NATIONAL COMPOSITES CENTRE

TRANSFORMING INDUSTRY TOGETHER

NATIONAL COMPOSITES CENTRE | University of BRISTOL | Bristol Composites Institute | CATAPULT High Value Manufacturing | UKRI Innovate UK

The National Composites Centre was conceived in 2009 as part of the UK composites strategy to create a national centre of excellence for research and development following the inclusion of this disruptive technology into government industrial strategy.

Its task- to be recognised as a world leader in composite technology, accelerating the development and uptake of digital technologies for sustainable composites and growing the market for composites by driving innovation through collaboration and partnerships.

Wholly owned by the University of Bristol, it was incorporated into the Catapult Network when it formed in 2011, specifically as part of the High Value Manufacturing Catapult.

"The National Composites Centre's vision is to bring together the best people and the best technologies, providing an end-to-end engineering capability to solve some of the world's most complex engineering challenges."

Since then the National Composites Centre has become a true Strategic National Asset that holds the IP of the nation, having grown its industrial membership, its team and the size and capability of its facility. The NCC is currently home to **over 450 composites experts** with an additional 200 researchers at the University of Bristol. Over £300m has been invested in state-of-the-art capabilities and knowledge that allows the NCC to convene innovators, provide expertise to deliver R&D; and to pull technology through from fundamental research to industrial application.

The NCC's portfolio has grown extensively since its inception and currently works with companies of all sizes from micro-organisations and start-ups to some of the world's largest and most respected innovators. It operates in sectors as diverse as aerospace, transport, defence, space, construction, infrastructure, leisure, energy and medical.

NATIONAL COMPOSITES CENTRE

The National Composites Centre's key areas of focus

Pushing the boundaries of composite technologies as the UK's world-leading R&D centre.

- Developing new materials, processes and capabilities
- Creating UK supply chains and providing workforce development
- Bringing together the best people and the best technologies to innovate

Taking the lead on **sustainability**

- Providing global thought leadership in the future of composites materials and de-risking sustainable solutions for industry
- Covering all aspects of sustainability: design, materials, reuse, recycle, end-of-life
- Developing the 'Sustainable Composites Partnership' with CPI and industry to create the art of the possible in terms of new products

Emerging as a leader in **digital engineering**

- Developing, demystifying and de-risking the digital engineering solutions that today's industry needs and tomorrow's productivity requires
- Utilising a full product lifecycle approach
- 'Re-engineering engineering' using digital technologies
- Promoting sustainability through use of digital techniques

Supporting **industrial transformation**

- De-risking processes and novel technologies for industry
- Providing workforce development and upskilling
- Creating high value design and engineering jobs

NCC Progression Summary

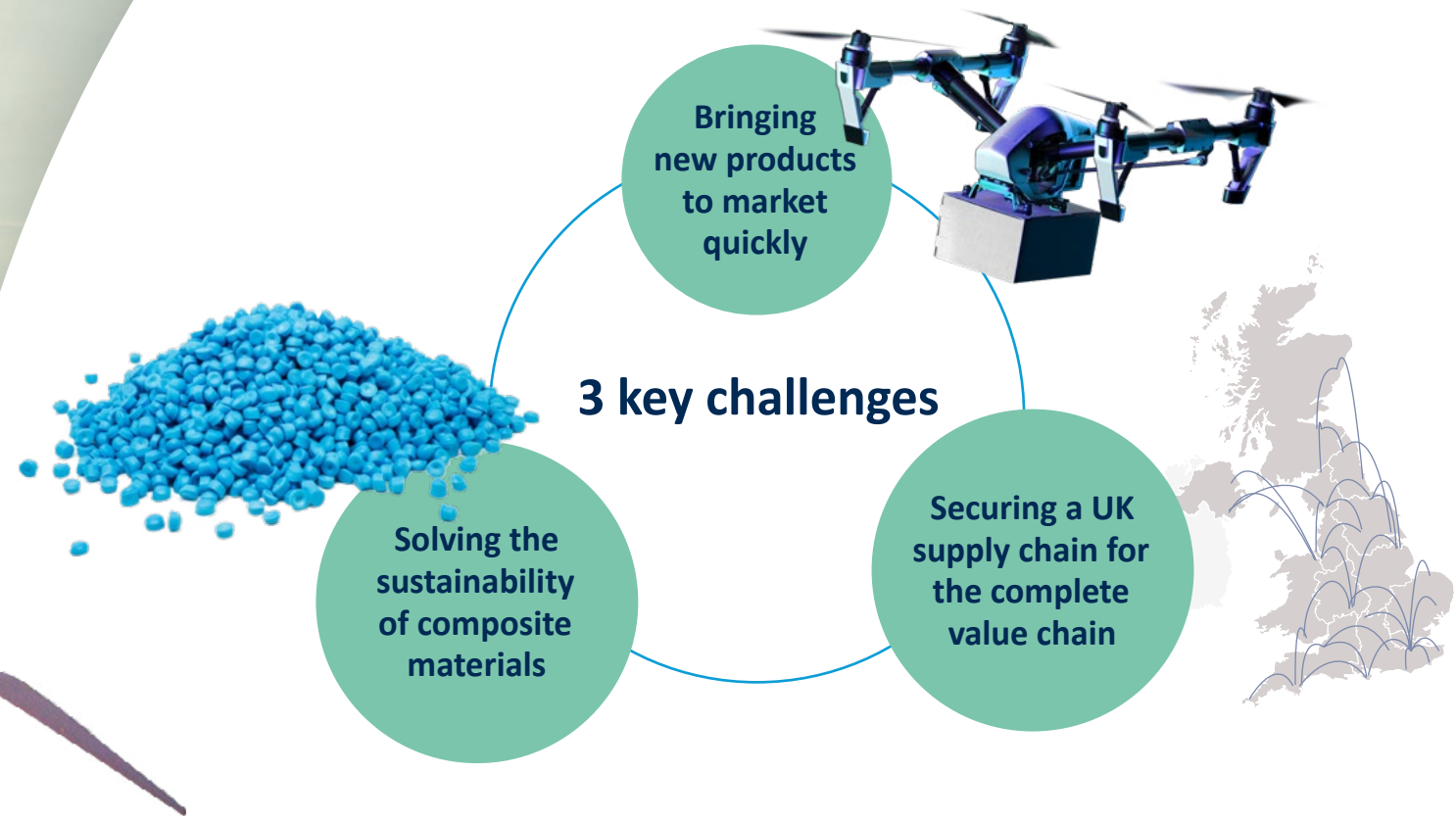
Why focus on composites?

Decarbonisation is the biggest global challenge we face. The UK's government has set in law the world's most ambitious climate change targets: a 78% reduction in carbon levels, compared to 1990, within fourteen years, and to achieve 'Net Zero' by 2050.

Lightweight, strong, flexible and adaptable, composites are crucial for enabling decarbonisation. From automotive to aerospace, defence, and energy through to healthcare, our powerhouse industries rely on composites to make better products, more quickly with less waste, to maintain leadership.

To stay competitive, the UK must be at the forefront of this disruptive technology and address three challenges; to push the boundaries of composites technology, to bring new sustainable, composite products to market quickly, securing a UK supply chain for the complete value chain.

To address it requires transformational technology that will deliver a step change in performance and position the UK as a world leading, technology driven economy.



Composites are forecast to grow faster than global economy

- 6-9% per annum growth
- Disruptive technology, playing a critical role to unlock engineering challenges
- Providing high value jobs in all parts of the UK
- Drawing industrial sectors to the UK including aerospace, energy, renewables, transport, infrastructure, defence and medical
- Opportunity for UK to play a major role in global trade

Critical enabling technology to decarbonise, deliver net zero and provide clean, affordable energy security

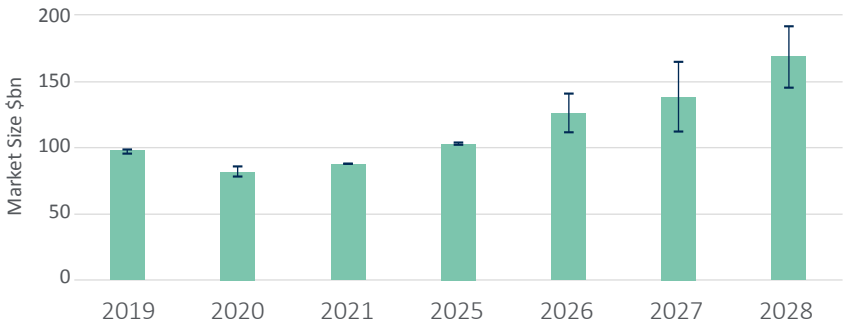
- Composites critical to many aspects of energy transition
- UK offshore wind could provide clean, affordable energy sovereignty by 2030
- They will unlock future mobility solutions
- Create efficient, clean and sustainable infrastructure

Key new industrial opportunities for the UK

- UK could play key global role in materials and recycling – capturing even more value from composites
- Anchoring the leadership of new groundbreaking products such as floating offshore wind and urban air mobility
- Establishing new industries e.g. Hydrogen

Global composite market forecast

(Averaged from multiple sources)

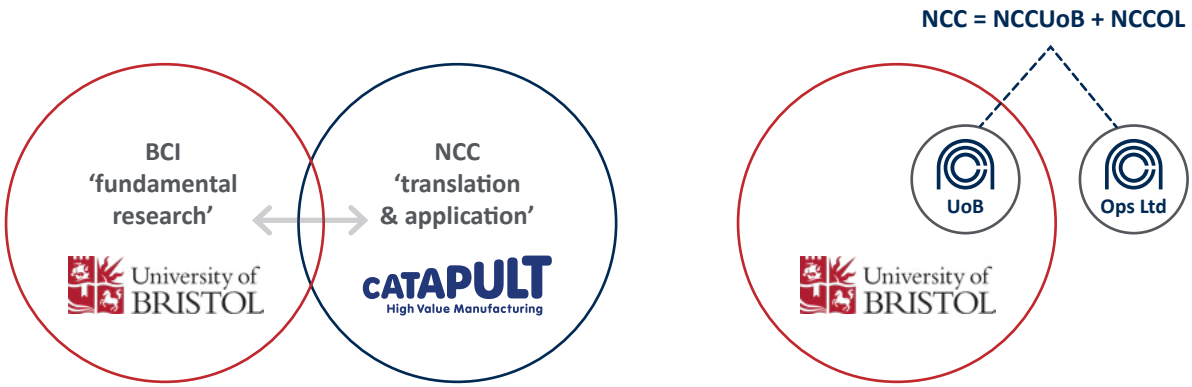


Structure

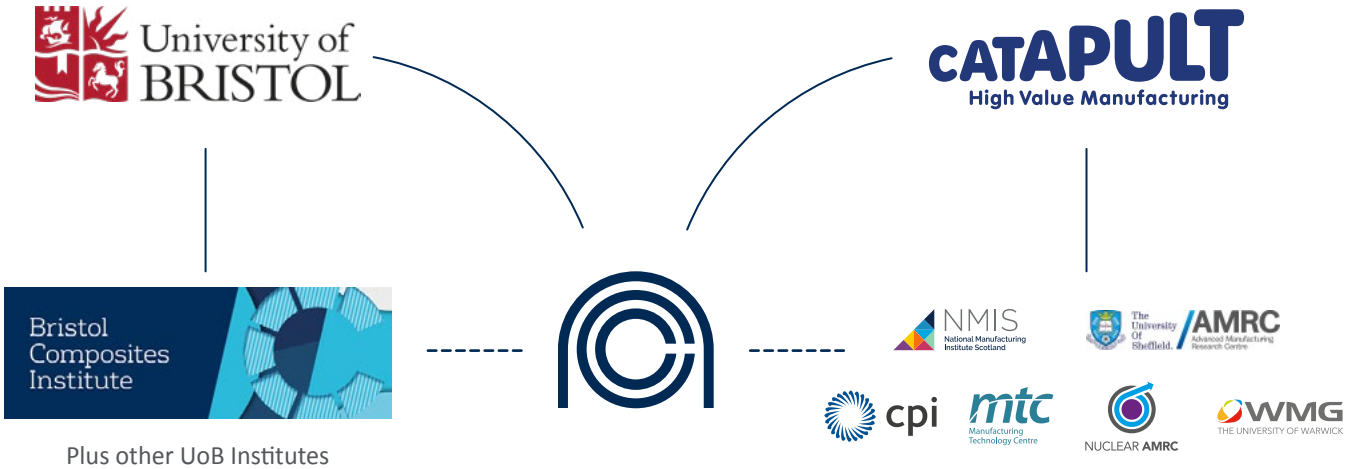
The National Composites Centre is wholly owned by the University of Bristol and split into two parts:

- A subsidiary company which runs the commercial operations and the staff (NCCOL)
- Part of the University which includes all of the research work and assets (NCCUoB)

NCC structure – 'best of both worlds'



NCC - Part of University of Bristol & HVMC



Plus other UoB Institutes

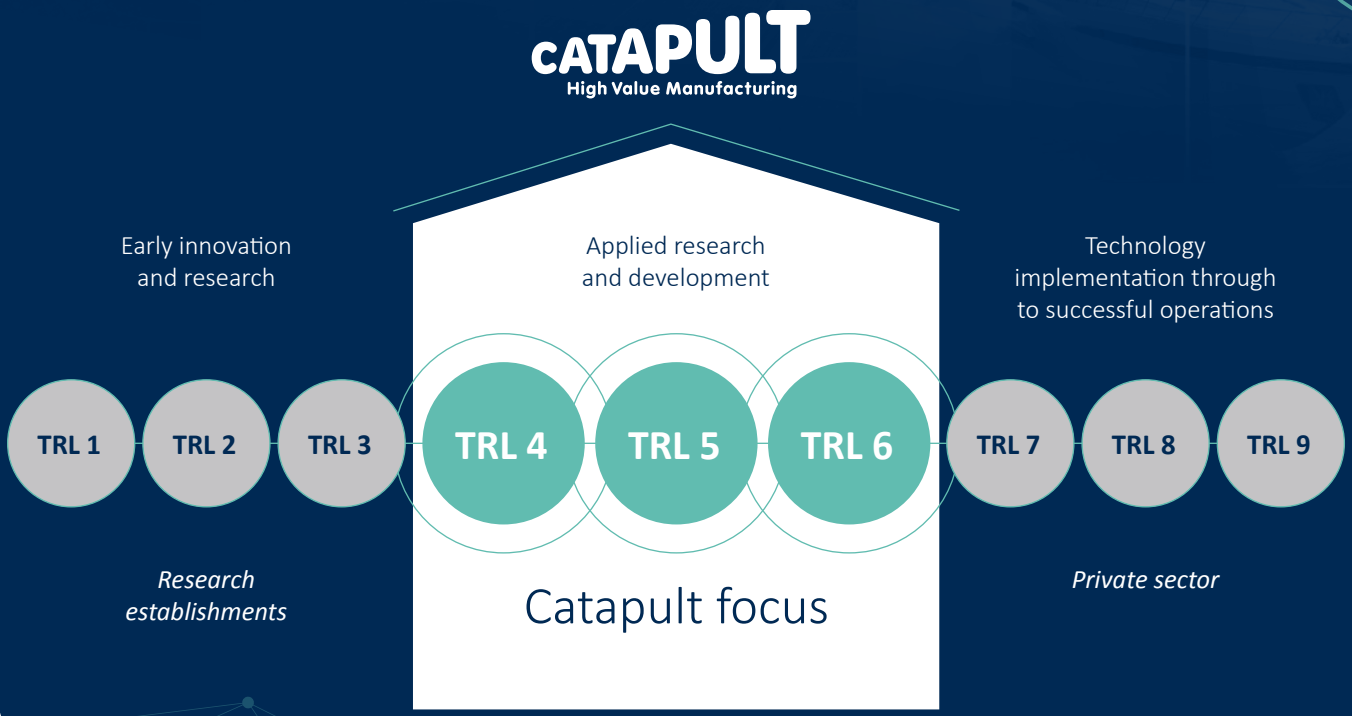
The High Value Manufacturing Catapult contracts with the University of Bristol, as the core grant sits in NCCUoB.

The National Composites Centre follows the Catapult funding model where one third of funding comes from core Government grants delivered through Innovate UK – part of UKRI, one third from competitively won Research & Development grant-funded activities; and one third from commercial work.

The National Composites Centre has a 'sister' composite research institute, Bristol Composites Institute (BCI); which sits inside the University of Bristol's Faculty of Engineering. This faculty undertakes fundamental research in the lower Technology Readiness Levels (TRL) where the National Composites Centre specialises in translation and application into industry.

The National Composites Centre also works with a network of other academic institutes from around the UK and across the globe to 'pull through' ground-breaking technology to industry.

Translating Research into Application – bridging the 'valley of death'



Engaging with thousands of companies each year to boost UK manufacturing performance, the centres that make up the High Value Manufacturing Catapult translate and apply early-stage research from world-leading UK universities to the commercial market, to help companies to implement, design, make and transform products and workforce skills.

Working in collaboration to deliver industrial transformation, the extensive network of Catapult centres support and inform government, shaping and implementing industrial policy.

Addressing key challenges together, and in partnership, through a comprehensive range of technologies will drive the transformation to a low carbon future, create new opportunities for UK manufacturing content and enable UK leadership in emerging technologies and strategic sectors. Together, we are transforming UK manufacturing, with almost half a £billion of R&D directly linked to activity each year.

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Material Change: How composites will unlock a greener future

Advancing Offshore Wind

The UK is a global success story when it comes to wind power with the largest fleet of offshore turbines in the world currently supplying circa 20% of our electricity need.

The Government has committed to increasing this four-fold by 2030 and seven-fold by 2050. The clean, sustainable power will bring us a UK-owned supply of affordable, green energy. It will also offer up global export opportunities.

Achieving this increase will, however, push design, manufacturing and materials technology to the limit. The NCC is working with Government and an array of research and industry partners to understand how we will create both the technology and a UK supply chain for the next generation of offshore turbines the size of the Shard with blades the length of the Eiffel Tower that will float on platforms in harsh and deep oceans. We are also looking at what to do with existing turbines that are coming to end-of-life and designing out waste for future developments.

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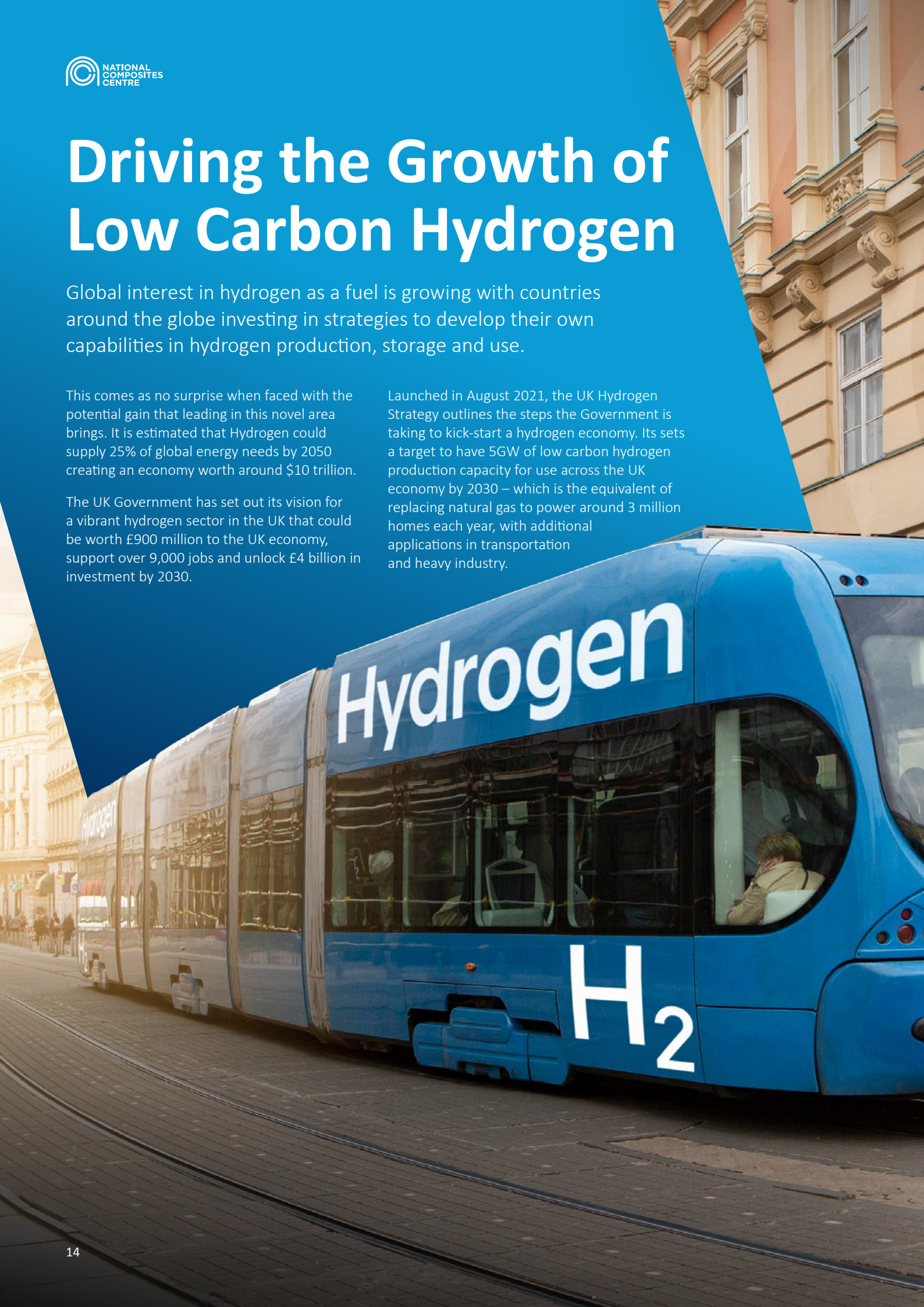
Driving the Growth of Low Carbon Hydrogen

Global interest in hydrogen as a fuel is growing with countries around the globe investing in strategies to develop their own capabilities in hydrogen production, storage and use.

This comes as no surprise when faced with the potential gain that leading in this novel area brings. It is estimated that Hydrogen could supply 25% of global energy needs by 2050 creating an economy worth around $10 trillion.

The UK Government has set out its vision for a vibrant hydrogen sector in the UK that could be worth £900 million to the UK economy, support over 9,000 jobs and unlock £4 billion in investment by 2030.

Launched in August 2021, the UK Hydrogen Strategy outlines the steps the Government is taking to kick-start a hydrogen economy. Its sets a target to have 5GW of low carbon hydrogen production capacity for use across the UK economy by 2030 – which is the equivalent of replacing natural gas to power around 3 million homes each year, with additional applications in transportation and heavy industry.



The Government believes that by 2030, hydrogen could play a key role in decarbonising energy-intensive industries such as chemicals, oil refineries, power and heavy transport (such as shipping, HGV lorries and trains), helping these sectors to move away from fossil fuel consumption.

Hydrogen can be used in fuel cells to generate electricity or in modified engines with water as its only emission at its point of use.

Work is currently being done to look at environmentally friendly methods of hydrogen production – and this presents the UK with compelling opportunities – firstly to use its growing low carbon energy infrastructure to produce 'green' hydrogen and secondly to capitalise on hydrogen as an energy vector for large transport such as trucks, trains, buses, ships and aircraft – research into cars and personal mobility is also underway.

Composites will be critical in unlocking this technology through their use in storage and distribution systems. Hydrogen gas needs to be stored at very high pressure or very low temperature and only fibre reinforced materials combine the low mass and weight with the strength needed to withstand the immense pressures involved. This will result in a five-fold increase in demand for carbon fibre between 2025 and 2030.

CASE STUDY

UK team successfully recycles reclaimed continuous carbon fibres from composite pressure tanks

In a world first the National Composites Centre with partners B&M Longworth and Cygnet Texkimp achieve continuous carbon fibre recovery.

A successful trial marks the significant first step in ambitious hydrogen innovation programme to deliver sustainable composite pressure vessels.

The team is ready to industrialise the process with companies looking to expand pressure vessel manufacturing capabilities.

Engineers at the National Composites Centre along with SME partners

B&M Longworth Ltd and Cygnet Texkimp, have successfully reclaimed continuous carbon fibres from a whole pressure vessel and re-used them to manufacture a new pressure vessel. This is the first time this process has been achieved and represents a significant milestone in the development of Britain's hydrogen capability.

As the gas has low energy density it needs to be compressed and stored at very high pressures, between 350 to 700 bar (5,076 - 10,152 psi). This makes high-strength, lower-weight carbon fibre the material of choice, especially for hydrogen pressure vessels in vehicles such as cars or aircraft, where power-to-weight is critical. Demand for carbon-fibre is expected to grow five-fold between 2025 and 2030, exceeding global manufacturing capacity. Creating viable, low cost recovery processes, that retain the inherent strength of

"Our dream is for the UK composites industry to succeed, through collaboration and true partnership. By pulling together we can onshore advanced material production, optimise reuse, reduce import and supply chain issues and improve the UK's export potential, all while leading on sustainability in composites."

Jen Hill, Director of B&M Longworth Ltd

continuous carbon fibres for recycling, is therefore key to the development of the hydrogen economy.

Until recently, recycling processes for composite components such as aircraft wings and wind turbine blades has resulted in short fibres with lower mechanical properties than virgin fibre. Whilst there are applications for this material, it is not suitable for re-use in high performing products.

Partnering with Lancashire-based B&M Longworth Ltd, the National Composites Centre team successfully reclaimed continuous carbon fibre, from end-of-life composite pressure tanks, using the company's revolutionary DEECOM® process. Originally designed to remove waste polymers from filters and production equipment, the process uses superheated steam, under compression, to penetrate microscopic fissures in the composite's polymer, where it then condenses. On decompression, it boils and expands, cracking the polymer and carrying away broken particles. This pressure swing cycle is then repeated until all the matrix (the material suspended in the polymer) has been separated from the fibre, allowing the monomers to also be reclaimed for possible reprocessing.

Crucially, the DEECOM® process leaves the primary component material intact and undamaged, allowing for any length to be retained. As a result, National Composites Centre engineers working with Cygnet Texkimp Ltd, a Cheshire-based, global leader of fibre handling and conversion technology, could use the reclaimed continuous carbon fibre to make a new pressure vessel using filament winding.

The partnership is now looking to work with manufacturers to scale and industrialise this process, sharing the knowledge of recent recycling trials. The next step is to undertake fibre characterisation analysis of the reclaimed material and recycled vessel, as the team works towards their ultimate goal: developing the disruptive technologies that enable sustainable hydrogen storage solutions.

The fibre recovery and recycling project, forms part of the National Composites Centre's Hydrogen programme, developing and sharing the technical knowledge, cross-sector composite expertise and state of the art technology that businesses need to achieve their hydrogen ambitions.

As part of this programme, National Composite Centre engineers have worked to refine composite pressure vessel designs, producing detailed design and analysis to minimise waste and trial the tools and manufacturing processes industry will use to reclaim and recycle continuous carbon fibres. They have also delivered a composite design specification for cryogenic pressure vessels and are working on a certification pathway for composite pressure pipes, including those to be used offshore.

The project won the prize for Innovation in Composites Materials at the 2022 UK Composites Awards and was shortlisted for the prestigious US CAMX Award for Composite Innovation.

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CASE STUDY

A pipeline of innovation

As the transition from fossil fuels to a hydrogen (H2) economy accelerates, so does the need to repurpose the existing network infrastructure to transport H2 from generator to consumer. As such, there are several areas where the use of composite pipes can help unblock both economic and technical barriers.

That's why the NCC has invested in developing its capability and knowledge of manufacturing thermoplastic reinforced piping to support the energy industry on its journey. Two years into our own journey, we've developed our own manufacturing capability and in 2023 will be designing and prototyping pipe concepts to the DNV industry standard for use in critical applications.

Looking to 2025 and beyond, the ultimate aim is to a create a smart pipe (with integrated sensors providing real-time data). A pipe that enables the new and next-generation hydrogen infrastructure we're going to need to power our homes and industry.

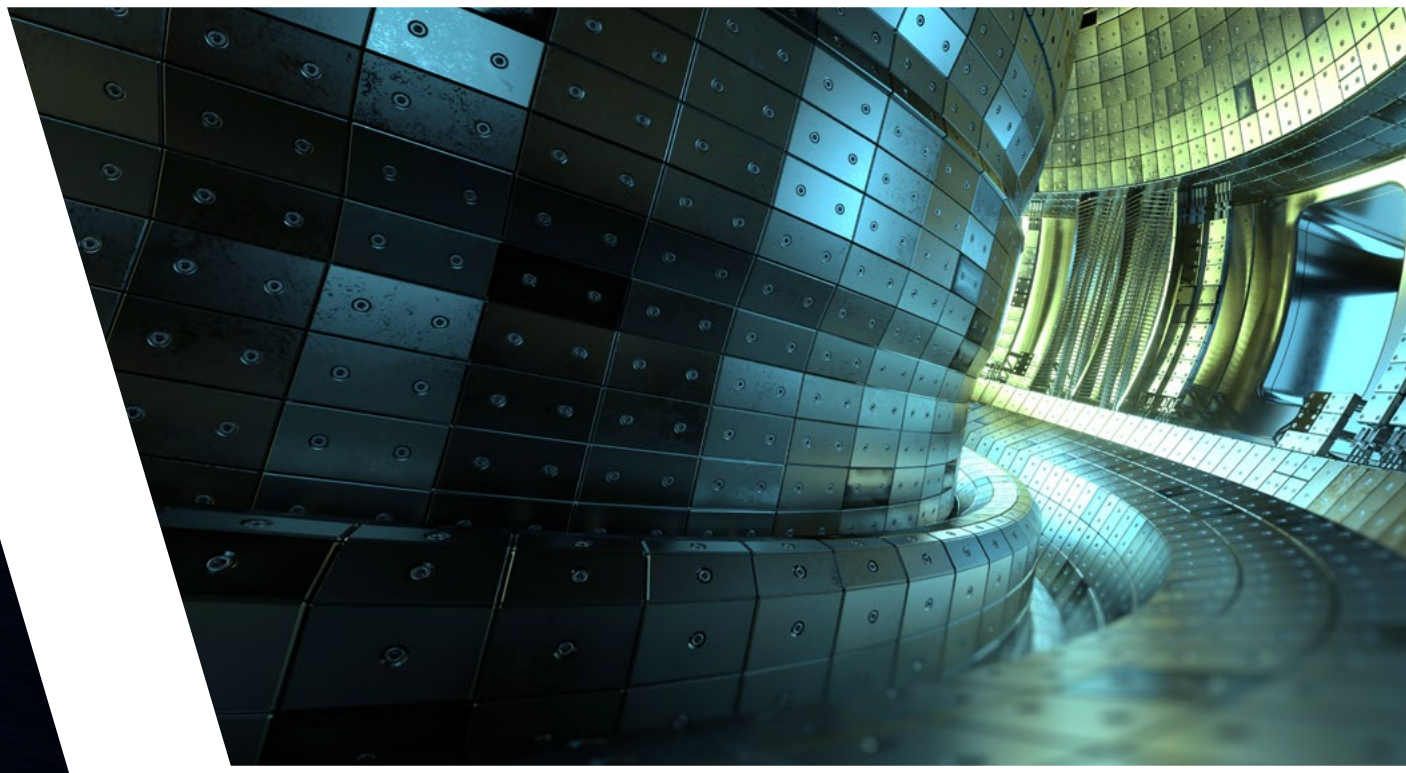
Delivering New and Advanced Nuclear

UK scientists and engineers are working to develop both small nuclear reactors and nuclear fusion reactors – the latter producing unlimited renewable energy with no radioactive waste by replicating the processes that power the sun. A UK prototype nuclear fusion reactor is due to be operational by 2040.

The former could enter service by 2030 and generate £52 billion of value to the UK economy over ten years. These will feature composites that must withstand incredible temperatures.

At the National Composites Centre we work on a large array of composite materials, many of them polymer based, however for extreme applications such as in nuclear, space and aerospace we look to using a group of composites called “Ceramic Matrix Composites” (CMCs) These amazing materials can endure extreme environments, for example where polymer composites can operate up to 200C, ceramic composites can operate up to 1600C.

If CMCs can be used to make the structure of the fusion reactor, this would enable higher operating temperatures and increases in efficiency by 40% when compared to steel. This could save the UK £billions by building fewer fusion reactors. The NCC is working with the UKAEA (Atomic Energy Association) to manufacture and model a 1st generation nuclear ceramic composite material. We’re hoping to collaborate with the UKAEA for many years to enable ceramic composites to be deployed in future UK reactors.



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Accelerating the Shift to Zero Emission Vehicles

In the next decade new petrol and diesel vehicles will be a thing of the past and there will be radical changes to the way we travel and ship goods with re-defined public transport, an emphasis on personal mobility and a radical overhaul in the way goods are transported.

Composites technologies will unlock opportunities – from lightweighting electric vehicles to increase the range of batteries and fuel cells to enabling hydrogen powered buses and trains.

CASE STUDY

Lightening the load of the world's favourite commercial van: composites innovation for a cleaner, greener Ford Transit

To stay competitive, the Ford Transit van has continued to evolve – delivering ever greater payload capacity and lower fuel consumption. As the 2030 net zero emission target for new cars and vans draws closer, this challenge is even more pressing.

Engineering innovation needs to deliver more efficient commercial vehicles that are 'clean and green' and affordable to own and run

CHALLENGE

To meet the 2030 target, the industry is shifting to alternative power sources, such as electric and hydrogen-based powertrains. Each of these pose a weight gain issue for vehicles, setting the challenge to manufacturers to deliver performance whilst maintaining carrying capacity. Any loss in capacity impacts fleet size and for fleet owners, more vehicles means additional costs of manpower, fuel and maintenance. Being able to switch to EV without impacting fleet size, ultimately strengthens their business case for electrification.

The weight of the vehicle base is critical to optimising its performance. Fully loaded, the current Ford Transit van has up to a two-and-a-half-ton payload capacity in a five-ton GVM configuration. Provided it did not compromise on strength or durability, reducing the mass of this base would increase the amount of cargo weight the Transit van could carry. It would also improve the fuel economy and reduce impact on the environment.

Using alternative powertrains such as electric vehicles also enables operators to access clean air zones within inner city areas. This means they can complete their journeys without having to switch to a different, cleaner vehicle that is permitted within those zones.

Ford set the challenge of reducing the weight of three suspension components by 40%, equivalent to 27kg, whilst also meeting the cost, production rate and performance characteristics of existing components. New designs, materials, and manufacturing processes would be needed to reach a full global production rate of around 500,000 vehicles per year and meet a sub five-minute cycle time.

INNOVATION

The CHASSIS project (Composite Hybrid Automotive Suspension System Innovative Structures) led by a team at Ford Motor Company, Dunton, in partnership with Gestamp Chassis, the National Composites Centre (NCC) and the University of Nottingham, set out to investigate and test hybrid composite solutions using metal, carbon fibre and glass fibre, assessing them for weight saving, reduced CO2 emissions and performance benefits. The three-year, £2.5m research and development project, part-funded by Innovate UK, also looked at how the total number of parts used across the full Transit van chassis might be reduced, simplifying the bill of materials for the vehicle and making it easier to schedule the parts to the manufacturing line. This reduces complexity, points of failure and the time required to assemble.

The team identified three components within the suspension system as ideal candidates for further weight reduction: the Front Subframe, the Front Lower Control Arm (FLCA) and the Rear Deadbeam Axle with a focus on harnessing the potential of advanced composites to deliver a considerable reduction in mass, whilst offering new design flexibility. The NCC team worked on the FLCA and Deadbeam components.

IMPACT

The CHASSIS project demonstrated that composite and hybrid multi-material components can be used to realise significant weight savings, while meeting the rate and performance requirements of Ford's Transit, and at affordable cost. A part weight reduction of 32.3kg or 46% on a long-established product model is significant.

During the project, the consortium also developed significant experience in the design and manufacture of long fibre-injection moulded and over-moulded thermoplastic components, which can be applied to future projects. The National Composites Centre continues to develop its Overmoulding and Pultrusion technology offering through its capability development work.

The patented designs from Gestamp Chassis won the project consortium team the UK Composites Awards – Innovation in Composite Design award in 2020 and the project was a finalist in the JEC innovation awards 2021.

Zero emission flight

The UK is one of the leading countries in the world in Aerospace R&D, with more than 3000 companies supporting around 300,000 jobs but the sector is in transition.

On its current trajectory, aero is predicted to be the second highest emitter of greenhouse gas by 2050 – to stop this from happening, radical changes in the way aircraft are designed and powered need to take place. We're working with industry to ensure that people will be able to explore the planet and connect with each other without the resultant carbon footprint.

For the UK to remain competitive, we need to be at the forefront of the world's transition to greener air travel and, at the NCC, we are leading some of the critical activity in this area.

The UK is world-leading in wing development. Airbus, along with GKN, Spirit and others make critical components for some of the world's most successful aircraft here in the UK. For over a decade we have been working with these organisations to develop the next generation of wing design and methods of manufacture that will allow companies to produce the lowest emission aircraft ever, at rate.

We are also actively working on novel propulsion systems. First as a key partner to Rolls-Royce. Working on composite fan / case and high temperature CMC's which allow the engine to run hotter for longer and a step change in improved fuel burn (25% more efficient than previous generations). Second we have developed next generation propellors in partnership with GE Dowty Propellors – creating a novel and unique way of manufacturing blades using thermoplastic material which can be rapidly processed and then melted and recycled at the end of its life.

We are playing a role in Urban Air Mobility, working closely with partners such as Vertical Aerospace, to create the structures and rotors that will define this next generation of transport. Ensuring the UK has the capability to make these competitively

We are also supporting the ATI led FlyZero programme, designing the cryogenic H2 tanks that will power the zero-emission aircraft of the future.

CASE STUDY

Brace for landing

As part of the Landing Gear Wing of the Future initiative, NCC worked with Airbus and other UK consortium partners to develop composite materials for use in the landing gear of medium-sized single aisle aircraft.

The project aimed to improve understanding of the design requirements and different certifications required for composite front landing-gear components, as well as the impact on component cost and weight. SALCO also provided a focus for the UK supply chain to develop supporting technologies that would cement its world-leading position in landing gear design and secure employment.

The SALCO component achieved an impressive 25% reduction in weight (from 21kg to 16kg) compared to the existing aluminium drag brace. Add to this, the associated improvements in fuel efficiency and a lower carbon footprint due to less carbon intensive processes and the life-time benefits become even more apparent.

CASE STUDY

Letting aerospace innovation take flight

We provided GKN Aerospace, a leading UK aerospace innovator, with the capability and the equipment it couldn't find elsewhere in the UK so it could develop the composites technology for use in its next generation of advanced wings.

The aim of this project was to develop an innovative winglet – used to improve an aircraft's rate of climb, and reduce fuel burn and noise – using fully automated manufacturing processes. And in so doing, cut production times and improve manufacturing quality, consistency and repeatability.

The complex geometry of the winglet's carbon fibre lower skin was manufactured using the latest automated fibre placement (AFP) technology. We also drew on advanced software tools and development processes to prove new modelling, manufacturing and testing methods for use in future production programmes.

It's another example of how the NCC can help companies scale from prototype production to high-volume manufacture through design simulation, innovative tooling, and process optimisation.

Greener Buildings and Infrastructure

The world's infrastructure needs to be fit for the future so that we are ready for the energy transition to a low carbon future. Our buildings, transport systems, power supplies and communication networks need to be more reliable for the increasing capacity that is expected for future generations.

The UN has highlighted that 70% of all greenhouse gas emissions come from urban areas. The homes and buildings in which we live and work need to be warmer and more energy efficient, longer lasting and maintenance free. They also need to be safe for many future generations, free from fumes and well ventilated, and cheaper and faster to construct from low environmental impact materials.

Composites can provide solutions to many of these challenges where our existing building materials and methods are falling short.

Longer life and low maintenance infrastructure

Composites can be tailored to their specific application. For those where very long life is needed, we can use matrices and fibres that will stand the test of time in even the harshest of environments – from arctic to equator and desert to the bottom of the ocean.

More efficient homes & buildings with reduced carbon impact

Composite materials can be designed to have very low thermal conductivity yet immense strength. This gives them an advantage over traditional building materials. For example, metal structural elements that create cold bridges can be replaced with composite alternatives, increasing the efficiency of the building. This can extend life, leading to huge energy savings and a much lower total full-life Global Warming Potential (GWP).

Low impact construction methods and materials

Existing construction materials can be very energy intensive in their manufacture, difficult to transport and hard to handle onsite. This leads to buildings and infrastructure with high embodied energy. Careful selection of the right composite material can lead to reduced embodied carbon, while the lightweight structure is less intrusive and faster to install, reducing the impact on natural environments.

Modular off-site construction

The construction industry is revolutionising the way it works, moving more towards a manufacturing approach where homes, buildings and even bridges are being built in factories rather than construction sites. They are then relocated to their final installation site. This off-site methodology brings much tighter controls, efficient, lean manufacturing methods and results in better buildings that are deployed faster, giving a faster return on investment.

CASE STUDY

NCC and Skanska trial low carbon concrete

An industry-first low carbon reinforced concrete solution is being trialled on National Highways M42 Junction 6 improvement scheme.

The £282m project – designed to alleviate congestion for motorists at a well-known bottleneck in the Midlands – is trialling the use of low carbon concrete and basalt fibre reinforcement on a temporary haul road for construction vehicles.

The trial, led by Skanska, in partnership with the National Composites Centre and funded by National Highways (NH), compares traditional steel reinforced concrete with a low carbon concrete reinforced with basalt fibre.

Production of cement, a key ingredient in concrete, currently accounts for around seven per cent of the world's CO2 emissions. In the UK, this figure is less than 1.5 per cent thanks to the industry's innovation and investment in efficient plant, fuel switching and the use of low carbon cement substitutes that are by-products from other industries.

Glennan Blackmore, Operations Director (Highways), Skanska UK said: *"With support and funding from customer National Highways, we have been able to bring together the knowledge, skills and innovative thinking from expert teams within Skanska, the National Composites Centre and supply chain partners Basalt Technologies and Tarmac to carry out this exciting trial.*

"Through using a unique combination of materials, we are working to not only cut carbon, but also aiming to improve the structural performance of reinforced concrete and deliver better productivity, safety and cost outcomes.

"It's a great example of how by working collaboratively we can innovate to help tackle climate change, by working towards net-zero carbon solutions, and deliver long-term benefits for the industry.

"We are thrilled at the progress achieved to date and we are very excited to see the results.

"The combination of the low carbon concrete and the replacement of the steel with a lightweight composite reinforcement dramatically reduces the carbon footprint by more than 50 percent."

National Highways Programme Leader, **Anita Prashar**, said: *"This trial is a ground-breaking piece of work and we're pleased to be supporting it on the M42 junction 6 upgrades here in the Midlands. We are committed to working with partners to explore ways of reducing our carbon footprint as part of the project and this trial is a fundamental step in that process."*

More about the trial

Field and laboratory tests will be carried out over the coming months following the start of the trial in early December 2021. Four reinforced concrete slabs were cast at the M42 Junction 6 site as part of a temporary haul road that will be heavily used by construction vehicles and will be monitored over the works duration. The slabs are made up of:

- **Slab A** – Conventional concrete + steel reinforcement
- **Slab B** – Low carbon concrete + steel reinforcement
- **Slab C** – Conventional concrete + basalt reinforcement
- **Slab D** – Low carbon concrete + basalt reinforcement

The team is now monitoring the slabs in-situ. Full scale test slabs have been sent to a specialist laboratory for bending and shear testing. All the collected test results will build knowledge of the curing process, ease of construction, safety benefits, functional properties, and structural behaviour of the various concrete and reinforcement combinations. This will provide insight into the future use of longer lasting materials in construction.

The trial will also provide a better understanding of the impact of the use of these materials ahead of the proposed revision to Eurocode 2 standards that will include use of composites in the design of concrete structures. This is currently being developed.

The Skanska and National Composites Centre team will also be working with HS2 to further research and develop this innovative low carbon solution.

Work on the M42 junction upgrade is set to be complete 2024/25.

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CASE STUDY

Tuproofs: Results worth shouting from the rooftops

The aim of this 16-week sprint project was to develop an easy-to-install, factory-built, and pre-assembled roof, using composites that included a range of technologies to increase a home's energy efficiency. For example, insulation to keep heat in and cold out, solar thermal to heat water, and photo-voltaic (PV) to generate electricity.

The result is TUPROOFS (Thermal under PV Roofing SIP). A structural insulated panel roof with integrated solar thermal and PV. The two composite elements used are a recycled insulation material (Armacell rPET) and a graphite liquid epoxy to transmit heat more efficiently.

TUPROOFS meets the latest building regulations, as well as Passive House standards of insulation. In tests, it generated nearly 600 watts of thermal energy.

Originally conceived to retrofit roofing on social housing, the concept is now being developed for potential use in new-build homes where economies of scale provide more commercial opportunities.

Protecting our Natural Environment

Composites let us design and make better products.

From lightweighting vehicles and aircraft to reduce emissions, adding strength and flexibility to super-turbine blade design, to increasing product lifespans by decades through corrosion resistance and durability.

Composites already play an important role in driving decarbonisation. But there is more we can do. We are acting now to build a future using sustainable composites. Harnessing our expertise to redefine a new generation of products that will create a greener, cleaner future for all.

Answering the challenge

Only 15% of the 110,000 tonnes of composites produced in the UK each year will be reused or recycled at their end-of-life. There are limited options for recycling, with processes that often degrade the materials' performance. More than 95% of composites are made from raw materials and resins that are unsustainable.

To answer these challenges, we need to accelerate our capabilities in recycling our composites, extracting the maximum potential from every strand of high performance fibre.

The NCC is bringing together industry, researchers and our team of specialists to address major challenges to composites recycling and re-use through the Sustainable Composites partnership. By acting now, we will open up new opportunities for the UK supply chain in a global end-of-life composite components market expected to be in excess of £2bn per annum.

NATIONAL COMPOSITES CENTRE

CASE STUDY

Money for new rope

Working with UK SME, ARC Marine, the National Composite Centre (NCC) has proven that a new, composite rope could offer a natural alternative to plastic ropes currently used in the marine industry.

CHALLENGE

ARC Marine are an award-winning company specialising in accelerating reef creation, offering sustainable alternatives to offshore construction that will help restore the ocean eco-system. Having developed a carbon-neutral marine matt to be used to secure and protect submerged pipes and cables on the seabed, ARC Marine approached the NCC to help create a plastic-free, durable rope that could be used to secure the matt, and that could become part of a natural reef.

"Our innovative plastic-free rope will undoubtedly change the face of the industry by preventing tonnes of plastic from entering the sea whilst enhancing marine ecosystems."

INNOVATION

The team of specialist engineers at the NCC explored using various mineral fibres for the core, focusing on those with low ecological impact. The hardy, low carbon alternative was braided into a rope using the NCC's two-ring braider. A natural fibre outing was added to make the product more handleable. It also makes the product bio-inclusive, with ocean life having something to cling on to, facilitating the formation of a natural reef over time.

IMPACT

A product such as this isn't currently available on the market, but the new natural material rope- which has been designed to withstand the harsh sea environment – could lead to a CO2 reduction of up to 88% when compared with a standard polypropylene rope.

By accessing funding through Innovate UK's EDGE scheme, ARC Marine have been able to work with the NCC to prove their concept and will now look to develop it further in readiness for market across a range of sectors, including offshore energy, oil and gas, coastal defence and agriculture.

Tom Birbeck, Co-Founder and CEO of ARC Marine, says: *"With each traditional mattress deployed, there's an average of 140 meters of plastic rope that enters the ocean with it. Marine plastics damage our seas by harming numerous sea creatures, including fish, cetaceans, turtles, seabirds, coral and even humans.*

"Our innovative plastic-free rope will undoubtedly change the face of the industry by preventing tonnes of plastic from entering the sea whilst enhancing marine ecosystems. That's why we're incredibly proud to have worked with the NCC to create it - they've been instrumental in developing and refining the design.

"It really is time for change, and we hope that this marine rope can be utilised across the world, alongside our plastic-free Marine Matts as a sustainable way to protect subsea cables and other assets in growing offshore energy and traditional sectors as we transition to net zero."

Digital: Reimagining the Products of the Future

To achieve net zero by 2050, we need to invest in new ways to reduce and remove carbon emissions from what we produce and how we consume it.

Providing an exciting opportunity to engineer better, sustainable products, much faster using digital technologies will accelerate innovation to drive decarbonisation. In parallel the UK has a skills problem – the demand for digital transformation of its engineering industries is outstripping the number of engineers with digital skills.

Led by the National Composites Centre, Digital Engineering Technology & Innovation (DETI) is a research, innovation and skills programme that helps companies to identify and develop the tools, technologies and processes needed to rapidly boost digital engineering capabilities. It also includes a skills programme that provides courses to upskill the current workforce, and a STEM programme to inspire and build a diverse and inclusive future generation of engineers.

Over an initial two-year pilot programme DETI produced a series of demonstrators showing businesses how they can address common challenges to digital transformation. These ranged from speeding up the product design process using immersive technologies and concurrent engineering techniques to utilising the power of 5G and quantum computing to allow manufacturing operatives to securely control robots remotely and in real time with no latency.

Results at end of the 2-year pilot:

- 32 completed projects demonstrating how digital engineering can transform industry
- Industry now has access to 10 industrial test beds where they can trial technologies and de-risk their own digital transformation
- 17k children aged 4-18 and 452 teachers across 218 schools engaged directly. 106k children reached through STEM activities. 456 engineers shared their experiences as well as 18 industry partners and 4 charities
- 29% of the children involved in this programme came from the top 20% of deprived areas in the region
- 31 SMEs engaged
- 87 FTE roles created/safeguarded

Benefits to the UK

- The use of digital in engineering allows industry to engineer better products, more quickly, and at lower cost, enabling engineering leadership in the global competitive marketplace
- Helps businesses become more productive and resilient, developing a diverse, inclusive digital-ready workforce, creating employment opportunities for high value jobs
- Enables the UK to shift more quickly to a low-carbon economy

Workforce development

The NCC is working with partners across the country to provide world-leading training, advice and support to upskill workforces and help our technology rich UK industry to succeed.

Workforce development initiatives help the UK to attract and retain talent. They boost productivity for businesses and provides an opportunity for individuals, communities and industry to prosper.

As an employer, the NCC adopts a people-first approach to workforce development, offering a range of options for our staff to upskill and improve their career prospects. We provide internal and external training, mentoring and coaching, as well as access to Charterships and professional registrations.

Supporting SMEs

The National Composites Centre works with and advises businesses of all sizes. It has a specific team that engage with and help SMEs. Whether an organisation is looking for expertise on a technical challenge, access to the latest technology or training to upskill its team, the NCC can help.

NCC Connect is a dedicated SME support team set up to ensure businesses can swiftly access our resources in the most appropriate way, tailored to the organisation's individual needs.

CASE STUDY

Supporting an exciting UK micro company to prove a concept

We worked with micro-company Limosaero Ltd to develop a simplified, scaled-down demonstrator of their solar-powered, long-endurance, low-altitude UAV (uncrewed aerial vehicle).

The UAV offers a range of remote-sensing applications including monitoring marine and coastal environments, wildfires, and Arctic ice flows. The British Antarctic Survey has already adopted Limosaero's prototype technology.

To achieve long-endurance flight, mass is obviously key. With the grant from Innovate UK Edge fund, Limosaero chose the NCC to build the critical lightweight carbon composite parts for the UAV's wing spar and wing ribs.

"The support from the NCC's SME team was excellent. They understood the challenges we faced as a small company and helped us overcome the hurdles to make the parts within the time and budget constraints. It was extremely helpful how the Innovate UK Edge programme connected us with the NCC to progress our company forwards."

Hilary Costello, Founder, Limosaero Ltd.

CASE STUDY

Keeping the manufacture of Robot birds in the UK

Robop is a Scottish SME who manufacture bird control systems based on their patented R-Falcon, a robot designed to look, move and sound like a peregrine falcon. These are used by owners of large buildings and other facilities world-wide to eliminate problems caused by roosting and nesting birds and in some applications to protect birds from man-made pollution hazards.

Their product's body parts need to be strong, light and durable to withstand years of wild weather in exposed locations. They are hand-made in composite materials usually glass/polyester and sometimes in a glass/Kevlar/carbon construction. Robop approached the NCC to investigate a repeatable and cost-effective method of manufacturing the wings, including multiple fibre options to ensure they were both lighter and stronger than before. The NCC trialled six different material combinations and simple manufacturing techniques to compare the various solutions available. This resulted in the production of five different prototypes, including one that is 36% lighter than the original product's weight.

The process developed by the NCC's specialist engineers was both faster and more cost effective than the current way of manufacturing the product, and all prototypes were stronger and lighter than the original model.

The team at the NCC designed the process, including the Bill of Materials, to be used in-house by Robop, or to be outsourced to a manufacturer to recreate the chosen prototype. Robop are now looking at what other components can be manufactured using the method developed by the NCC, as well as investigating if they can bring the manufacturing in house, which would allow them to upskill their workforce and save costs.

This project was completed as part of the NCC's SME Boost programme, which offers match funding up to £25k to small and medium-sized enterprises (SMEs) in the UK to help them develop composites products.

CASE STUDY

From genius idea to a thriving business

Lineat was established at the NCC in 2020 through its SME connect programme, allowing the rapid expansion and development of its HiPerDiF carbon fibre recycling process; which was invented at the University of Bristol with support in its development from the NCC.

Fast forward and it has grown from two people in a small flex cell at the NCC's headquarters in Bristol, to a team of eleven now based at the NCC's Filton site, giving space to build the world's first highly aligned recycled carbon tape machine. Engagement with the NCC has allowed direct collaboration with OEM and Tier 1 members and to further endorse the patented system, which has seen Lineat, in collaboration with Wilson Sports; reclaim, recycle, align and manufacture the world's first recycled tennis racket.

"With commercial orders already flowing in, having the required technical resources through the NCC has positioned Lineat in a great position for further expansion."

Gary Owen, CEO, Lineat

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NATIONAL COMPOSITES CENTRE

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