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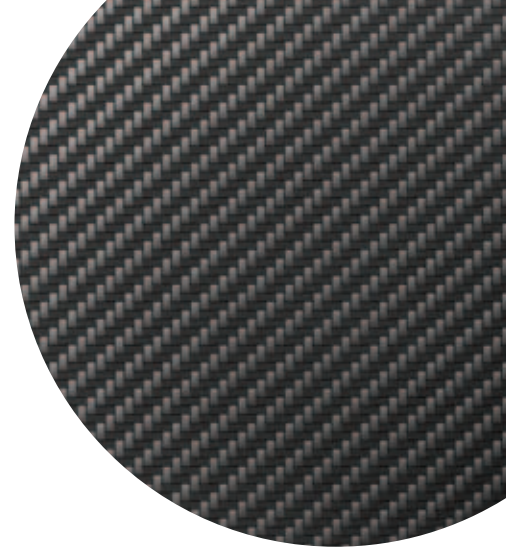
EPSRC

Fairline Boats

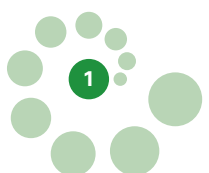
GKN plc

Gurit UK

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The UK Composites Strategy



The UK has a rich industrial heritage. Far from being a part of our history we proudly look back on, manufacturing is central to the future success

of the UK economy. More countries are competing to secure a stronghold in high value-added manufacturing. Ensuring that the UK strengthens its position in this sector and becomes a world leader in the years ahead is a priority for this Government.

We know that moving to a low carbon economy will change the way that we produce our goods, heat our homes and transport ourselves. It will create a greater demand in the global economy for new products which are at the cutting edge of advanced manufacturing. It is not an option for the UK to sit by and allow other countries to capture this rapidly growing market.

Increasingly, industry is using advanced composites in more durable, lightweight and higher-performance products. In our policy document, *New Industry, New Jobs*, the Government identified composites as a key driver in enabling the UK's manufacturing base to flourish in the coming decades. It is clear that the commercial opportunities from these materials are vast and will benefit the largest aerospace companies through to the smallest innovative start-ups.

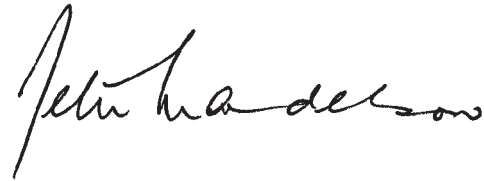
The UK already has a developed expertise in using composites in aerospace and high-performance cars but we need to do better in the increasingly competitive composites industry. Up to now activity has been too sector specific which has limited the development of a cohesive composites industry and the transfer of technology to the manufacture of other products in other sectors which could be built using composites. There is a role for Government, working with business, to raise awareness of the commercial opportunities, as well as shaping the technical and economic

conditions necessary to develop rapid manufacturing on a scale which we have not seen before.

Laying the foundations now will allow for a skilled workforce equipped with the techniques and processes to produce high value goods such as aircraft wings, automotive components and wind turbine blades at greater volumes to a consistent standard. By laying these strong foundations the potential to increase and develop the use of advanced composites across other sectors is well within our grasp. The winners will not simply be our manufacturers, but also the supply chains which will support these companies as the industry expands.

The Composites Strategy sets out how we achieve this, building on previous measures to support this industry. A co-ordinated approach bringing together Government, the regions, industry, research institutes and academia will provide the focus needed to take full advantage of the commercial opportunities. Establishing a national centre dedicated to building the prototypes and the rapid manufacturing processes the UK requires will boost the industry. Developing smarter practices in recycling will make better use of composite materials. And training tailored to the sector's needs will ensure it has the skilled workforce it requires to provide the expertise for the composites industry to grow in the future.

This approach is a crucial element of the Government's commitment to an active industrial strategy which will secure economic growth, prosperity and employment following the global downturn. Putting in place this framework now will ensure UK manufacturing will go from strength to strength.



**Peter Mandelson, Secretary of State
for Business, Innovation and Skills**

Removing barriers to market in composites



The global composite industry is becoming increasingly competitive. Market barriers exist that may hinder further commercial investment in composites and technological development. The UK composites industry is **fragmented** and lacks a single voice to articulate industry requirements. This has resulted in **co-ordination failures** as few firms have the critical mass to invest in equipment to make composite structures at the speed and cost industry requires. Consequently, **technology and skill transfer** between companies and sectors has been hindered by the industry's structure.

Alongside this, there is a shortage of the **necessary skills** at nearly all levels, as training is difficult to identify and access and qualifications address specific industry sectors rather than the composites industry itself. In **sustainability and recycling**, further development of recycling process technology and added value applications for recycled advanced composite materials are needed to satisfy growing end of life concerns;

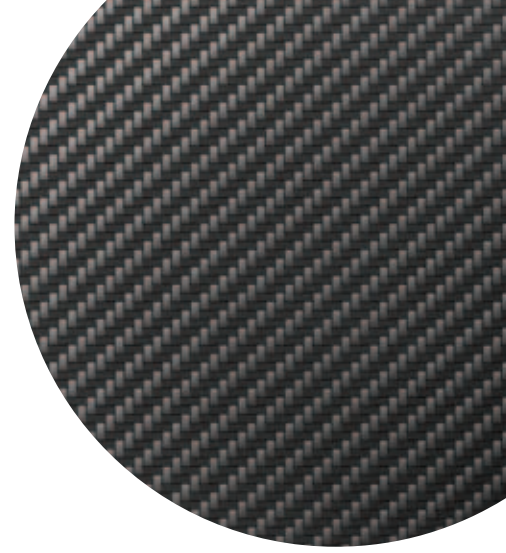
additionally, we need to commercialise our offering in recycling advanced composite materials and continue work on the properties of sustainable composites.

In this Strategy, we refer to a 'composites industry'. While recognising companies belong mainly to sectors such as aerospace rather than an actual 'composites industry', our aim is to create the conditions where companies can beneficially work together across sectors and co-operate with each other to create such an industry. Our proposals aim to address these challenges and enable businesses to succeed in the future. As this market evolves, so will our approach. We will continue to work with businesses, industry bodies, trade unions, working groups, academics, Regional Development Agencies (RDAs) and the Devolved Administrations to deliver our Strategy.

Figure 1 – Our proposals for the composites industry

Strengthening Capability – Leadership, Skills and Awareness	
<ul style="list-style-type: none"> ● Strengthen leadership in composites by establishing a Composites Leadership Forum chaired by a BIS Minister, involving key composite companies and industry stakeholders ● Develop future technical and manufacturing capabilities in composites through a more coordinated approach to skills development via: <ul style="list-style-type: none"> – building on Government support for this key sector as outlined in <i>Skills for Growth: a national skills strategy for economic growth and individual prosperity</i> and in <i>Higher Ambitions: the future of universities in a knowledge economy</i> – Semta and Cogent Sector Skills Council partnership supporting businesses. ● Raise awareness of the commercial opportunities presented by composites through: <ul style="list-style-type: none"> – Composites Supply Chain initiative led by RDAs, with the composite Centres of Excellence to include promotional activities and support to companies; – Strengthening the network of Centres of Excellence, led by the new National Composite Centre, to co-ordinate technology transfer across regions – BIS, UKTI and the RDAs will work with other Government Departments, including DECC, and industry, to map, grow and market the UK's capability in composites. This work will target increased Foreign Direct Investment and help UK companies win trade opportunities across the world. 	
Building Capacity – Rapid Manufacturing	Increasing Sustainability and Recycling
<ul style="list-style-type: none"> ● Developing rapid manufacturing through <ul style="list-style-type: none"> – launch of a National Composite Centre with £16m of Government funding to research ways composite structures can be produced cost effectively and quickly – a £6m Technology Strategy Board Challenge to spark innovative solutions for rapid manufacture of composites. 	<ul style="list-style-type: none"> ● Establish a consortium of businesses, leading universities, DEFRA, the Technology Strategy Board and EPSRC to prioritise work on sustainability issues such as improving recycling processes and applications for recycle, and to identify gaps in our current knowledge base for composites recycling and the broader issue of sustainability of composite materials.

What are Composite materials?



In their most basic form, composites are made from at least two materials that together produce material properties that are different from the properties of those materials on their own. In practice, most composites consist of a bulk material (the 'matrix'), and a reinforcement of some kind (typically fibres, particles or flakes), added primarily to increase the strength and stiffness of the material. This Strategy seeks to focus on advanced composites (***Structural Fibre-reinforced Polymer Matrix Composites***), where we believe we can seize competitive advantage, extend our share of existing sectors and ensure the use of composites in new industries.

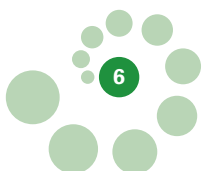
The Benefits of Composites

The properties of composites and the benefits derived from their use will drive demand from modern manufacturers in the coming years. Advanced composites are light-weight, higher-performance materials. Their use to reduce weight in automotive, aerospace and other transport applications can deliver **savings in running costs** and,

more significantly, **carbon emissions**, helping increase resource efficiency and drive our shift to low carbon vehicles. Without underestimating the challenges of incorporating advanced composites in mass-production cars, work by some manufacturers indicates that there could be significant gains made from their use in other low volume vehicles like trucks, buses and other large transport vehicles in the next few years.

In many applications the **high-strength to weight ratio** of composites (i.e. lighter weight for the same load-carry capability) and speed of installation makes them ideal for use in structures such as bridges. Network Rail (see the composite footbridge case study for an example), the Highways Agency and London Underground have all benefited from the fast, simple and low-cost installation of composite materials in infrastructure projects.

To produce higher power wind turbines, the offshore wind industry is increasingly looking to design and manufacture turbines with larger blades. In September the Government





announced £4.4m of support for Clipper Wind to develop their first prototype 71.5m blade for the Britannia project – the largest wind turbines in the world. The increase in size and corresponding increase in weight of larger blades requires stiffer materials to prevent blades bending and hitting the turbine tower. The **strength and stiffness** of advanced composites make them an ideal material for the production of this new generation of wind turbines.

Composites' **excellent fatigue endurance**, under varying degrees of stress and pressure, means these materials are already used widely in high-performance cars and military jets. But an even greater number of sectors, products and applications could benefit from this capability, if available more widely.

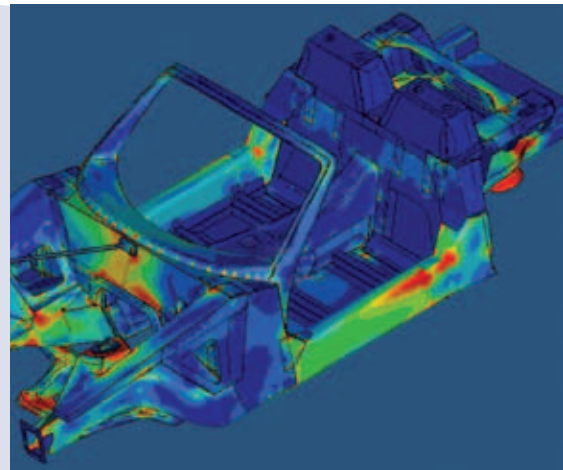
The outstanding **corrosion resistance** of composite materials makes them ideal for use in sectors such as aerospace, whose end-products are often used in extreme environments.

CASE STUDY:

Bentley Motors

At Bentley Motors, research into composite materials is focussing on the next generation of carbon fibre reinforced materials and high value manufacturing processes. This research will bring a step change in the use of composites as an automotive material, and drive the application of high volume composite manufacturing methods to vehicle concepts. At Bentley the target is to achieve low weight and lower production costs while achieving lower carbon emissions on vehicles in line with future legislation and market demand.

Development work by Bentley has clearly shown that by using composites the weight of the main structural component can be reduced by 60%. As a direct result and in combination with engine downsizing, reductions in vehicle emissions of up to 30% are expected by 2015.



Our focus is on Advanced Composites

Our focus is on advanced composites where we believe we can build competitive advantage, increase our market share of existing sectors and ensure the use of composites in new industries.

Polymer matrix composites (commonly known as PMCs or fibre reinforced polymer/plastic – FRPs) have a wide range of properties depending on the fibre or matrix used. Most provide improved strength-to-weight ratios, stiffness-to-weight ratios, fatigue properties and corrosion resistance, in comparison to other commonly used engineering materials such as aluminium alloys. This document focuses on a subset of PMCs, which will be called advanced composites and is defined as ***Structural Fibre-reinforced Polymer Matrix Composites***.

Their manufacture often depends on the formulation and combination of component materials including chemicals from a highly-skilled and technically-advanced composites industry.

One example of an advanced composite is carbon fibre reinforced plastic (CFRP). This has long been used in technology-intensive applications such as motorsport and aerospace due to its significant strength, stiffness and weight advantages over other engineering materials. Solutions focused on reducing the cost and time to manufacture CFRP components could make composites a more viable substitute for other materials.

Our Strategy is focused on removing the main constraints common to a number of sectors to aid the development and commercialisation of advanced composites. As such it does not cover all the products or all the markets using advanced composites nor does it address all constraints. Given this, our aim is to address challenges in those areas and capabilities where the UK can sustain a competitive advantage in the development and commercialisation of advanced composites and where targeted Government intervention can make a difference.

We acknowledge there are other light-weighting materials that will compete with composites, for example, aluminium alloys, and that other competing materials will evolve in the future to meet industry needs.



Composites also have the advantage over some metallic counterparts. For example, intelligent **design** can save further weight by only using material where it is required to handle specific load bearing areas of structures.

A further advantage of using composites is that it is far easier to embed **functionality** within composite structures. This means it is possible to place sensors that enable real time monitoring of components and other features. This property offers huge benefits in maintenance and monitoring and can save even more weight by removing the need to have separate monitoring components. Composite materials can also be designed to partly repair themselves when damaged, which has benefits for structures that may be regularly damaged or are difficult to repair.

As we move towards a low carbon economy, it will become critical to consider the whole life impacts of innovative materials, from feedstock and manufacture to end-of life options. While composites in general possess many attributes that contribute favourably to a low carbon agenda, through the reduction of energy consumption in transport due to light weighting and the elimination of electrochemical corrosion, their role in developing **sustainable** products requires further work. Most resin systems are currently oil based while both carbon and glass fibres are produced using energy intensive processes.

CASE STUDY:

AgustaWestland

At AgustaWestland, the company has achieved advances in aeromechanics and composite manufacturing technology in partnership with the Ministry of Defence over a number of years. AgustaWestland first introduced composite rotor blades into military helicopters in the 1980s, firstly on the Sea King then on the Lynx. Although up to three times as expensive as the previous metallic blades, these blades took advantage of the excellent fatigue behaviour and durability of composite materials. As a result, the composite blades were projected to last the life of the aircraft, where before up to 20 sets of metallic blades were needed – thus making a considerable life saving.

More recently the British Experimental Rotor Programme has produced major developments in composite capability. Their use in the Lynx and EH-101 aircraft best illustrate the benefits gained. Both aircraft have 40% greater payload capacity compared to similar helicopters using more conventional rotor technology, the equivalent of an extra rotor blade's worth of performance.



Composites which include naturally derived fibres such as jute, hemp, ramie and sisal could provide sustainability benefits as well as meeting technical requirements for strength and light-weighting. Hemp fibres have been used for a number of years by BMW, Mercedes, Volvo and many other automotive manufacturers for interior mouldings. Resins from plant origins are also being developed which in the future will lead to the development of completely renewable composite materials. Further research is required for naturally derived fibre to provide the same performance properties as advanced composite materials.



Additionally, while there are significant attractive properties of advanced composite materials there is scope to address other issues that may influence the take up of advanced composite materials. These include issues around repair, joining with other materials and cost although in many applications there is cost advantage to using composite materials taking into account the lifetime costs of manufactured products (see the AgustaWestland case study). However, this Strategy sets out the significant benefits in using advanced composite materials and we anticipate that composites, like other materials, will evolve to meet industry requirements. Further technical information on advanced composites can be found at this link. This information was prepared by the Inter Agency Composite Group (IACG):

<http://interactive.bis.gov.uk/advancedmanufacturing/composite-strategy-documents/>

CASE STUDY:

The University of Bristol and Engineering and Physical Sciences Research Council

'New Skin' for self heal planes – Ailing aircraft could heal themselves during flight thanks to a revolutionary new system

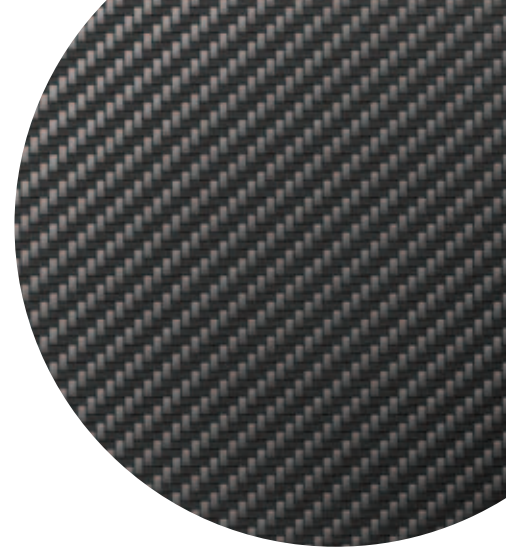
This technology, that mimics the healing processes found in nature, has been developed by aerospace engineers at the University of Bristol, with funding from the Engineering and Physical Sciences Research Council (EPSRC), and could be available for commercial use within four years.

If a tiny hole or crack appears in the aircraft – due to fatigue or a stone strike – epoxy resin 'bleeds' from embedded vessels near the crack to quickly seal it and restore integrity. The resin and hardener enable the composite material to recover up to 80–90 per cent of its original strength – comfortably allowing a plane to function at its normal operational load. Dye in the resin would allow engineers to pinpoint damage repair during subsequent ground inspections.

The system could be used in other industries, such as car, wind turbine and even spacecraft manufacturing. The University of Bristol research team, in collaboration with researchers at Imperial College London, have been awarded a further £600,000 from EPSRC to continue the development of these techniques.



The Global Market for Composites



The global forces that have led to the shift in UK manufacturing, over the last few decades, to more value-added, and technology and research intensive products and services will continue to shape our country's economic success in the future. The big trends toward sophisticated technologies such as industrial biotechnology, advanced chemicals, nanotechnology and low carbon solutions, as well as the potential strong growth of the world's emerging economies will bring both new opportunities and greater competitive pressures.

Global markets place a premium on the high-value skills, technologies and solutions the UK can offer. Building UK strengths in the production and use of materials like advanced composites will enable us to compete more effectively, as countries with lower labour costs also seek to invest in composites.

Future Growth

According to market experts, the global industry for composites materials is estimated to grow in the mid-single digits in the next five years¹. The two sectors that will drive this growth are anticipated to be aerospace and wind energy, expected to grow by 15.6% and 13.3% each year respectively².

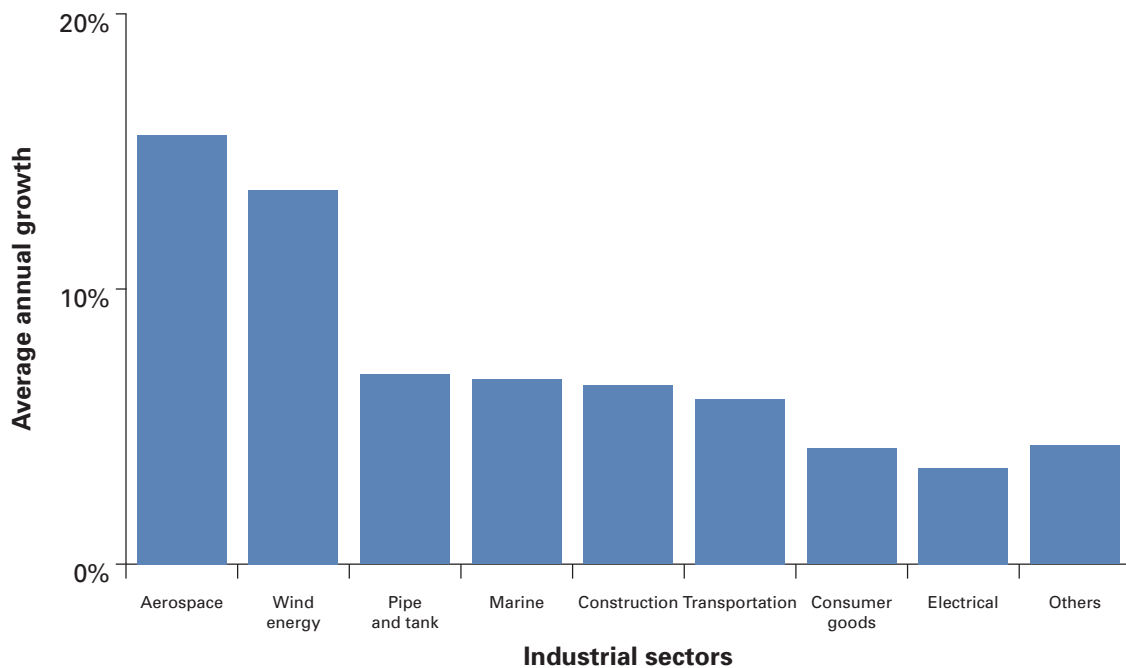
Japan and the USA – Global leaders in carbon fibre composites

Japan and USA are the leading global investors in carbon fibre. Japan is home to the world's top three suppliers of carbon fibre, representing over 70% of global production with its main application sectors being aerospace, automotive, wind energy and industrial equipment.

¹ 'Global Composite Market 2009–2014; Materials, Markets and Technologies', Lucintel 2009.

² 'Global Composite Market 2009–2014; Materials, Markets and Technologies', Lucintel 2009.

Figure 2 – Average annual global growth composite material forecasts by market segment, 2009–2014³



Japanese Government support is mainly through collaborative industrial projects, in particular large-scale demonstrator projects to encourage aerospace and automotive manufacturers to consider composites. These programmes are delivered through Materials and Textiles Directorates (METI) and the Government agency for composites developments (RIMCOFF).

USA producers of carbon fibre, Hexcel and Cytec, have secured almost 15% of global carbon fibre production. Most US Government action is targeted towards the development of space, defence and aerospace applications. For example, the Department for Defense invests a large amount in composites

which is then leveraged for commercial applications.

Europe – Increasing Competition

Our biggest European competitors such as Germany, France and Spain, have also recognised the growth potential in composite materials. The German Federal Government, through the regions, has earmarked funding over the next five years to develop its two composite clusters. CFK-Valley Stade near Hamburg focuses on developing emerging carbon fibre manufacturing processes, including automation. Stade also plays an important role in training composite engineers and technicians. A second centre, the Augsburg centre,

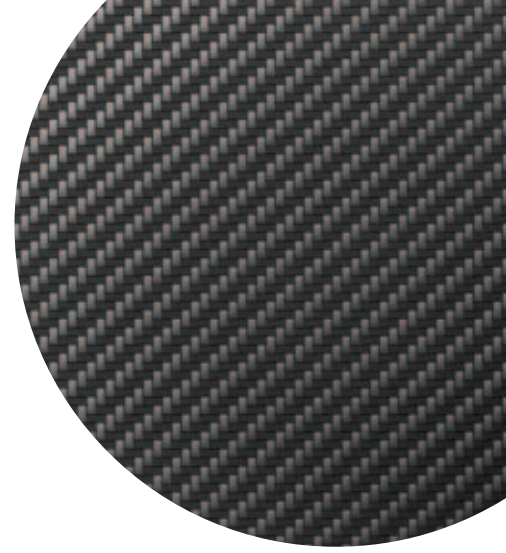
³ 'Global Composite Market 2009–2014; Materials, Markets and Technologies', Lucintel 2009.

concentrates on carbon fibre composite technology.

France is developing several new and existing clusters of composite expertise. The largest cluster, based in Nantes, is undertaking research and development of composite materials, with support from Airbus and EADS. Other clusters include the aerospace centre in Aquitaine, while a new cluster is also being developed in the Moselle region.

Spain is primarily targeting action in the aerospace industry. It has built capability primarily in four clusters. The largest is around Madrid employing 17,000 people. Spain is also a world leader in wind energy and in 2009, the wind turbine manufacturer, Gamesa, announced a joint R&D programme with MTorres, a Spanish machine manufacturer, to work on a new composite-related concept for wind turbine blades.

The UK Industry – The Potential for Growth



Increased competition from emerging economies means that UK comparative advantage will continue to be built around the design and delivery of high-value added goods and services, based on sophisticated technology and skills such as advanced manufacturing. The fragmentation of global supply chains means that many British firms are now more likely to produce and trade in intermediate goods rather than finished consumer products. This is where our strengths in composites may provide pivotal opportunities.

We believe that through investment in automation equipment, combined with UK expertise in design, innovation and technology, British companies can produce cost-effective, world-class composite products – fit to compete with the best in the market.

The Market Opportunity

Several, major sector opportunities exist:

Wind energy, particularly offshore, presents possibly the biggest and most immediate opportunity in the UK. In the Low Carbon Industrial Strategy, the Government earmarked up to £120 million to support the development of a UK-based offshore wind industry. With the potential deployment of up to 29GW of additional offshore wind capacity by 2020, the UK is the single, largest market for offshore wind globally for the foreseeable future. This presents a major opportunity for the UK given the potential demand for bigger, stronger and more durable composite turbine blades.

Wave and tidal energy. The UK's extensive river and coastal resources provide significant opportunities to contribute to our renewable energy mix. Many innovative UK companies are harnessing the latest wave and tidal power technologies, using advanced composite materials, to exploit this opportunity.



In **aerospace**, the growing demand for lower emissions, aligned with advances in composite construction techniques, has led to a significant increase in the use of composites in civil aircraft in the last few years. This is from a base of around 10% to 15% of the structural weight to 25% for the Airbus A380 and 50% for the Boeing 787 and the Airbus A350 XWB. Further advances in design and technology are likely to push this figure higher for the next generation narrow body aircraft.

In **automotive**, as the UK moves towards a low carbon economy, more environmentally-friendly car designs will increasingly seek out lightweight materials, such as advanced composites, to cut fuel emissions and lower running costs. The *New Automotive Innovation and Growth Team (NAIGT)* report by industry refers to the future importance of lightweighting materials for the automotive sector. In the shorter term, as set out above, there is potential to expand the use of composites in low carbon, higher value and lower production volume vehicles such as trucks, buses and other large transport vehicles. In the medium term, the possibility exists to transfer more of this knowledge and skills to higher production volume vehicles.

In **marine**, use of composite materials, using mainly glass fibre and polyester resins, is long established as the main construction material for boat hulls, decks and superstructures in the recreational boatbuilding sector. Marine composites have the proven advantages of function, cost and quality and are used extensively in the UK in production

of boats up to 37 metres long, and in some larger one-off vessels. There are similar applications in commercial and military small craft. Advanced composite technologies are now being explored and applied selectively in the UK boatbuilding sector, including closed mould processes such as resin infusion for hulls and decks and lightweight CFRP opening roof structures in motor yachts. These offer potential for further process efficiency and product differentiation that are essential to sustain the UK competitive position in all marine product segments. Other large scale opportunities for the use of composites exist in marine, especially in topside structures, fixtures and fittings of cruise ships and military vessels.

For some sectors advanced proof of reliability in harsh environments over long periods of time is critical before widespread adoption takes place. However, drawing on our North Sea experience, the UK is well-placed to benefit from the **oil and gas** industry's



future use of composites to rehabilitate corroded steel structures and develop technologies to discover untapped energy reserves off shore, at greater depths.

In **construction**, opportunities also exist in residential and non-residential buildings, and other structures such as bridges. Opportunities for increased use of composites have arisen due to their durability, insulating and high load bearing qualities. The reduced weight of composites relative to many other engineering materials allows composite structures to be fabricated offsite and installed quickly with minimal overall environmental impact, shown by bridges. These qualities also make them attractive as a repair material.

In **satellite** construction, the need to improve thermal stability in orbit is driving the requirement for carbon fibre composite skinned panels. Satellites operate in some of the most extreme conditions known and the UK will need to generate this new advanced manufacturing capability if it is to retain its competitive position in satellite platforms. Industry and Government have launched an Innovation and Growth Team (IGT) for the sector that will address exactly how such UK capabilities can be developed and the economic benefits associated with the manufacturing activity. Further information on our sector capability in composites can be found at this link:

<http://interactive.bis.gov.uk/advanced-manufacturing/composite-strategy-documents/>

CASE STUDY:

Cooney Marine

Kettering-based Cooney Marine now manufactures its *Cobra* dinghy launch system (davit) out of fibre reinforced composite rather than the conventional steel because the composite material provides a stronger and more corrosion resistant structure.

The lightweight *Cobra* system has a safe working load of 400kg and can be colour-keyed to complement the styling adopted by contemporary yacht builders. Technical support from the National Composite Network helped bring the *Cobra* to market.



CASE STUDY:

New Composite Footbridge Installed in Six Hours

In May 2009, a new composite Network Rail footbridge was installed within six hours in Blackpool, Lancashire during a routine rail closure. The composite bridge is expected to last over 60 years and be virtually maintenance free.

The bridge was manufactured by AM Structures Ltd for Network Rail, using Gurit UK's patented Sprint epoxy polymer composite material, resulting in a virtually steel free construction, with each 12m span weighing only 1.6 tonnes. Polymer composite materials offer many qualities that are of particular benefit for structures such as bridges.

They are resistant to corrosion and are very tough, resisting abuse and cracking and chipping. Their lightweight features mean that longer spans are possible as composite bridges have less weight of their own to support. This is helpful, for example, on motorways where a central pillar can be omitted over a 50 metre or more span.



The UK Industry – Delivering World-Class Expertise

Based on the market data available, the UK industry for composites is currently worth £1bn annually in terms of finished parts⁴. We expect this figure could increase significantly in future years as the production of composite components for the new Airbus A350 XWB and the Bombardier CSeries aircraft begins in the UK. Our research indicates the value of the commercial aircraft composite components that are due to be manufactured in the UK will be in the region of £14bn⁵ over the period from 2008 until 2020. This figure, however, could be higher as this excludes the composite components for military aircraft, which we will be producing for the Eurofighter/Typhoon, Joint Strike Fighter and A400M over this period – all of which will contain a significant amount of composite materials.

A significant opportunity also exists in the market for offshore wind turbine blades. The offshore wind market is growing rapidly in the UK and will play an important part in meeting Britain's renewable energy and carbon emission reduction targets. Analysis conducted by the Carbon Trust (2008) has shown there is the potential to install 29GW of offshore wind energy in UK waters

4 *The UK Carbon Fibre Composites Industry*
NetComposites.

5 This figure has been calculated from the discounted sum of the estimated value of the composite parts that are expected to be produced in the UK for Bombardier and Airbus aircraft between 2008 and 2020. It has been calculated based on estimates of the composite content of future Airbus and Bombardier aircraft and on their projected sales and current prices. The discount rate utilised for the figures calculation was 10%.

by 2020⁶, potentially requiring up to £65bn–£75bn⁷ of capital expenditure; £38.35bn–£44.25bn⁸ of which will be accounted for by the wind turbines themselves. As the Carbon Trust estimates 22.5% of the total cost of a typical offshore turbine is attributable to each turbine's blade system, this means blades worth up to £8bn–£10bn would need to be produced between now and 2020 to install this additional capacity, representing a significant market opportunity for manufacturers of wind turbine blades. Furthermore, with such expansion, this sector has the potential to employ a further 40,000–70,000 workers in the UK, bringing annual economic benefits and investment to Britain of £6bn–£8bn⁹.

Although more difficult to quantify there are significant opportunities in automotive, marine, oil and gas, construction and other sectors. To find out more information on the UK composites (carbon fibre) market please see the study BIS commissioned NetComposites to undertake at this link:

<http://interactive.bis.gov.uk/advancedmanufacturing/composite-strategy-documents/>

British expertise in composites stretches back to the 1940s with the first application in aerospace, to its successful use in Formula 1 motor racing in the 1970s and 1980s. We have a strong foundation on which to build. Industry participants believe the UK is the best in the world in

the use of composites for helicopter production and high-end cars. We are also considered a leading power for composites in the manufacture of civil and military aircraft.

Britain's manufacturing base excels in the areas of industrial design, R&D and innovation at the high-value knowledge intensive end of the supply chain. This is evidenced by our work in Formula 1 – the UK is the base to six of the top Formula 1 teams, and also, for high-performance vehicles such as the Mercedes SLR McLaren and Lotus Cars and aerospace. Airbus UK is the acknowledged global leader for the design, development and manufacture of wings for many Airbus products. Bombardier Aerospace Belfast has been selected as the advanced composite wing leader for Bombardier's first composite-winged aircraft the CSeries. The wing is one of the most complex parts of the aircraft. Defining aerodynamic performance, it carries the landing gear and engines, houses the fuel system and carries fuel.

Another major area of UK expertise is in the development of efficient recovery systems that can separate carbon fibres from the polymer matrix in scrap parts, boosting recycling capabilities within this industry. The University of Nottingham is a key research player in this area and UK company Recycled Carbon Fibre Ltd has established links in aerospace with Boeing and Airbus.

6 Carbon Trust (2008) *Offshore Wind Power: big challenge, big opportunity*.

7 These figures have been calculated by the Carbon Trust and represent the discounted sum of the capital expenditure they expect to be required in order to install 29GW of offshore wind capacity in UK waters by 2020. The Carbon Trust used a 10% discount rate in their calculation.

8 These figures are based on Carbon Trust estimates that show that 59% of the capital expenditures required when installing offshore wind turbines are accounted for by the wind turbines themselves.

9 Carbon Trust (2008) *Offshore Wind Power: big challenge, big opportunity*.

CASE STUDY:

GKN plc

GKN Aerospace is a worldwide supplier of composite structures and is at the forefront of aerospace technology. One major programme has been developing automated manufacturing processes for the production of the wing spars (the spine) of the Airbus military transport aircraft the A400M.

Originally the spars had been made by hand which was a labour intensive, slow and costly process. GKN has invested in Automated Tape Layer (ATL) machinery which can put down composite material at up to 50 times the manual rate and at 10% of the cost. The machine can produce spars of up to 14 metres in length of a high and consistent quality. GKN's investment in such machinery makes it possible for it to compete with low cost overseas competition on a quality and technology basis.



British universities are leading academic R&D in composites with considerable success. Of the 40 UK universities working in this area, several are regarded as centres of composites expertise, including Bristol, Manchester, Nottingham, Sheffield, Southampton, Warwick, Cranfield and Loughborough Universities, and Imperial College. The Engineering and Physical Sciences Research Council (EPSRC) currently funds over £50 million of composites-related research at 28 institutions and within their Innovative Manufacturing Research Centres (IMRCs).

EPSRC has recently funded a Doctoral Training Centre (DTC) at the University of Bristol's Advanced Composites Centre for Innovation and Science. This will recruit 50 doctoral researchers over the next five years; the first 10 students of which started in October 2009. EPSRC is additionally funding 60 doctoral studentships through a variety of mechanisms.

Industry and Government through the National Composite Network (NCN), as part of the Materials Knowledge Transfer Network, promotes knowledge transfer in the UK composites industry. The NCN also works with the RDAs and the Devolved Administrations to integrate five Regional Centres of composite Excellence:

- The Composite Structures Development Centre at Airbus UK, Filton, focuses on the technological development of large wing structures, including low-cost, high volume technologies for the wider structural applications of composite materials

- The Composites Research Centre, based at GKN on the Isle of Wight, studies the automated manufacture of complex composite parts for high performance sub-assemblies, particularly wing spars and fan blades
- The Composites NDT Validation Centre at TWI, Port Talbot, assesses the accuracy and consistency of non-destructive testing methods used in manufacturing and construction industries
- The North West Composite Centre is a collaborative venture between the Universities of Manchester, Liverpool, Lancaster, Glyndwr and Bolton. The centre deals with rapid cure, 3D textile lay-up and certification and evaluation.
- The Advanced Manufacturing Research Centre Composites Centre, based at the Advanced Manufacturing Park in South Yorkshire, was created through a partnership between the University of Sheffield and Boeing. It works on the production of small structures containing components made from different materials, as well as drilling, machining and joining composite materials.

The RDAs and Devolved Administrations have been actively involved in promoting UK composite capabilities. Please see the attached link that describes much of this activity:

<http://interactive.bis.gov.uk/advancedmanufacturing/composite-strategy-documents/>

In addition, the Technology Strategy Board's Technology Programme, is

also funding collaborative R&D in this field. Last year the Technology Strategy Board invested more than £71 million in composites-related projects worth over £216 million. This includes the Next Generation Composite Wing research project, led by Airbus and encompassing the input of 18 other companies, the Technology Strategy Board, 9 RDAs and the Devolved Administrations.

New Centres

In Scotland, Spirit AeroSystems has recently opened a new multi-million pound Composite Development Centre focusing on design, product development and manufacture of future aircraft wing structures. We anticipate that discussions will take place to consider how the centre may be linked with other centres of composite excellence in the UK. The creation of an Advanced Composite Research & Technology Development Centre in Northern Ireland is also being discussed.

The North West Composite Centre is establishing a Composites Certification and Evaluation Facility with £8.2m funding from the Northwest Development Agency, University of Manchester and industry. This facility will enable composite testing for companies with limited resources and experience in this industry; the project started in July 2009.

Several UK bodies also offer a source of expertise and support for different parts of the UK composite community. These include the Materials KTN, the NCN,

Composites UK, the British Composites Society and the Institute of Materials, Minerals and Mining.

Barriers to Growth

To help fully realise the growth potential of the UK's composite industry in the years ahead, Government action is needed in partnership with business to overcome barriers and ensure the industry is equipped for success in the future.

The composites industry has a fragmented structure which means that it has less incentive to invest in skills and technology. The structure of the industry consists of SMEs, niche producers and large sector specific manufacturers such as aerospace. SMEs and niche producers individually face challenges in the form of large up-front costs required to develop capital intensive processes and the risk of developing products for potential markets.

Given this, we have identified four issues to be addressed – to identify these, we have worked with major industry players, research organisations and the RDAs:

The industry's fragmentation is leading to a **lack of coordination** across sectors. As a result, most companies perceive themselves as belonging to an industry sector e.g. aerospace or automotive rather than being part of a wider composites industry. In addition, most companies are SMEs and, outside of those with aerospace as their specialism, many struggle to

generate the critical mass needed to boost investment in cost effective rapid manufacturing and other advances.

Knowledge and technical transfer

is also affected between companies and industry sectors by the industry's fragmentation. Measures are needed to strengthen and accelerate the sharing of ideas and technologies throughout our composite industry.

The development of composites demands new **skills** at nearly all levels. Action is required to identify and deliver the right training and qualifications to meet skills gaps and address the specific needs of individual sectors using these cross-cutting technologies.

To increase the **sustainability** of this industry, measures are needed to strengthen recycling processes and develop added-value applications for recycled advanced composite materials to satisfy end of life concerns. In addition, Britain must act to further commercialise and promote its capability to recycle advanced composite materials and drive work on the properties of sustainable composites.

Helping UK industry Succeed

Based on the ability of UK companies to exploit the growth opportunities detailed in this Strategy, analysis of the challenges that exist and the strategic impact Government action can have in these areas, Government is taking the following actions, as summarised in Figure 1 (p5).

Our overall aim is to increase industry adoption of advanced composites and enable British businesses to secure market share quickly and strengthen the UK's global competitive advantage in composites in the years ahead.

To achieve that, Government will be working with industry, trade associations, universities and colleges, the RDAs and the Devolved Administrations.

There have been a wide range of activities that have led to our proposals. The RDAs have provided to BIS a report containing recommendations, BIS has held discussions with UK composite companies and BIS has commissioned a report, compiled by NetComposites, analysing the UK composites (carbon fibre) industry which included interviews with at least 40 of the leading UK

composite companies – see this link for a report on the UK carbon fibre composites market:

<http://interactive.bis.gov.uk/advancedmanufacturing/composite-strategy-documents/>

We also consulted sector representatives and recently held two industry workshops.

1. Strengthening Capability

Provide Leadership

Cohesive leadership will help the UK composite industry foster a business environment that supports growth and ensures effective engagement with Government. It will also increase awareness of the opportunities that composites present and encourage more co-ordinated sectoral spill-over and skills and knowledge transfer.

Working with the industry, Government will establish a new **Composites Leadership Forum**. This will be chaired by a BIS Minister and involve key

composite companies and industry stakeholders.

The Leadership Forum will:

- Help provide strategic direction to the UK composite industry and identify key actions to enable it to grasp the commercial opportunities the global shift to light weighting provides
- Encourage the development of new industrial collaborations and the development of supply chains and networks
- Encourage and provide direction to the national development of new manufacturing processes and materials
- Monitor delivery of the commitments in the Composites Strategy.

The Forum is intended as a short term activity so we will review its work after two years and decide how it should proceed further.

Increase Awareness in the UK and Overseas

Greater awareness of UK strengths and capabilities in composites will help the Government, working with UKTI and the RDAs, to promote the UK industry overseas and attract foreign investment, potentially including carbon fibre and manufacturing equipment suppliers.

BIS will coordinate the following activities:

- UKTI already promotes the UK's Advanced Engineering sector overseas, helping to bring valuable inward investment into the UK and

help British companies, of all sizes, to win business across the world. UKTI has identified composites as a key priority for this work and will work with BIS, RDAs, other Government Departments such as the Department of Energy and Climate Change, and industry to map, grow and market the UK's capability in composites. This work will target increased Foreign Direct Investment in this specific industry, and the UK industry as a whole and help UK companies take advantage of this growing global market through trade opportunities. In addition, up-to-date information and business intelligence from mapping the UK's supply chain and capabilities will be used to analyse more fully potential supply chain issues such as Intellectual Property and security of material supply, and identify future challenges and opportunities

- The new National Composite Centre (see below) will lead the co-ordination of a strengthened network of regional centres of composites excellence and will work with them to co-ordinate technology transfer across regions through sign-posting, identifying and facilitating mentors from experienced companies, and arranging technical based workshops and seminars. This work will be undertaken in conjunction with the NCN. The new network will maximise the impact of support for rapid manufacturing technologies and cross-sectoral coverage, and also help to avoid unnecessary duplication of support

- RDAs, with BIS involvement, will work together with the network of centres of composites excellence to strengthen the UK's composites supply chain. With funding from RDAs of £0.5m over the next two years, this new support for the composites supply chain will include promotional material and events to raise awareness of the potential applications of advanced composites materials and market opportunities, and specific support to help key companies to develop their knowledge of and capabilities in composite materials.

Develop UK Skills

To build a globally successful composites industry, UK businesses require skilled workers and expertise at nearly all levels. Action is needed to assess skills needs and develop training to meet them, help companies across the UK supply chain to identify and access relevant training, encourage more investment in work-based training and development and attract qualified workers into this industry. Ensuring better skills should lead to faster growth in those sectors, such as marine, that are currently behind more advanced sectors such as aerospace and automotive.

Skills are a devolved matter but the Sector Skills Councils (SSC) and the UK Commission for Employment and Skills (UKCES) have a UK-wide remit. Composites are within the scope of two SSCs – Semta and Cogent. Semta is responsible for the manufacture of the equipment, components and tools that

either use or are associated with the use of composites. Cogent is responsible for the manufacture of composites.

To ensure a coherent and coordinated approach to tackling the sector's skills needs, **Semta** and **Cogent** are entering into a **partnership agreement**:

This agreement will help to:

- Quantify demand for skills with Further Education, Higher Education and accredited qualifications
- Coordinate initiatives and identify best practice on school and Further Education
- Develop and implement a coherent strategy for approaching and influencing Higher Education on behalf of employers
- Ensure appropriate provision through the Semta and Cogent Skills Academies for increasing skills and training in the existing workforce and
- Draw up a joint Action Plan to address the key issues. This will include setting up a representative group of composite employers to lead the development of a skills strategy, building on the work that has already been done, for example under the South West Composites Gateway initiative (see below).

The NCN paper sets out in more detail the skills challenges and the elements to be covered in the action plan at this link:

<http://interactive.bis.gov.uk/advancedmanufacturing/composite-strategy-documents/>

The **new National Composite Centre** will include a training facility working with public and private sector training providers to provide a learning resource focusing on advanced and specialist composites technologies.

Using funding from the Learning and Skills Council and the European Regional Development Fund (ERDF), the **Composites Gateway project** is bringing together industry and training providers to identify future demand and the curriculum content needed to meet it. Courses are being developed to deliver:

- Higher level apprenticeships for both skilled staff converting from conventional materials and young apprentices. This could extend to units in undergraduate engineering and science programmes
- Industrial short courses, providing 2–5 day modules on emerging composite technologies and
- Continuous professional development for academic and education staff to disseminate developing technology.

As one of the key sectors identified in the *New Industry, New Jobs* strategy, the composites industry will benefit from the measures set out in the Government's skills strategy for England, ***Skills for Growth***, published on 11 November and ***Higher Ambitions: the Government's new framework for HE***, published on 3 November, to give new priority to programmes that meet the need for intermediate and higher level skills in key sectors. The Government's overarching ambition

is for three quarters of people to undertake higher education or complete an advanced apprenticeship or equivalent technician level course by the age of 30.

The apprenticeship programme can make a significant contribution towards remedying the shortage of skilled technicians. The composites sector will be one of those benefiting from the additional 35,000 additional advanced apprenticeships available for 19–30 year olds over the next two years.

More of the adult skills budget will be focused on areas of the economy which can do most to drive growth and jobs. A Joint Investment Scheme of up to £50m with a cash match from employers will be piloted by SSCs. Both of these measures could benefit the composites sector.

The Higher Education Funding Council for England (HEFCE) will be consulting on how to implement enhanced support for the relevant skills and direct a greater share of funding to those universities who can best respond to the evolving economic challenges. The Composites Leadership Forum, outlined earlier, will help to shape the outcome of that debate.

Higher Ambitions also contained proposals for bringing together higher education institutions, employers, SSCs, and sectoral experts in High-Level Skills Market Teams to focus customer demand for high level skills and accelerate the response from universities to meet that demand. We will also work with the relevant SSCs

to look at how this model can help to address skills needs in composites.

To identify the composites jobs and skills needs for the longer term, the UKCES and Skills will work with SSCs and advise Government on sector trends and skills needs. The HEFCE science, technology engineering and mathematics (STEM) programme launched in August 2009 will help to deliver a sustained increase in STEM graduates and raise aspirations among young people to study science subjects at university. The composites sector will benefit from this initiative.

EPSRC currently sponsors 60 doctoral studentships in composites-related research. Many of these students will work closely with industry, providing an effective route for knowledge transfer.

EPSRC will make additional investments into composites-related post-graduate training. The most relevant is the centre at the University of Bristol's Advanced Composites Centre for Innovation and Science, which will look to recruit 50 doctoral students, from a range of engineering and physical science backgrounds, over the next 5 years.

In Wales, the workforce for composites across the 80-plus identified composites businesses is difficult to estimate but is probably in the region of 1,500–2,000 in total today. This number will increase over the next three years as a sizeable proportion of the workforces at the Maintenance, Repair and Overhaul (MRO) operators and supply chain will need to be trained in composites manufacturing, maintenance and repair. This will provide a critical mass within

Wales for training in skills related to composites.

Wales has made a commitment to increase the number of places for apprenticeship training over the next three years which will include composites training where appropriate.

The Welsh abolition of the upper age limit for apprenticeships has already enabled a broader range of people to benefit from the programme.

In Scotland, the Scottish Funding Council (SFC) has provided an additional £5m for this academic year to support STEM. In addition, the SFC and Skills Development Scotland have a joint Skills Committee responsible for enhancing the match between supply and demand for higher skills in all sectors, including composites.



2. Building Capacity

Rapid Manufacturing

One of the key technological advances required in a range of industrial sectors is the ability to manufacture composite parts at the size, quality and rates required on a cost effective basis; no country has as yet fully developed this capability. Developing this capability will improve product consistency and reduce both tooling and labour costs, but will also increase the need for specialist skills. If the UK succeeds in this challenge it will gain competitive advantage, and help drive the use of advanced composites in more sectors and enable the UK to maintain its competitive position in existing sectors.

For these reasons, the Government will invest £16m to set up a **National Composite Centre**, which will co-ordinate and build upon the capabilities of the NCN regional centres.

This Centre will be a collaboration with South West RDA and the University of Bristol. So far Vestas, Airbus UK, GKN and Rolls-Royce have agreed to participate in the centre. We anticipate that other companies and universities, particularly in other sectors, will join this venture. The National Composite Centre will be based in Bristol.

This Centre will provide manufacturing facilities at an industrial scale, capable of building prototypes to validate design concepts and rapid manufacturing processes. This centre will have a cross-sectoral focus.

The Centre will help:

- Facilitate the implementation of rapid manufacturing technologies and systems across UK regions
- Play a full role in coordinating the UK network of composite centres of excellence and collaborate with these and other technology providers to give comprehensive support to high value-added manufacturing industry
- Help to develop the skills needed in cost-effective rapid manufacturing.

In addition, the Technology Strategy Board will launch a **Grand Challenge in Affordable Composites Manufacturing** to stimulate innovative solutions for cost effective rapid manufacturing. BIS has allocated an indicative amount of £6m to fund this investment.

The objective is to provide a stimulus by awarding a prize of up to £5m for the most promising solution that will lead to the greater uptake of advanced composites, across a range of market sectors through the development and demonstration of step-change manufacturing technologies that allow the more cost-effective and rapid production of high performance, high value products. For industry, this offers the chance to become world class in cost-effective rapid manufacturing.

Emphasis will be on solutions that can be applied across more than one sector to take advantage of their high strength and stiffness, exceptional strength-to-weight ratios, dimensional stability, improved fatigue strength and impact resistance, and corrosion resistance. The ability to manufacture

complex components reliably to high quality will be a key metric. Design for manufacturing development activities will be within scope provided that they are part of a fully integrated manufacturing programme. Related issues such as, for example, Non-Destructive Evaluation (NDE) and joining, including to metallic components, are not directly within the scope of this programme, but should be considered in the context of the viability of proposed manufacturing processes.

Funding will be available for the best proposition from an industry-led consortium to develop innovative propositions and a prize fund of £5m will be awarded to the winning consortium.

Further details of this can be found at this link where the Technology Strategy Board outlines the challenge process in more detail:

<http://www.innovateuk.org/deliveringinnovation/forthcomingcompetitions.ashx>

3. Increase Sustainability and Recycling

To ensure the sustainability of this industry, increase uptake and secure the future use of advanced composites, measures are needed to improve recycling processes, develop added-value applications for recyclate or re-using composites, and to address the lack of suitable, environmentally-friendly composite materials.

Government will establish a consortium of organisations initially including GKN,

Airbus, Bombardier, Umeco Composites Structural Materials, Recycled Carbon Fibre, the British Plastics Federation, DEFRA, the Technology Strategy Board, and the EPSRC that will work with a leading university (Nottingham) to address sustainability challenges, determined primarily by UK industry.

The Group will:

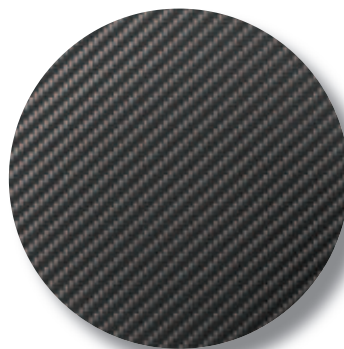
- Help provide continued industry investment in improved and more cost effective recycling methods at demonstration scale
- Consider possible funding of additional studies on the applications for recycled fibres to support businesses in this industry
- Consider future interventions to ensure increased recycling/recovery processes relevant to composite parts
- Conduct gap analysis to understand the current situation on recycling and industry's requirements.

Improving recycling processes and developing new applications for recyclate will signal to users of composites that sustainability issues are being addressed and ultimately encourage greater usage.

The benefit of this approach is that it will provide an industry focus to existing work and will coordinate funding, which is currently being spent on a diverse range of recycling research activities. Ultimately by building on existing world leading expertise UK industry needs will be met and the UK will create and develop a commercial opportunity to be exploited internationally.

**We want to thank the
following for their contribution
to our Strategy:**

AgustaWestland
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British Plastics Federation
CBI
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Clipper Windpower
Cooney Marine
Devolved Administrations
EEF
EPSRC
GKN plc
Gurit UK
Inter-Agency Composites Group
Lucintel
Merl Ltd
National Composites Network
NetComposites
Regional Development Agencies
Society of British Aerospace Companies
Solent Composites Systems Ltd
Technology Strategy Board
TUC
TWI



<http://interactive.bis.gov.uk/advancedmanufacturing>

We will work closely with the Devolved Administrations in Northern Ireland, Scotland and Wales, recognising their particular and varying responsibilities. While some of the policies in this Strategy are specific to England, the challenges are common across the four countries of the United Kingdom. Each will consider the most appropriate arrangements in those areas for which they have devolved responsibility, to address the issues in ways that meet their own circumstances and needs.