycled plastics due to concerns over contamination.

The project, led by ReNew ELP, received £4.4 million in funding via the SSPP Challenge. The firm is currently building a commercial-scale plant in Teesside, where in the longer term it aims to process up to 80,000 tonnes of waste plastic each year.

Buildings and infrastructure

Making buildings more energy efficient is a key element of net zero. As part of the government's Ten Point Plan for a Green Industrial Revolution[4], homes will move away from fossil fuel boilers over the next 15 years to a lower carbon, more efficient alternative. The Transforming Construction Challenge is helping shift construction towards manufacturing and digital processes, while reducing the carbon footprint. Active buildings are also vital, combining renewable energy technologies to generate, store and release heat and electricity.

Transforming Construction Challenge

This challenge is an integral part of the Construction Sector Deal[27], shifting construction towards manufacturing and digital processes, while reducing the carbon footprint.

The Industrial Strategy Challenge Fund's **Transforming Construction Challenge** has invested £170 million, matched by £250 million from industry, in bringing together contractors, supply chains, innovators, government, clients and the research community.

The investment is overturning a system in which the cheapest solutions have until now been prioritised. The priority now is to deliver greater 'whole-life value' to society.

Targets of the challenge are to:
- deliver projects 50% faster
- reduce whole life costs by 33%
- slash lifetime emissions by half
- raise productivity by 15%.

These targets are already being met, and as new approaches and technologies are more widely adopted, we can expect even bigger gains.

Net zero

The challenge has been working through the net zero agenda on a range of areas across construction, from cement replacements and alterations to reducing embodied and operational carbon.

Part of this is the **Active Building Centre**, a £36 million investment transforming the UK construction and energy sectors. The concept of active buildings is where buildings produce and store enough renewable energy to meet their own needs and more. This investment is contributing to more efficient energy use, and decarbonisation.

The focus is now on sharing and involving government and industry in the outcomes of the challenge's investments and adoption at scale.

The Transforming Construction Challenge is funded by UK Research and Innovation and delivered by Innovate UK, the Engineering and Physical Sciences Research Council, and the Economic and Social Research Council.

CASE STUDY
STELLAR

This project is reimagining the supply chain so SMEs can benefit from modern methods of construction.

The term modern methods of construction (MMC) describes alternative construction practices that incorporate off-site techniques for faster delivery and maximum efficiency of resources. While housebuilders appreciate its benefits, for local labour and SMEs the current supply chain model is designed for an existing system that is not currently set up to deliver MMC at scale.

Totally Modular has pulled together a consortium to create STELLAR, a hub-and-spoke model that is reinventing the supply chain. Central hub factories manufacture structural frameworks at scale, while regional spoke factories satisfy those areas with highest demand, and use local trades to finish off the MMC process.

Regardless of their size, it means SMEs can now benefit from lower cost, increased productivity and quality, and help deliver social homes using MMC that meet community needs.

The green impact is:
- **assurance** – building off site within a controlled factory environment minimises risk, assures quality control and enhances build performance standards
- **cost** – the annual running costs for a three-bedroom house (with five occupants) is around £540, or £1.48 a day
- **lower emissions** – lighter-weight materials, digital planning and production technologies will enable the homes to attain new levels of quality and energy efficiency. In the future, a digital passport app will track/report embodied carbon within the materials and monitor energy usage emissions.

SPECIFIC Innovation and Knowledge Centre

SPECIFIC is one of seven Innovation and Knowledge Centres set up in 2011 to foster new industries by closing the gap between scientific research and its commercial exploitation, with a net zero focus.

Heating and powering buildings accounts for about 40% of the UK's energy usage[28]. The Industrial Strategy Challenge Fund's **SPECIFIC** works on energy technologies and systems, from the fundamental science of materials and products to full-scale demonstration on buildings. This comes together in one design concept: active buildings.

Based in the **College of Engineering at Swansea University**, SPECIFIC has achieved a number of successes. Since 2016, it has:

- created research partnerships with 34 research organisations (12 overseas)
- published 301 journal papers (154 with international co-authors) with 4,784 citations
- engaged with 220 businesses (101 of which are SMEs), supporting innovation and demonstration activities
- attracted £13.4 million in private investment support to collaborating businesses
- progressed 45 proof of concepts and 67 demonstration activities
- overseen completion of 47 doctoral and 16 masters students
- created seven spin-outs
- developed five full-scale building demonstrators
- retained 73 jobs as a result of UKRI funding
- created 23 new jobs
- won £89 million in competitive R&D and innovation awards, boosting its capacity.

Active buildings

An active building combines a range of integrated renewable energy technologies that work together in one system to generate, store and release heat and electricity.

Using data from the building, the national grid and electric vehicles (EV), the system can manage and optimise energy performance – and also exchange or trade energy. This creates communities of energy that are more resilient to sudden changes in supply or demand.

With funding from the Engineering and Physical Sciences Research Council, Innovate UK and the European Regional Development Fund, SPECIFIC created the **Active Classroom** in 2017 and the **Active Office** in 2018, integrating components of active buildings within their construction and fabric. It has enabled the development of a whole arm of activity in building performance, monitoring and integration with its ecosystem (namely, grid and EV charging).

Earlier this year, Flintshire County Council approached the **Active Building Centre** about decarbonising a planned housing development. As a result, the houses will now achieve a 97% improvement on Part L building regulations and have predicted heating costs of £84 per year, compared with the original estimate of £1,440.

Catalysing innovation

Innovate UK provides regular opportunities for businesses to come together and for industry to connect with academia. In so doing we help the UK to remain at the forefront of ideas and technology that will help us to achieve net zero by 2050.

Knowledge Transfer Network

Innovate UK's Knowledge Transfer Network connects ideas, people and communities via its dedicated net zero programme.

Innovation is essential if the UK is to create a more sustainable society and economy and if it is to meet its net zero goals by 2050. It requires extensive collaboration across academia, industry, government agencies, the third sector and research bodies, and a concerted effort to turn ideas into action.

That's what the **Knowledge Transfer Network (KTN)** was set up to achieve, in collaboration with Innovate UK. The organisation, which combines business, research and funding, connects ideas, people and communities in order to meet the societal, environmental and economic challenges facing the world today.

It brings together science, business and creative industries, connecting innovators with new partners. This facilitates the transfer of knowledge and helps innovators convert their ideas into solutions for pressing real-world problems, accelerating the time to market.

KTN, which is grant funded by Innovate UK, has five top priorities:

- net zero
- equality, diversity and inclusion
- place
- global innovation
- innovation adoption and diffusion.

It has a comprehensive net zero programme in place, including a focus on zero carbon energy, the circular economy, place-based innovation and enabling solutions. It also offers targeted support aimed specifically at SMEs.

There are five key planks to the KTN net zero programme. It will:

- identify the technologies and capabilities that will enable net zero
- connect net zero innovators to established industry
- accelerate the adoption of proven innovations across diverse industry sectors
- use its network to support the development of low-carbon supply chains
- provide cross-sector insights to inform a positive policy environment.

KTN has a strong innovation network for organisations to tap into. For example, it has built up innovation communities in the fields of cross-sector battery systems, the hydrogen economy and the decarbonisation of ports and harbours. It brings together interested parties through events and networking opportunities. KTN also provides advice and information on what government funding and commercial investment is available and how to access it.

CASE STUDY

KTN Innovation Exchange Programme

This program supports innovation transfer by matching industry challenges to innovative companies from other sectors.

The KTN Innovation Exchange Programme (KTN-iX) connects companies with net zero challenges to innovators who are already working on those challenges. This innovation transfer both helps business and enables net zero solutions to get to market more quickly.

With proven successes in the energy, defence, health and transport sectors over the past four years, the programme is now expanding into other areas, such as agri-tech and infrastructure.

So far, there have been 1,700 innovation applications across 80 challenges, with 289 UK companies submitting their ideas. This has led to 87 innovation trials taking place, generating £17.2 million to challenge holders and 20 commercial contracts being issued, with a combined value of £2.2 million.

Sustainability events

COVID-19 saw many events move online to keep up the momentum of net zero change, with additional events set to go ahead in the autumn of 2021 and stretching to 2022.

Rushlight Showcases

Innovate UK-funded Rushlight Showcases typically bring together hundreds of delegates. The events promote clean technology, knowledge and cooperation within the sector.

The Rushlight event in 2021 took place from 10 to 11 March online, incorporating:

- an exhibition of innovative clean technology solutions, including the Innovate UK Infrastructure Systems Showcase
- Cleantech Conference, incorporating the Cleantech Innovation Showcase
- Sustainable Solutions Market Panel of heads of sustainability and procurement of major corporates
- natural capital and resource session, in association with the Circular Economy Club
- UK Energy session.

Rushlight Awards

Innovate UK is the lead sponsor for **Rushlight Awards**, an event that is now in its 14th year. The awards celebrate new technology, innovation and best practice across the environment spectrum for UK and global organisations.

Mixergy, the Innovate UK-funded cleantech company developing residential smart hot water tanks, was the 2020-21 winner of the Rushlight Solar Award and also the Rushlight Natural Energy Award.

The start-up has now raised £3.6 million in Series A round from Foresight Williams Technology, Oxford Sciences Innovation, IP Group and Centrica.

Mixergy will use the funding to expand its business, with the aim to decarbonise households and reduce consumer energy usage.

Business growth

In March 2020, the government announced a record increase in public investment in R&D, committing to reaching £22 billion per year by 2024-25[29]. To build a future that is greener, safer and healthier means releasing the potential of centres of excellence in science, research and innovation. This requires unlocking and embracing talent, diversity, resilience and adaptability – and achieving net zero carbon emissions by 2050. Empowering innovative businesses to grow and achieve their industry- and society-transforming ambitions will be a crucial part of this.

Innovate UK EDGE

Innovate UK EDGE provides bespoke support for innovative companies, helping them develop growth-orientated commercial strategies.

Innovate UK EDGE is a key part of Innovate UK's investment in businesses to drive economic growth. It complements Innovate UK's project funding with intensive specialist-led support for ambitious SMEs, including beneficiaries of Innovate UK funding.

Thousands of businesses have received support from Innovate UK EDGE, many with intensive support from its c.250 innovation and growth specialists located around the country.

Meeting challenges

Many companies experienced challenges as a result of COVID-19. To help meet these challenges, Innovate UK EDGE benefited from extended government funding of £39 million over two years from April 2020.

This funding bolstered initiatives of most value to boost company capabilities and, in some cases, to assist companies in their challenge of coping with unexpected growth opportunities.

CASE STUDIES

Extreme Low Energy

This multi-award-winning UK business specialises in green, low-energy lighting, heating and power. In 2020, Extreme Low Energy was chosen by Innovate UK EDGE for its Scaleup Programme. It has helped with finance in particular: developing a business plan with its coach has helped it to see the business from the outside, prompting it to do things differently. In May 2021, the Prime Minister said that he wanted to see "more companies replicating the success of Skelmersdale's Extreme Low Energy".

TFP Hydrogen Products

This Cornwall-based electrochemical innovator is helping accelerate the transition to net zero by making the production of hydrogen more efficient and affordable. It is planning global expansion, following marketing, innovation and internationalisation support from Innovate UK EDGE. In January 2021, TFP Hydrogen Products was acquired by Technical Fibre Products. TFP's Managing Director, Dr David Hodgson, said: "Having worked with Innovate UK EDGE, we found we had ready-made answers to a lot of the questions put to us by the acquiring partner, and real confidence in how we were presenting our company."

Gommyr Power Networks

Innovate UK EDGE worked with Gommyr to help the company commercialise eStreet and implement an initial pilot system in the Democratic Republic of Congo. eStreet is a solar battery microgrid that provides water, telecom access, sanitation and security to its business clients. The specialists also recommended and supported Gommyr's successful application to the Energy Catalyst programme.

COVID green recovery

Innovate UK has delivered a £550 million investment to support thousands of companies to survive and thrive through COVID-19[30]. Overall 3,153 businesses received funding, over 1,000 new products came to market and a further 4,172 received business support to help them steer through the pandemic. The net zero agenda has been a vital focus within this in order to enable a green recovery from the pandemic; this investment is empowering companies to tackle urgent societal needs in a clean, green response to COVID-19.

CASE STUDY

Fernhay

This company's four-wheeled e-assist delivery cycle helps reduce air pollution and congestion.

Fernhay provides intelligent and environmentally sustainable transportation solutions. With support from the Fast Start programme, Fernhay responded to the COVID-19 crisis with an updated electric assist, emission-free eQuad, which can be used to pick up and deliver packages throughout the city.

Fernhay applied for Fast Start funding to redesign the emission-free eQuad so the company could develop a more COVID-safe design. At the core of the eQuad bike is a box that carries 200kg. The Fernhay team knew that it was difficult to operate the box safely with the normal requirement of two people; to be COVID-safe, it needed to be operated by only one person. With the Fast Start funding, the team redesigned the box to be operated by one only person, safely and with ease.

Fernhay is now exporting the UK-built eQuad to the EU and hopes to be on every delivery network in the world. The American parcel delivery firm UPS is currently using the eQuad in several European countries as well as Dubai Expo 2020.

Sustainable Innovation Fund

Across the package of measures to support companies during the pandemic many companies developed projects to help the UK's economy and society recover in a greener, fairer and more resilient way. The £175 million Sustainable Innovation Fund particularly focused on this more sustainable approach, with over 1,000 projects across the UK receiving financial investments of £25,000 to £3 million to develop their ideas for a more resilient future.

CASE STUDY

Radical Fibres Ltd

The use of nanofibres is reducing CO_2 emissions across a range of sectors.

Radical Fibres Ltd is using electrospinning to turn polymer materials into nanofibres. These nanofibres have many uses across the following sectors:

- aerospace
- architecture
- automotive
- energy
- infrastructure
- marine
- military
- sports/recreation.

This applied nanotechnology enables stronger, lighter vehicles resulting in fewer emissions and cheaper travel via a reduction of fuel usage and CO_2 emissions.

With the help of funding from the Sustainable Innovation Fund, Radical Fibres will produce panels made from 100% waste stream materials that exemplify principles of circularity, low-carbon manufacturing, and sustainability.

Diversity and inclusion

Women in Innovation Awards

Achieving net zero will require a diverse range of talent, which we encourage through approaches such as Women in Innovation and our young people's programme, Ideas Mean Business. Six of this year's winners of the Women in Innovation Awards offer products or services that are focused on net zero.

A product rental service, reusable period pads, plastic processing machines and a digital carbon footprint game called 'How Bad are Bananas?'. These are some of the winners of Innovate UK's **Women In Innovation Awards** 2020/21.

The Awards focus on female entrepreneurs who are tackling the important societal, environmental and economic challenges facing the world today. Six of this year's winners are involved in net zero projects. Each of the winners will receive a £50,000 grant, plus mentoring, coaching and business support to help them deliver on their aims.

Several of the winning projects have been created to reduce waste. **Plastic@Bay** aims to remove and reuse plastic pollution found on beaches and end-of-life fishing gear. The Scottish company is building cheap, low-tech plastic processing machines that will convert plastic into construction material such as fence posts, planks and decking.

Co-founder Joan D'Arcy wants to design a Local Ocean Plastic Recycling Facility that can recycle ocean plastic onsite at harbours and rural coastal communities around the UK. As well as reducing waste, the initiative will also provide local employment and training opportunities for young people in rural areas.

Jacqueline Morrison is co-founder of **Cedeco Contractors**, another Scotland-based net zero initiative. The company is developing a mechanical gripper to be used as an alternative to grout within the foundations of offshore wind turbines. Using the mechanical gripper will reduce installation times and costs for wind developers. The gripper can also be recycled at end-of-life.

Three female entrepreneurs – Emma Shaw, Rebecca Trevalyan and Sophia Wyatt – are behind the **Library of Things (LoT)**, a product rental service set up to reduce waste and save people money at the same time. Through LoT, people can rent 50 good-quality DIY and entertainment products from kiosks located in urban hubs. It's the first and only product rental kiosk operator in the world and the founders hope to launch 100 kiosks by 2025.

Dsposal is another waste-reduction initiative, this time taking the form of software innovation. COO and co-founder Sophie Walker wants to use the award to develop innovative software aimed at organisations with complex waste supply chains, such as the NHS. Users of the software will be able to better manage their waste supply chain, which will reduce their environmental impact, improve resource efficiency and save on time and costs.

Celia Pool is co-founder of **Dame**, a start-up that launched the world's first reusable tampon applicator in 2019 and then the reusable period pad in 2020. Also the first ever Carbon Neutral Plus company in the UK, Dame is tackling the huge global period care plastic problem.

The digital carbon footprint game 'How Bad are Bananas?' helps people learn about the carbon footprint we all create and how to minimise our individual impact on the environment. The game builds on the book by Professor Mike Berners-Lee called *How Bad are Bananas? The Carbon Footprint of Everything*. Two female entrepreneurs are behind the game – Dr Emma Fieldhouse, Director of the environmental consultancy **Future We Want**, and Anja Fischenich.

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We fund business and research collaborations to accelerate innovation and drive business investment into R&D. Our support is available to businesses across all economic sectors, value chains and UK regions.

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