Open consultation - UK Advanced Materials: Call for Evidence
Response from the Composite Leadership Forum (CLF)

Executive Summary

The UK's world-leading science, engineering and innovation skills come together in our composites sector: a vibrant ecosystem expert at tackling real-world problems. This response to BEIS' Advanced Materials Consultation is provided by the UK's Composite Leadership Forum, a partnership of industry, academia and supporting organisations that provides an independent, pan-technology and cross-sector view of the challenges, opportunities, lessons to be learnt internationally, strengths and gaps for the UK's composite industry.

Key points to be taken away:

Net Zero

- Composites are an essential part of the plan to deliver NetZero. For example, wind turbine blades, hydrogen pressure vessels and low carbon electric/hydrogen aircraft, in the potentially-enormous, advanced air mobility market, cannot be produced without composites.
- 70% of the total embodied emissions in manufactured products reside within the materials that are used in making the product. International collaboration and support are needed to develop material-agnostic life cycle analysis measurement techniques and a database of verifiable materials data to facilitate uptake of new lower embodied carbon materials. There is also an opportunity to ensure we have world-leading UK-based production of low embodied carbon materials.

Resilience

- Materials are at the sharp end of resilience planning. Without a source of composite materials, there is no manufacturing and no products such as wind turbine blades, hydrogen pressure vessels, aircraft wings etc.
- Currently no one has an understanding of the future composite material supply chain requirement to deliver key Government policies such as NetZero.
- Given that global requirement for carbon fibre is predicted to out-strip global capacity by 2025 [2], the UK stands the very real risk of having blade factories standing idle due to an inability to source the carbon fibre needed which puts the headline requirement to achieve 40GW of offshore wind by 2030 at real risk.

Industry Growth

- Global demand for composites is growing by 6- 8% CAGR until 2030.
- In the CLF's 2016 strategy the UK Composites Industry was predicted to grow to £12.5 bn by 2030. Taking into account the demand now expected be made on the Industry by NetZero requirements, this is expected to be significantly higher.
- The UK is world leading in research into composite materials but often fails to secure commercialisation of these ideas in the UK, thereby stifling industry growth, due to lack of funding through the innovation valley of death (TRL4+).
- The UK is world-leading in design and production of composite aerospace structures. Support is needed to take advantage of the Advanced Air Mobility market, predicted to be $510bn globally by 2040 [8].
- Increased industry recognition of the need to recycle means composite Industry growth will be stifled without support to develop a cross-sector recycling supply chain.

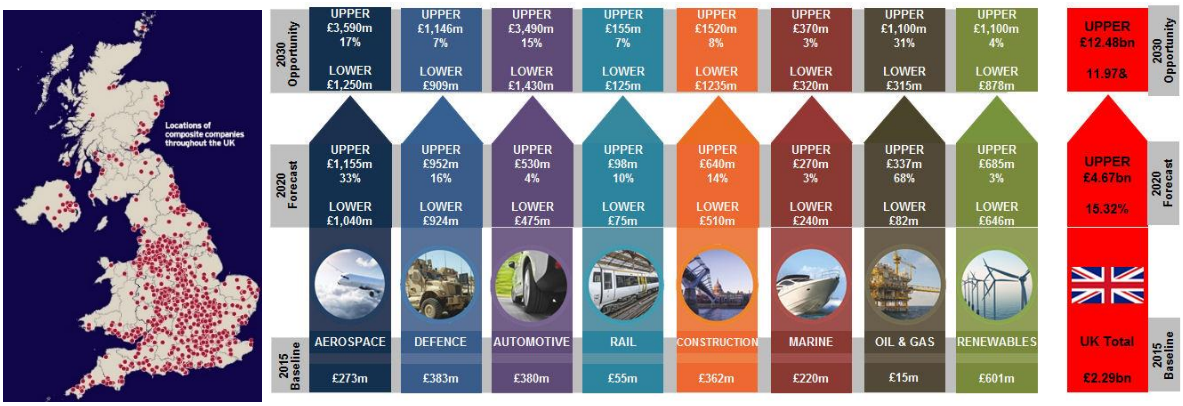
About the CLF

The CLF is the voice of the UK composites industry, leading strategy development and delivery. It is a partnership of industry, academia, funding bodies and supporting organisations, with Composites UK the trade association providing Secretariat, that works together to support the UK composites industry ensuring growth and industrial success for the UK. As such it can provide an independent, pan-technology and cross-sector view of the strengths, weaknesses and requirements of the UK's composite industry.

This response to the consultation is compiled from responses received by the CLF from organisations across the composite materials supply chain combined with the inherent knowledge the CLF has regarding the UK's composites sector.

About the UK Composite Sector

The UK has world-leading science, engineering and innovation skills that come together in our composites sector: a vibrant ecosystem of large and small firms, regionally distributed, expert at tackling real-world problems. Composites UK's database of companies in the UK composite supply chain [1] identifies around 1500 companies scattered across the UK (Figure 1a). Market data produced as part of the CLF's 2016 strategy, which focused on increasing productivity of the sector, predicted a UK composites market worth of £12.5bn by 2030 (Figure 1b). This is taking advantage of predicted global growth of the composites sector of between 6-8% depending on the region. A UK strategy refresh is underway to address opportunities and challenges presented by the move to NetZero, and we are confident that the 2030 UK composites market value will be significantly higher than the 2016 strategy predicted.



a) UK Composite Companies

b) UK market predictions from CLF's 2016 strategy.

Figure 1: UK Composites Sector Data

Responses to Consultation Questions

Question 1. Are there any challenges and/or opportunities for UK Advanced Materials?

Challenges:

One of the key challenges for the UK composite sector is the hollowing out of the supply chain and the lack of UK-based production of constituent and intermediate materials. This provides UK composite part producers with major issues in terms of guaranteeing supply and importing increased costs, with the combined result of reducing the competitiveness of UK-produced composite parts.

Carbon fibre is the constituent material that is cited most often as a supply issue. The UK produces only around 3% of the world's supply of carbon fibre and all of this exported which meant that in 2019, pre-pandemic, the UK imported carbon fibre worth in excess of £233m. The Advanced Propulsion Centre predicts that by 2035 the UK will require 11,000 tonnes of carbon fibre per year just to produce pressure vessels for the growing hydrogen supply chain. This is 9% of current global carbon fibre capacity and could be worth £176m/year. This makes conservative estimates of the amount of carbon fibre required each year to deliver the 40GW of wind turbines required in the UK by 2030, of 1500 tonnes/year (£19.5m), look small by comparison. Given that global requirement for carbon fibre is predicted to out-strip global capacity by 2025 [2], the UK stands the very real risk of having the £186m blade factory being built by Siemens and its projected 1,000 employees standing idle due to an inability to source the carbon fibre needed to deliver their 108m blades. More importantly it puts the headline requirement to achieve 40GW of offshore wind by 2030 at real risk. Materials are at the sharp end of resilience planning. Without a source of materials, there is no manufacturing and no products. In February 2021, the Biden Administration commissioned a 100-day review to address vulnerabilities in the supply chains of four key products. This included critical minerals with the following statement showing the level of importance afforded by the US to carbon fibre [3]: "Critical minerals are an essential part of defense, high-tech, and other products. From rare earths in our electric motors and generators to the **carbon fiber** used for airplanes—the United States needs to ensure we are not dependent upon foreign sources or single points of failure in times of national emergency." Efforts to build UK capability in this part of the supply chain through foreign investment have been hampered by a lack of understanding of, and support for, the importance of a UK-based materials supply chain to deliver on NetZero targets, and the carbon fibre risk highlighted above is a prime illustration of this.

According to the High Value Manufacturing Catapult, embodied emissions in manufactured products account for up to 43% of the total UK consumption emissions and approximately 70% of the total embodied emissions in manufactured products reside within the materials that are used in making the product. As the world reduces the level of at-source CO2 emissions through, for example, a move to electric propulsion in transport, there will be a move away from legislation just monitoring CO2 emissions to include the CO2 produced, or energy consumed, during material or part production (embodied emissions). This requires life cycle analysis (LCA) to be performed on everything produced from constituent materials through to finished parts. Without a UK strategy that links into efforts across other nations to develop material-agnostic LCA measurement techniques and a database of verifiable materials data, new innovative materials will be ignored by potential users in favour of better-understood legacy materials because of the financial penalty associated with developing LCA data for these new materials. Furthermore, importing constituents of composite materials produced in countries with CO_2-intensive energy sectors runs the risks of having customers reject the CO_2-intensive resultant part. Producing the material in the UK from renewable energy mitigates against this future risk.

The composites sector also faces a serious challenge with recycling. The wind blade sector is the most public face of this issue. Austria, Finland, Germany, and the Netherlands already have landfill bans in place for composite blades with a Europe-wide voluntary ban proposed by 2025 [4] and 52,000 tons of blades waste is predicted to exist by 2050 in Europe, and more than two million tons in the U.S. by 2050 [5]. Recycling technologies are now emerging but there is not yet a supply chain in place to enable the material recycling of all composite materials across all sectors that will be required by 2030.

The composite community, along with the rest of the materials sector, also suffers from the lack of support to translate the UK's excellence in academic research into commercial success. The absence of any support for TRL4+ materials-focused research to either develop new materials ideas into commercial reality or apply new materials across a range of industry sectors, means that companies often seek to exploit UK-developed materials research overseas where such support is more forthcoming.

Composite materials are often used to reduce the weight of parts and in doing so replace materials that have been used, in some cases, for decades. When seeking to design the new composite parts, a challenge often encountered is that the design protocols and associated standards for the part were written based on the assumption that the part was made from the original material and the testing required is not appropriate for composite materials. This requires re-writing of standards, which is a costly and lengthy procedure and until this is done, the composite product cannot be designed. BSI work closely with the composites industry to understand where issues will be arising, one good example being their report on lightweighting the transport sector [6], but progress with re-writing or up-grading of standards is always restricted by limited budget and therefore slow.

Finally, as with many engineering-based sectors, the composite materials sector faces a huge challenge in terms of recruitment. A trend for materials departments in universities to be merged with other engineering departments has resulted in fewer materials engineers graduating, and a lack of composite-specific information in courses adds to this problem. Add to this the growth of the sector and a historical reluctance by companies to spend time and money on training, believing they could just buy in materials knowledge, and we have the current situation where there is a deficit in composite engineers. The situation is similar globally, meaning UK companies cannot solve the problem simply by looking overseas.

Opportunities

The UK's commitment to achieve NetZero by 2050 will require new products, redesign of existing products and entire new supply chains. The CLF has outlined how the UK cannot achieve this 2050 Net Zero target without composites [7], providing drivers for increased use of composites in existing and new applications. Composites facilitate lightweight planes, cars and trucks to extend electric-powered ranges. Wind turbine power output is increased through increasing blade size, which can only be achieved through the use of composite materials which provide the required strength and stiffness at minimal weight. Pressurised storage of hydrogen for the emerging hydrogen economy at minimal weight also requires the use of composites.

The Advanced Air Mobility (AAM) market, which seeks to deliver electric and hydrogen-powered passenger air vehicles for intra-city, inter-city, personal and emergency/parapublic transport, is predicted to reach a value of $510bn globally by 2040 [8]. The UK is expected to be amongst the first countries to adopt this capability and the AAM aircraft currently being designed make extensive use of composite materials. The UK's world-leading capability in design and production of aerospace structures from composites (see question 3) provides an opportunity to secure manufacture of these aircraft in the UK. However, without support and incentives to understand and secure the benefits of UK-based manufacture, these companies will pay for the UK's design and production know-how and then build manufacturing facilities, with their associated jobs and supply chain growth, elsewhere. Developing a vibrant AAM manufacturing industry in the UK on the basis of our composite capability would also result in a less devastating loss of capability if Airbus finally bowed to pressure from other European countries to build its next generation of composite wings outside the UK.

In the area of ceramic matrix composites (CMCs), which are able to withstand extremely high temperatures, the UK has the opportunity to increase expertise and supply chain to deliver to applications including nuclear fusion and fission, aerospace propulsion, defence and space.

While supply of constituent materials such as carbon fibre is listed as a challenge, as we seek to address this challenge there is also the opportunity to put in place a roadmap to ensure that the materials we will use in the future will be more environmentally-friendly, with lower CO_2 emissions, and/or more sustainable. Work is ongoing to attract material production companies with world-leading environmental credentials to the UK.

Question 2. What lessons, if any, from other countries and companies could we learn from?
Germany featured often in responses to this question. It was felt that Germany recognises the importance and value in developing an onshore/in-country manufacturing capability and supply chain for composite materials to be used in key future manufacturing sectors and/or to meet key net-zero requirements. Comment was also made that they are advanced in their understanding and application of methods and data for calculation of the LCA of composites and other materials.

The US is described as actively recycling and reusing recycled carbon fibre cross-sectorially in a highly commercial way, something the UK has yet to achieve. The White House has also instigated the previously mentioned supply chain vulnerability review which includes analysis of US-based carbon fibre production in line with future requirements.

The UK is at odds with many other leading nations, such as the US, Japan and China (to name three), all of whom prioritise access to materials very highly. Those countries recognise that access to advanced materials such as composites drives economic and military success.

Comment was made that the UK should take time to understand what other countries have discovered and identified as priorities and work together. A case study could be Innovate UK's composite mission to the US in 2018 [9] which resulted in seven collaborative research projects between the UK and US jointly funded by Innovate UK and IACMI in the US to work on areas of priority for both countries [10].

Question 3. What are the strengths of UK Advanced Materials?
Almost every response the CLF received pointed to the UK's excellence in academic research and innovation in composites supported by initiatives such as CIMComp [11] and the 7 centres of the High Value Manufacturing Catapult. However, both of these organisations focus on support to companies to develop new end-use parts or products using composites. This focus needs to be matched with a capability to support manufacture of the constituent materials for composite products. Initiatives overseas, such as France's project FORCE [12], are already pulling R&D funding from UK-based material suppliers out of the UK and could lead to future investment in materials manufacturing outside the UK as well.

The UK is world-leading in design and production of composite aerospace wings. Our capability in the design of composite wing structures secured UK-based production (Broughton) of the wings for Airbus' A400M, A380 and A350. Similarly design and production capability brought production of (the aircraft then named) Bombardier's C-Series composite wing from the expected location in Canada to Belfast in the UK. This aircraft has since been acquired by Airbus and renamed the A220 and, until the Russians get their MS-21 aircraft certified, it is world-leading having the only certified composite wing produced from infusion technology. As mentioned in question 1, taking advantage of the growing AAM market to grow UK composite airframe production capabilities could mitigate against the risk of failing to gain production of Airbus' next generation composite wing.

Question 4. Are there any specific gaps in UK Advanced Materials capability that you would like to share?
As already fully described in the responses to the previous questions, the UK suffers in particular from a lack of constituent material producers (in particular carbon fibre) and of an adequately-developed recycling supply chain. It also needs the remit of the HVM Catapults to be extended to include research on manufacture of the constituents of composite materials, not just on their application into products. These are critical gaps in the UK's Advanced Materials capability that must be addressed quickly to ensure that the UK secures the majority of the huge potential value in the

composite supply chains needed to meet the UK's net zero targets and ambitions over the next 10-30 years.

Conclusions

Key points to be taken away:

Net Zero

- Composites are an essential part of the plan to deliver NetZero. For example, wind turbine blades, hydrogen pressure vessels and low carbon electric/hydrogen aircraft, in the potentially enormous, advanced air mobility market, cannot be produced without composites.
- 70% of the total embodied emissions in manufactured products reside within the materials that are used in making the product. International collaboration and support are needed to develop material-agnostic life cycle analysis measurement techniques and a database of verifiable materials data to facilitate uptake of new lower embodied carbon materials. There is also an opportunity to ensure we have world-leading UK-based production of low embodied carbon materials.

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- Given that global requirement for carbon fibre is predicted to out-strip global capacity by 2025 [2], the UK stands the very real risk of having blade factories standing idle due to an inability to source the carbon fibre needed which puts the headline requirement to achieve 40GW of offshore wind by 2030 at real risk.

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