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# MEETING THE GREATEST CHALLENGE

How the UK Composites Sector will deliver Net Zero

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# Introduction

Climate change is an existential threat. Every aspect of society will be impacted – from the way we produce food to the way we make power, where we live, how we travel, even the nature of work and staying healthy will change.

**“...78% reduction in carbon levels, compared to 1990, within fourteen years.”**

The Pandemic has temporarily disrupted the world but rising global temperatures will fundamentally reorder it. The process is already well underway.

Recognising this, in April 2021, the UK government set in law some of the world’s most ambitious climate change targets: a 78% reduction in carbon levels, compared to 1990, within fourteen years. ‘Net Zero’ by 2050.

**Composites will help us get there.**

Lightweight, adaptable, immensely strong and durable, composites are the essential enabling technology for decarbonisation. They hold the key to more efficient transport, sustainable energy – including the much-heralded hydrogen economy – and much else.

They will help our powerhouse industries – automotive, aerospace, defence, infrastructure – stay relevant and competitive. Their variety and versatility will unlock our creativity and help us reap the rewards of ‘digital engineering’, so we can make better products, more quickly, and with less waste. Products the world will want to buy.

Climate change is a daunting challenge that requires us to re-imagine traditional engineering. The UK has world-leading science, engineering and innovation skills. They come together in our composites sector: a vibrant ecosystem of large and small firms, regionally distributed, expert at tackling real-world problems.

Together they will drive the transformation to a low carbon future and, along the way, create new export opportunities, grow skilled jobs and support levelling up.

**But – only if we make the right choices now.**

Our composites industry is a Strategic National Asset, years in the making, but its advantages could quickly be lost.

Products must be redesigned for the Net Zero world; from ships to shoes, spacecraft to food packaging, the way we conceive, design, make, distribute, use and dispose of the stuff of everyday life, will change. To stay competitive, the UK must be at the forefront of this process.

By controlling the engineering (design) function for the next generation of products, we can shape supply chains and anchor value here in the UK. We do this by helping the sector innovate and develop skills, prove new methodologies and set standards for the world.

If we don’t, the centre of gravity will shift elsewhere, and Britain will become a customer for high value goods and services, rather than a provider of them.

As other nations invest in decarbonising their economies, demand for carbon fibre is predicted to exceed global production capacity within just a few years. Rather than Britain waiting in line for what supplies we can get, we can control our destiny and invest in onshore production and re-use to supply our domestic market, and for export.

Composites are famously tough but this durability is a double-edged sword: they are difficult to recycle. This is another market opportunity for the UK: we have the science, engineering and composites know-how to create innovative recycling processes and even invent new, more sustainable materials. Britain can be the architect of a circular composites economy worth billions.

# UK Strategy to Deliver Global Composite Solutions

The Composites Leadership Forum (CLF) was established as a result of the 2009 UK Composites Strategy, to bring independent leadership to the sector.

It comprises representatives from across the UK's composite base including the UK's world leading, government-backed National Composites Centre, industry trade body Composites UK and key industrial organisations who make up the backbone of the UK's engineering sector. The CLF works to ensure the UK's continued global success.

In 2016, the CLF published a strategy that identified the UK's need to develop higher rate and lower cost production technologies. Market data showed that this would contribute to the growth in value of UK-produced composites parts from £2.3bn in 2015, to £12.5bn in 2030.

Today the CLF has identified a second challenge which it has added to its strategy: the need to develop composite solutions to support the battle against climate change and decarbonise our economy. Working to understand how the UK composites industry can respond to, and capitalise upon, the new, overarching imperative of sustainability.

# How big is the composites opportunity?

The composites industry is forecast to resume growth at up to 9% per annum between 2021-2025.

Whilst the value of raw materials is significant (c. $78 billion in 2020[1]), the products they help create are worth vastly more. This will only increase as sectors including renewable energy, transport, defence, infrastructure and construction ramp up their use of composites, in line with Net Zero goals.

The UK is ideally positioned to benefit, thanks to its investment in a raft of high-tech and high value composite technologies and products.

[1] JEC OBSERVER: Current trends in the global composites industry 2020-2025

# A new energy future – Wind

Whatever else we might say about the British climate, it is near perfect for wind energy.

The UK currently has the world's largest fleet of offshore turbines[2], with an installed capacity of over 10GW[3] supplying c. 20% of our electricity need. The Government has committed to increasing this four-fold by 2030 and seven-fold by 2050. This coincides with an anticipated surge in demand to power electric vehicles, domestic heating and the production of green hydrogen[4].

Achieving this increase in energy output will push design, manufacturing and materials technology to the limits. Offshore turbines are now nearly a quarter of a kilometre in diameter and are set to get bigger still and be deployed further from shore, on floating platforms.

Offshore wind is attracting significant foreign direct investment[5] into the UK with recent announcements of major, new blade factories contributing to the levelling up agenda. While wind energy is expanding globally, particularly in China and the US, the UK will remain one of the world's largest markets for offshore power until 2050 or beyond. By designing and manufacturing a new generation of materials and high-value components here, rather than import them, as currently happens, we can reach the aspiration of 60% domestic ratio and capture much more of the business value in the UK[6].

[2] UK has largest economically exploitable offshore wind in Europe and in top 5 globally. Europe's onshore and offshore wind energy potential: An assessment of environmental and economic constraints

[3] Wind Energy Statistics, Renewable UK

[4] Hydrogen produced using electricity from renewable sources.

[5] Foreign Direct Investment including Siemens announcement to expand its existing facilities in Hull, LM's investment in Teesside which complement Vestas' on the Isle of Wight.

[6] https://www.offshorewind.biz/2020/10/06/uk-prime-minister-offshore-wind-to-power-every-home-by-2030/

# Nuclear

To meet the demand for low carbon energy, UK scientists and engineers are developing a new generation of Small Nuclear Reactors (SNRs).

Featuring composites that withstand incredibly high temperatures, these could enter service by 2030[7] and generate £52 billion of value to the UK economy by 2050. The technology could also open up a £250 billion export opportunity and generate up to 40,000 high-value jobs in communities across the UK[8].

In parallel, the UK's research base is developing fusion-reactors that offer the prospect of virtually limitless clean electricity by replicating the processes that power the Sun.

Whilst the science is understood, the engineering required is pushing the limits of our ingenuity. Once again, composites play a central role, with Ceramic Matrix Composites (CMCs) being used to contain the incredible temperatures involved.

[7] Green Hydrogen, The Fuel Of The Future, Set For 50-Fold Expansion, Forbes, 14 December 2020

[8] https://www.thisismoney.co.uk/money/markets/article-9581899/Rolls-Royce-starts-hunt-buyers-nuclear-reactor-boost.html

# Delivering the shift to new forms of mobility – Low Carbon Hydrogen Transport

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

It is predicted that the gas could supply 25% of global energy needs by 2050, creating an economy worth c. $10 trillion[9].

Work needs to be done before hydrogen truly becomes a Net Zero hero: almost all of the gas produced today comes from fossil fuels. It uses them in vast quantities too: 6% of global natural gas and 2% of global coal currently goes into hydrogen production. This presents the UK with a compelling opportunity to use our growing, low-carbon energy generation infrastructure – wind, solar and nuclear – to produce 'green' hydrogen, by electrolysis.

As Hydrogen gas is less energy dense than petrol or diesel, it needs to be stored in cryogenic or highly pressurised tanks. For this reason it is considered better suited to bigger vehicles such as trucks, buses, trains, ships and airliners. Nonetheless, hydrogen car production is forecast to grow 10-fold (albeit from a low base) in the next decade. As only fibre-reinforced materials combine low mass with the strength needed to withstand the immense pressures involved, this will result in a five-fold increase in demand for carbon fibre globally between 2025 and 2030.

[9] https://www.goldmansachs.com/insights/pages/gs-research/green-hydrogen/report.pdf

# The future of mobility

Radical changes are underway in the way we travel. In the next decade new petrol & diesel cars will be a thing of the past, public transport will be re-defined and personal mobility will be increasingly important.

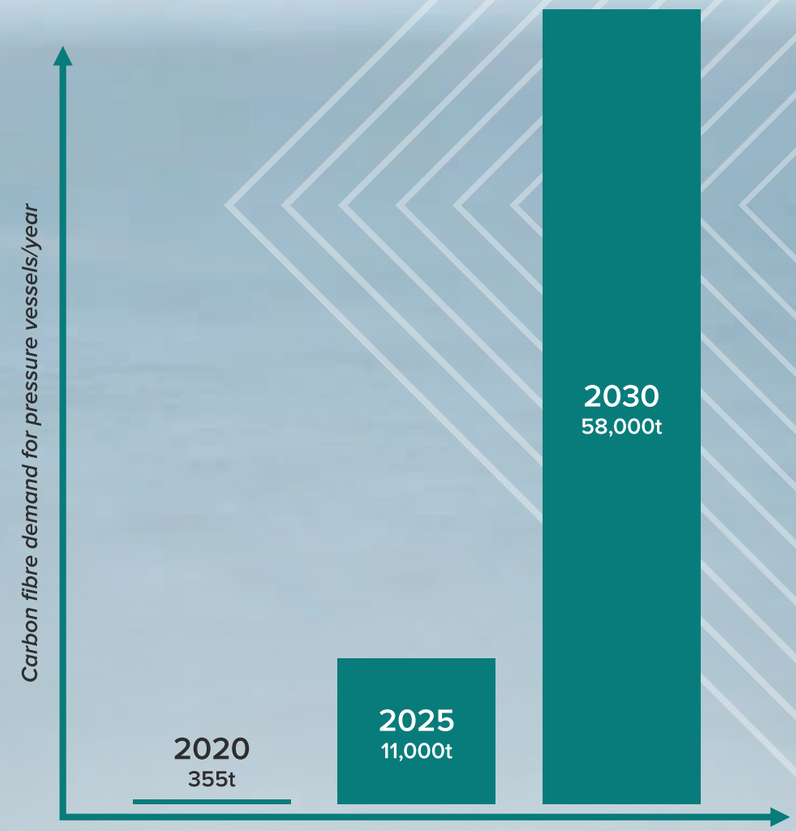
Composite technologies unlock these opportunities to revolutionise our personal mobility from light-weighting electric vehicles to offsetting the weight of the batteries to increase the range of cars to enabling hydrogen powered buses & trains. Bicycles already take advantage of composite materials with other forms of personal mobility being developed that will equally benefit.

This rise of new vehicles requiring composite solutions will see a huge rise in demand.



## Market Opportunity

Carbon fibre requirement for hydrogen pressure vessels in transportation[10].




**Conservative annual carbon fibre demand for transport pressure vessels: supply will not meet demand**

As new supply chains are developed the UK must capitalise on its existing position and expertise in composites to secure the transportation supply chains of the future.

[10] "Carbon Fibre Pressure Vessels for Hydrogen in Fuel Cells in Transportation – a real opportunity or an elusive dream?" Andrew Mafeld, Connectra. Go Carbon Fibre Conference. April 2021.

# Allowing us to fly without emissions – Enabling Jet Zero

The fourth generation of aerospace is upon us with alternative fuels and propulsion technologies coupled with novel aircraft designs providing the pathway to achieving emission free flight.

The Jet Zero & Fly Zero programmes are leading the way with composite technologies required to enable these aircraft of the future.

The UK is already a world leader in the application of composites for aerospace, producing complex, high-value components such as wings. Use of composites will only increase in future generations of aircraft while, new, smaller forms of air vehicles, such as delivery drones and air taxis, will be totally dependent on their unique power-to weight-to strength characteristics.

Composites are even going into space, with a UK firm pioneering the use of carbon fibre for reusable rocket launchers. Once again, sustainability is the driver, with the new design using less propellant on its way up and leaving no debris behind as it returns.

# Maintain our Defence

Defence will always be a national priority and requires materials capable of operating in the most extreme conditions including in orbit.

It is critical that the UK retains a sovereign capability to develop the materials, equipment and systems needed.

Advanced composites will play a vital role in programmes such as Tempest, the UK's Future Air Combat System, where the challenge is to provide better performance, at half the cost of the current solution.

The same properties of strength, stiffness, low-mass and stealth are equally applicable to surface ships, submarines, helicopters, UAVs, missiles and satellites, making composite materials a critical element of their design.

# Build back better – Construction, infrastructure and utilities

The global construction industry is one of the biggest emitters of carbon and the largest market for composite materials.

According to the UKGBC, the built environment contributes 42% of the UK's carbon emissions, with the bulk of this coming from existing buildings[11] that are poorly insulated and energy hungry. We not only need better homes, we need to build more of them, more quickly.

As we have seen, composite structures are light as well as strong, an important consideration when retrofitting buildings with weak foundations. In the case of new homes, composites lend themselves to modular, factory production. With 30% of building materials often wasted or damaged on site, this alone can dramatically improve environmental performance.

How we make buildings matters; re-thinking what we make them from matters even more. Like concrete, gypsum is one of the most widely used substances on Earth. It is also highly carbon intensive so UK composite experts are now developing – and selling – composite alternatives.

The UK will also need to invest significantly if the full benefits of advanced composite materials are to be realised in similar applications.

[11] https://www.building.co.uk/focus/countdown-to-zero-how-can-the-uk-meet-its-2050-carbon-targets/5109420.article

# Sustainability

One of the great strengths of composite materials is their durability. Whilst this enhances their in-service performance, it also makes them challenging to fully recycle[12].

This is all too apparent to the wind energy sector, which has thousands of turbine blades coming towards the end of their useful life. In addition, 98% of the resins used for composites are derived from petroleum products, and 95% of the fibres are from non-renewable sources.

These sustainability issues cry out for innovation. The UK has the skills to rethink recycling for composites, and to develop a market for cost competitive recycled feedstocks. Our world-class science sector can develop new, more sustainable fibres and resins, including alternatives such as bio-resins and natural fibres.

Significant UK composites recycling capability will also onshore our material supply needs, increasing resilience going forward.

The needs of Net Zero will only ever become more pressing, so the long-term business case for more sustainable composites looks compelling. With a global shortage of carbon fibre also on the horizon[13], a truly 'circular economy' for composites can't come soon enough.

[12] JEC report: just 2% of composite materials are currently recycled compared to plastics at 20%

[13] JEC report

# Summary

The way we create and use products needs to be fundamentally re-imagined.

The future will be defined by the need to do more, with less, in the face of ever-increasing international competition.

The UK cannot meet its net zero targets without composites. They are both a strategic asset and key differentiator for the UK and will underpin government strategies around Hydrogen, innovation, industrial and transport decarbonisation, exports and Net Zero.

The UK must seize the opportunity to create the composite supply chain of the future, developing the products and capabilities that will underpin the Green Industrial Revolution, ensuring the UK retains the jobs, economic value and technological leadership in these critical sectors for generations to come.

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