Tim Young

NCC Chief Technologist – Materials
UoB Industrial Professor

NATIONAL COMPOSITES CENTRE
Bristol Composites Institute
University of BRISTOL

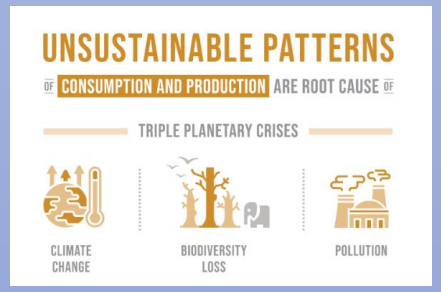
Advanced Materials & Sustainability – a perspective

To start: Sustainability

UN Sustainable Development Goals [4]

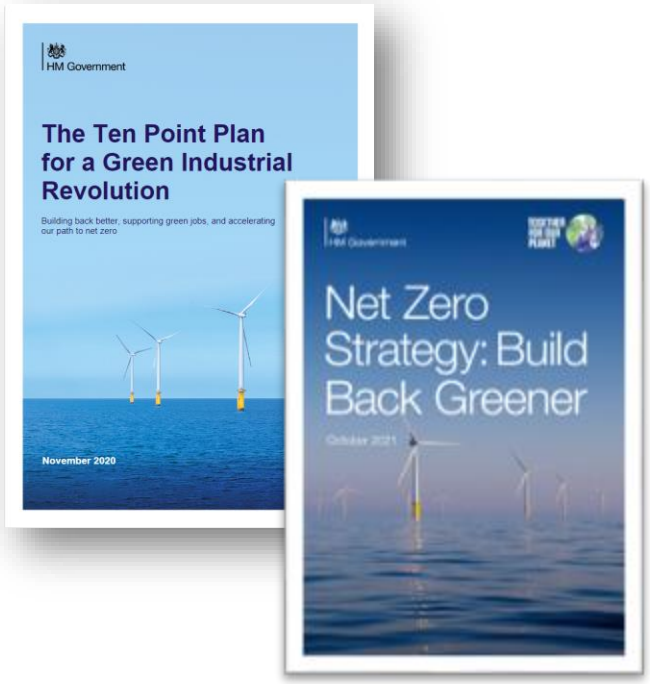
SDG 12 Responsible Consumption and Production

Ensure sustainable consumption and production patterns



SDG 13 Climate Action

Take urgent action to combat climate change and its impacts



[1] https://www.ipcc.ch/sr15/chapter/glossary/
[2] https://commonslibrary.parliament.uk/net-zero-emissions-a-new-uk-climate-change-target/
[3] HM Government, Department for Business, Energy & Industrial Strategy, Prime Minister's Office, 10 Downing Street, (18 November 2020), '*The Ten Point Plan for a Green Industrial Revolution*' [Online]. Available at: https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution (Accessed 02 February 2021)
[4] https://sdgs.un.org/

The UK has high quality research institutions and innovative firms. The UK produced 57% more academic publications than the US and six times more than China, in per capita terms, in 2020, and is a world leader in field-weighted citation impact (FWCI),[3] a benchmark for research quality.[4]

The Industrial Strategy will focus on the sectors which offer the highest growth opportunity for the economy and business. Eight growth-driving sectors have been identified: Advanced Manufacturing, Clean Energy Industries, Creative Industries, Defence, Digital and Technologies, Financial Services, Life Sciences, and Professional and Business Services. In the next stage of development of the Industrial Strategy, the Government will prioritise subsectors within these broad sectors that meet our objectives and where there is evidence that policy can address barriers to growth. Ambitious and targeted Sector Plans will be designed in partnership with business, devolved governments, regions, experts, and other stakeholders, through bespoke arrangements tailored to each sector.

The UK has a world-leading track record of decarbonisation. Underpinned by the world-leading Climate Change Act, the UK was the first major economy to halve its emissions, cutting them by 50% between 1990 and 2022, while also growing the economy by 79%.[8] The Institute for Public Policy Research suggests that the UK is already world-leading in making one in three products vital to the Net Zero transition,[9] and there is evidence that clean technology specialisms are spread across the UK.[10] The Clean Energy Mission will

EU Advanced Materials Strategies

“ Today, we are proposing a strategy for a joint action in the EU to boost our position in advanced materials, a key technology area for the future of our industries. This strategy will create new opportunities for EU companies and will equip Europe with the necessary infrastructures and skills to remain a strong player on the international scene. This is crucial for our competitiveness, open strategic autonomy and economic security. ”

Iliana Ivanova, Commissioner for Innovation, Research, Culture, Education and Youth

Horizon Europe, aiming at €500 million of investments for 2025-2027

“ The EU’s competitiveness relies on our technological edge and steady supply of advanced materials for our green and digital transitions. We must both support the development of these materials and deploy them efficiently in a sustainable way. Having listened to industrial stakeholders and national authorities, we are proposing a way forward that is beneficial to our long-term economic resilience. ”

Margrethe Vestager, Executive Vice-President for a Europe Fit for the Digital Age

https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1121

Advanced Materials: key to Net Zero

Net Zero UK current emission stats

24 % Transport
- Road Transport, Railways, Domestic aviation, Shipping, Fishing, Aircraft Support Vehicles

21% Energy
- Fuel combustion (Gas/Coal), Nuclear, Renewables

18% Business
- Combustion in industrial/commercial, industrial off-road machinery, refrigeration, aircon

16 % Residential
- Fuel combustion for heating & cooking, aerosols, inhalers, garden machinery

11% Agriculture
- Livestock, agricultural soils/fertiliser, stationary combustion, off-road machinery

9 % Other
- Waste management, industrial processes (cement, ammonia, lime), public buildings

Key Trends

Energy use
- Storage (H2, Electric)
- Transportation (H2)

Infrastructure

Carbon capture

Energy creation
- Wind & renewables
- Nuclear & fusion
- Alternative fuels

Reduction / Optimisation
- Insulation (new & retrofit)
- New heating systems
- Process optimisation, e.g. manufacturing

Products from natural resources
- Bio-fuels
- Methane/hydrogen
- Natural feedstocks (e.g. bio-polymer, lignin)

Enabling products from waste
- Recycled product / materials / fuels
- Coal offsetting (plastics in cement kiln)

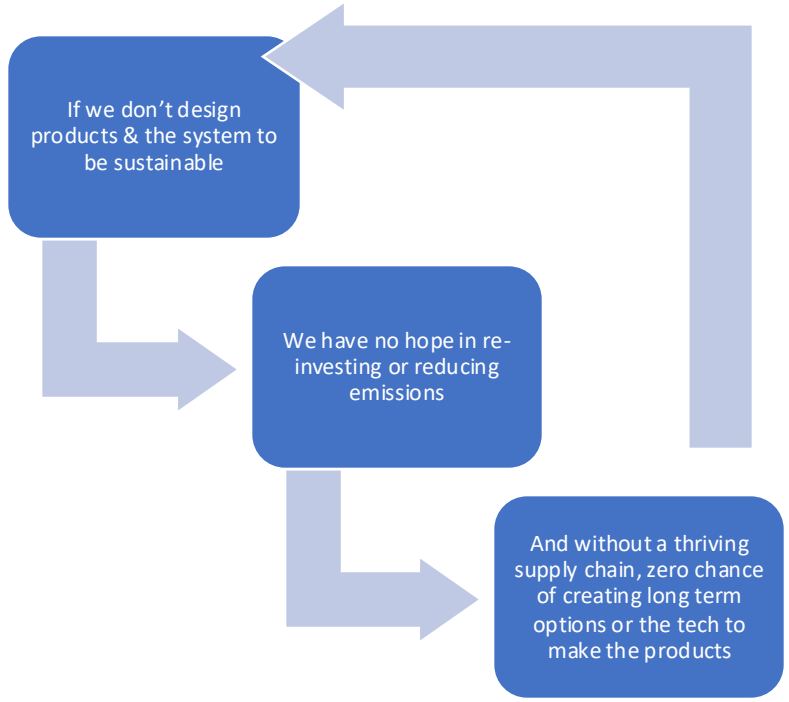
What does that mean?

Delivering sustainable product designs

Reducing impact, optimisation and adoption of state-of-art

Enabling products from CC, waste & natural resources

Cost of inaction



Key stats

Composites market > $70 Bn (Global) $4Bn (UK)

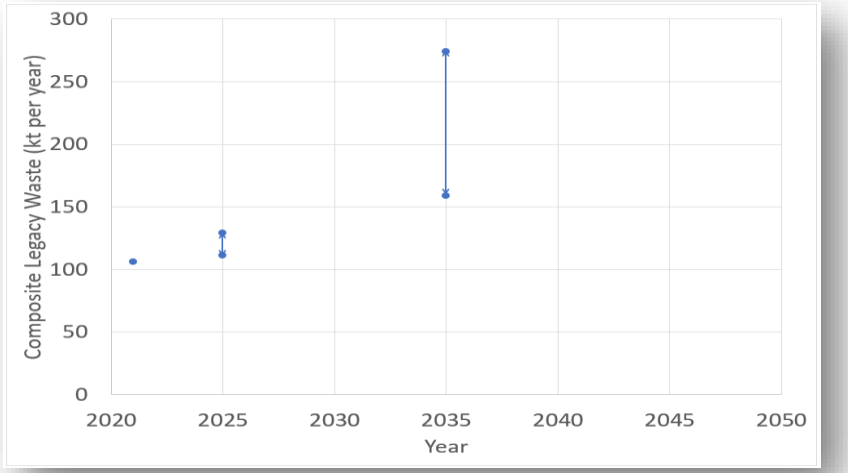
Carbon Fibre market = $4.7 Bn (Global)

Carbon Fibre Global Demand / Production Capacity = 113.8 kt / 170 kt (2022)

Key Material for

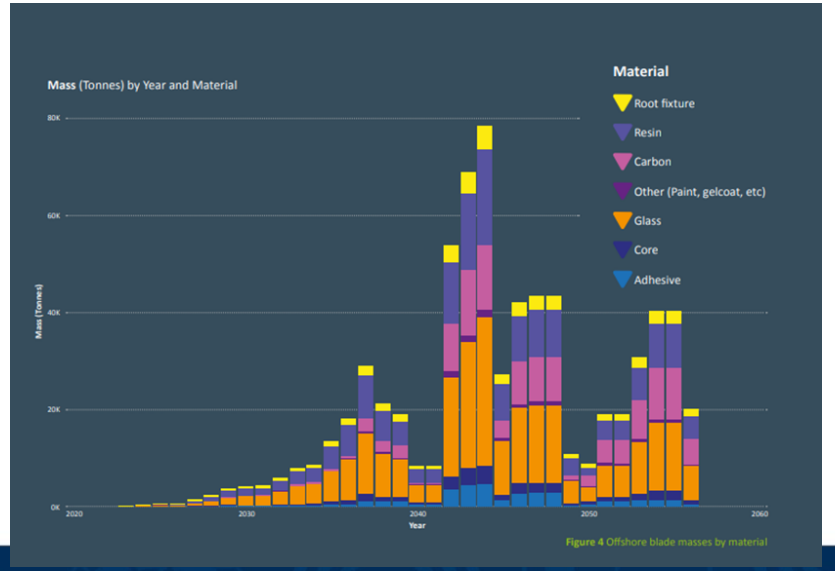
- 100 Bn renewables market with 250k jobs
- £35 Bn aero,
- £18.6 Bn auto } with 430k jobs combined
- £10 Bn Rail
- 110 Bn construction market
- £78 Bn Defence market with 370k jobs (1).

UK Composites Waste forecast



From "*Composite Waste Assessment*" Dave Greenhill NCC Document Unpublished 2022

UK Offshore Blade waste

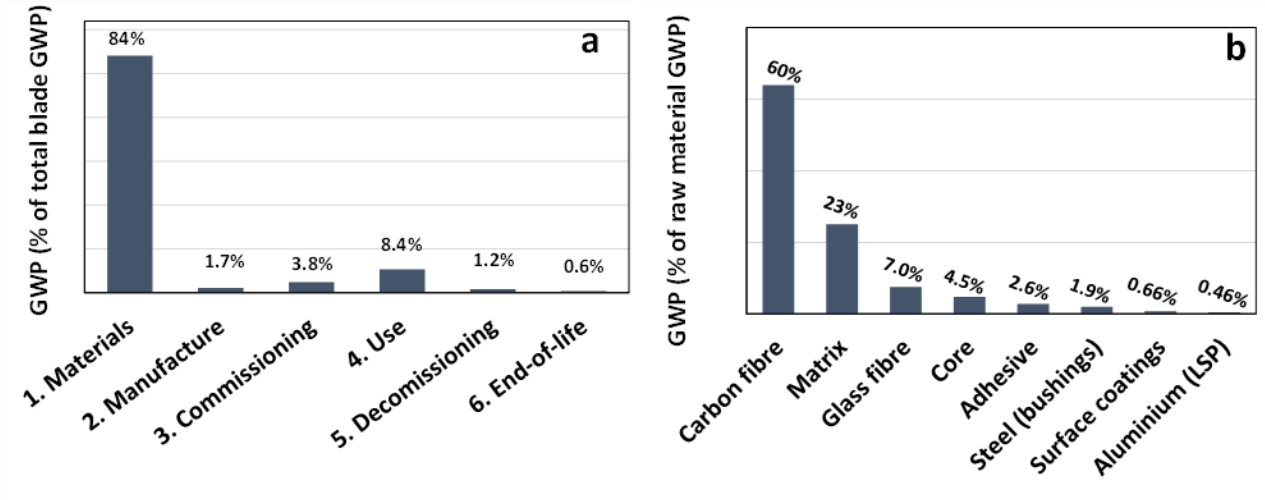


Robinson, Daniel. UK manufacturers' sales by product: 2022 results. *Office for National Statistics*

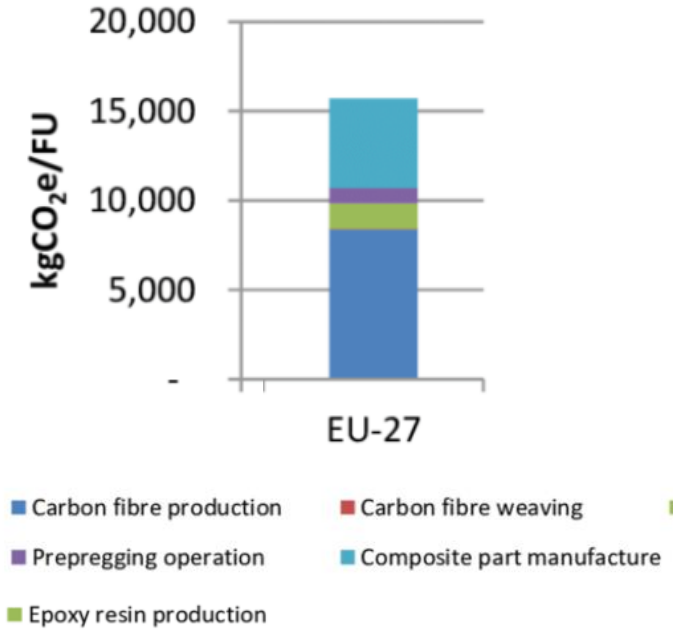
T Peijs, R Kirschbaum, P J Lemstra: Chapter 5: A critical review of carbon fiber and related products: Advanced Industrial and Engineering Polymer Research, Vol. 5.

https://www.nccuk.com/media/u1el5jap/suswind-annual-review-2022-final.pdf

Key stats



Proportional GWP for a reference blade (15MW offshore turbine) from SusWIND peer-reviewed LCA



Emission contribution on the carbon footprint of a composite upper wing cover

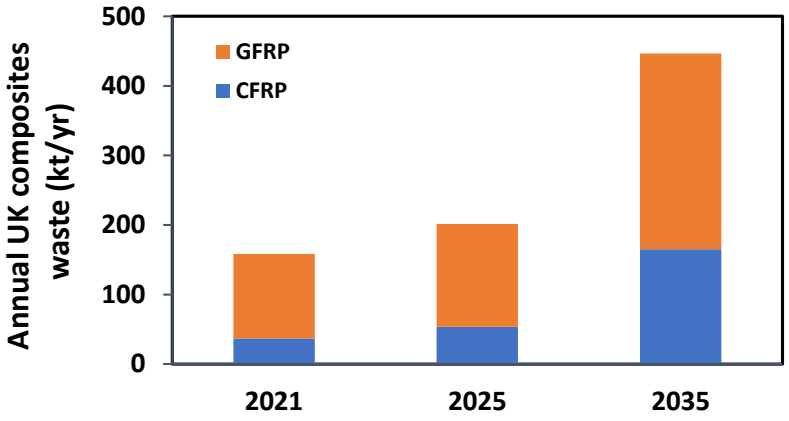
Innovation in advanced materials, especially Carbon Fibre, represents the biggest opportunity to reduce emissions for manufactured products

https://www.researchgate.net/figure/Effect-of-electricity-generation-mix-on-the-carbon-footprint-of-an-upper-wing-cover_fig2_354788267

Potential for recycling to decrease UK GHG emissions

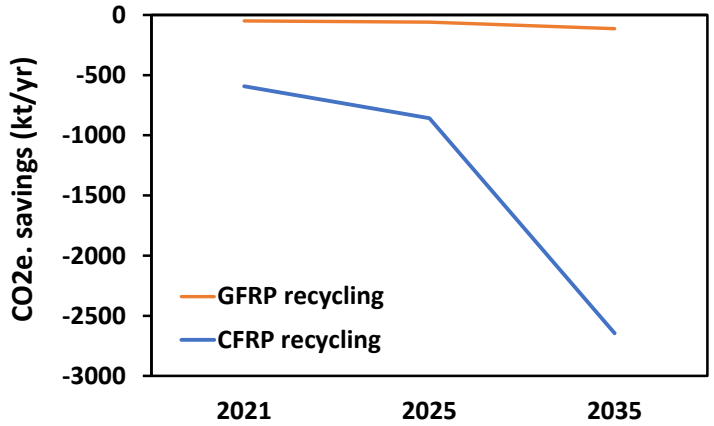
Recycling potential on UK CO2 emissions

Waste volume by fibre type



GFRP recycling greater potential to reduce UK landfill burden

Potential for UK CO2e. savings enabled by composite recycling



CFRP recycling greater potential to reduce GHG emissions

Current *Carbon footprint of recycling composites using different technologies*

	Glass fibre composites	Carbon fibre composites
Landfill		
EfW		
Cement kiln		
Mechanical		
Thermo-oxidation		
Pyrolysis		
Solvolysis		

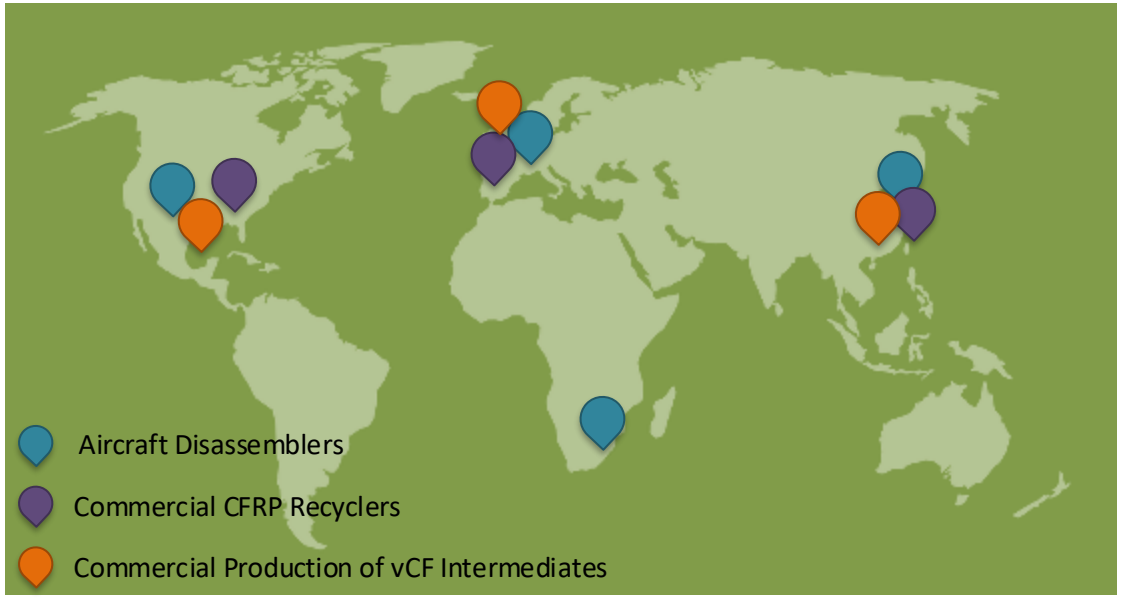
These results are
- Based on available reported data
- Low TRL technologies
- Small lab/academic scale
- Not optimised for commercial operations

Developmental technologies are likely to:
- Efficiency increases through scale up
- Better utilisation of waste heat
- Potential to reuse reclaimed polymer
- Optimise for recycled fibre performance

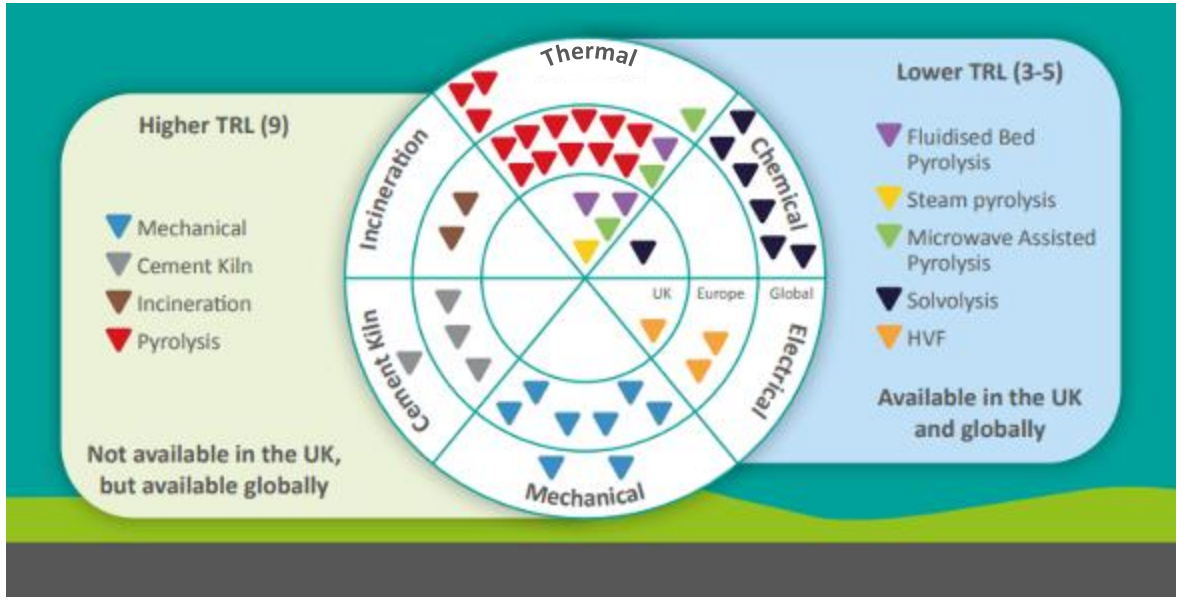
Recycling of GFRP composite has a greater potential to reduce UK landfill burden and CFRP composite recycling has greater potential to reduce GHG emissions

Global and UK Supply chain for EOL Composites

Globally available carbon fibre reclamation and reformatting processes

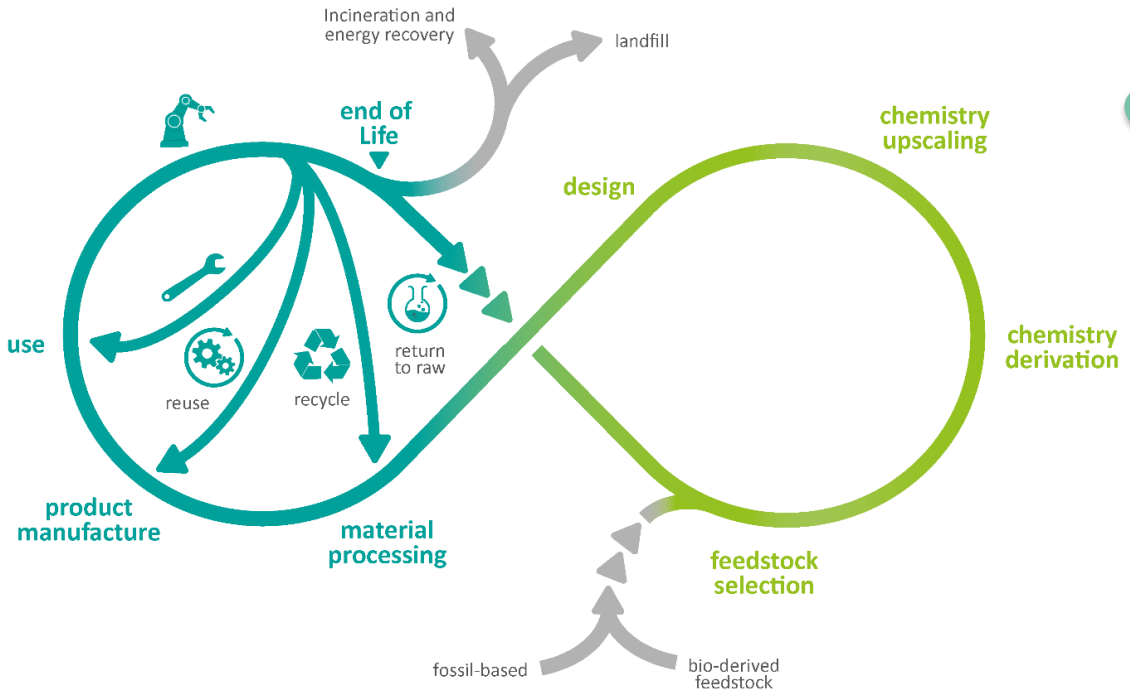


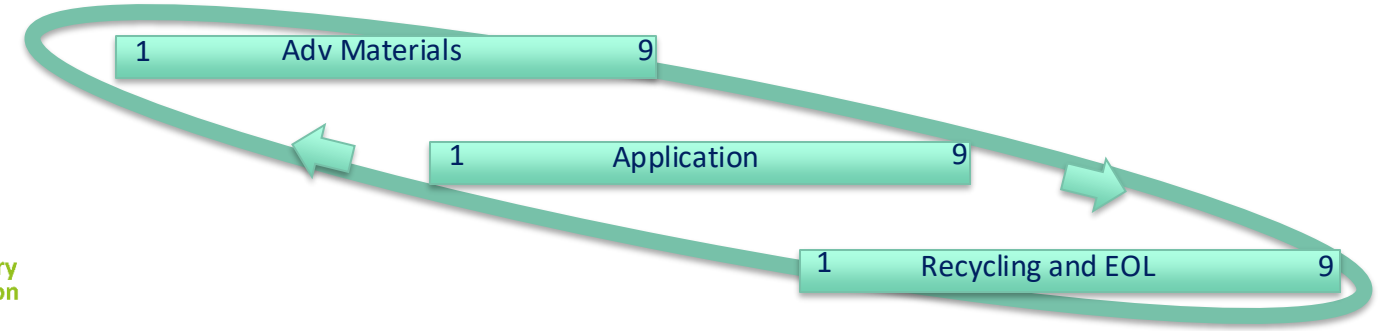
TRL and Regional Locations of Composite Recycling Technologies



Supply Chain & Solution development are both required

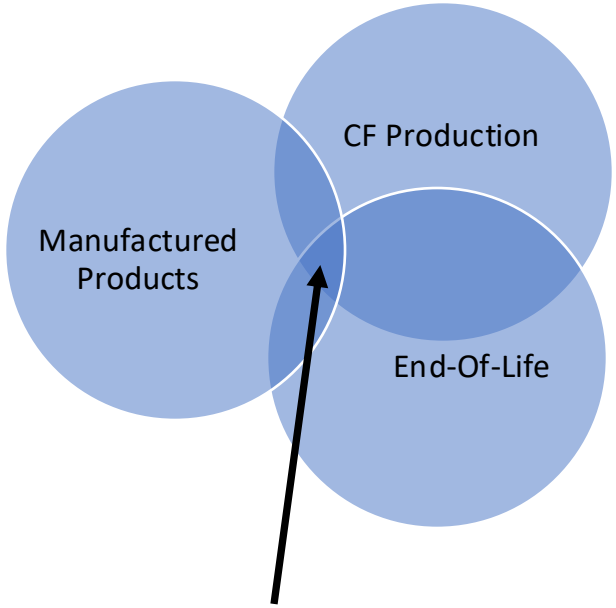
Innovation Challenges





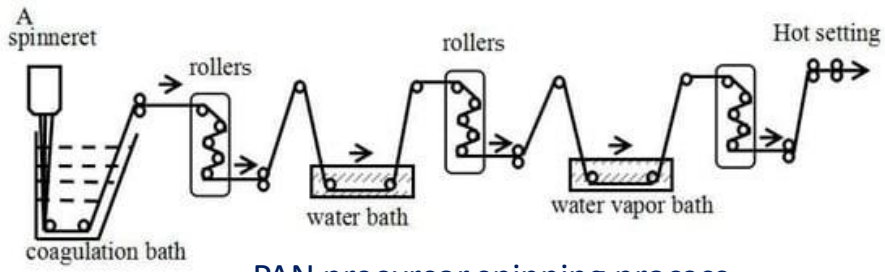
1. TRL scales are not aligned
2. Language is different
3. Recycling and EOL supply chain / TRL is the least mature
4. Technology solutions exist: the business cases / proof-of-concept / conditions do not
5. Breaking the complexity will require X-Sector, X-Discipline & Multi-TRL interventions

NCC Carbon Fibre Circularity

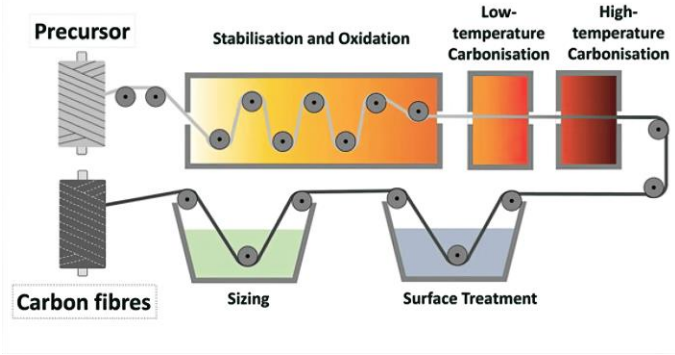


Innovate in Technologies,
Convene & Develop
Skills, Capabilities

Fossil Free & Net Zero performance carbon fibre



PAN precursor spinning process



Oxidation and Carbonisation process for Carbon Fibre

Circular carbon fibre

Waste composite tanks

Polymer recovery investigation

HENRY ROYCE INSTITUTE

CYGNET texkimp

Tank recycling and CF recovery

In line material inspection capability

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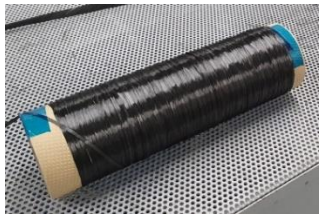

Recycled, continuous carbon fibre

Material and coupon characterisation capability

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CYGNET texkimp

NPL National Physical Laboratory

Material processing and manufacturing

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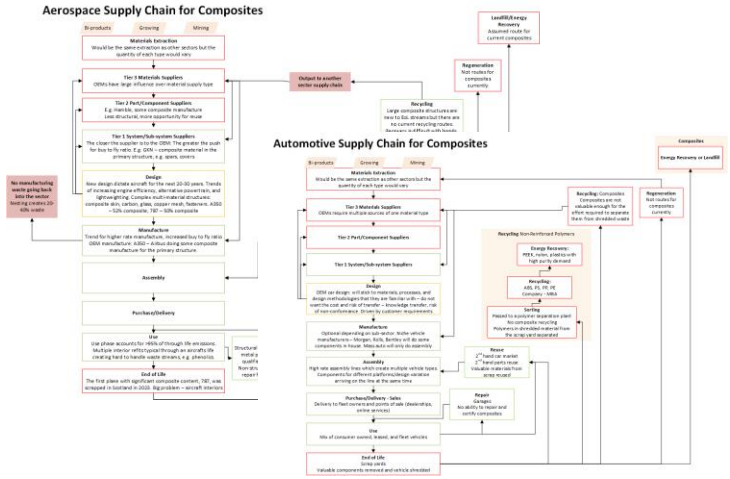
CYGNET texkimp

Second life demos with RTOs & industry

Circular Value Cycles from Complex Material Products

NCC X-Sector Circularity – a focus on implementation



Process Flows – multi-sector

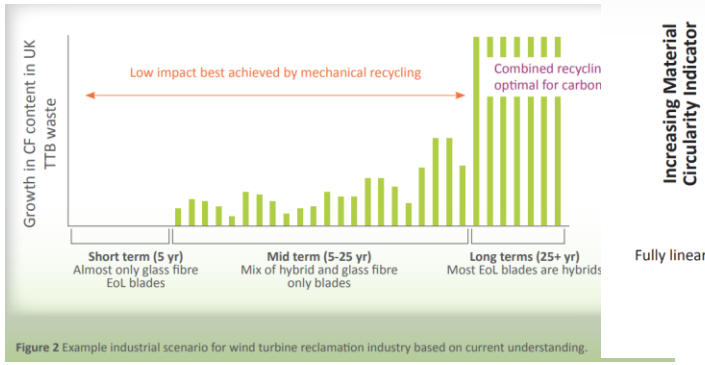


Figure 2 Example industrial scenario for wind turbine reclamation industry based on current understanding.

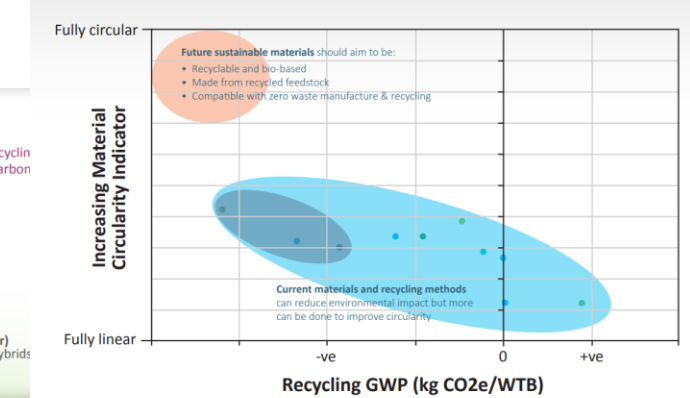
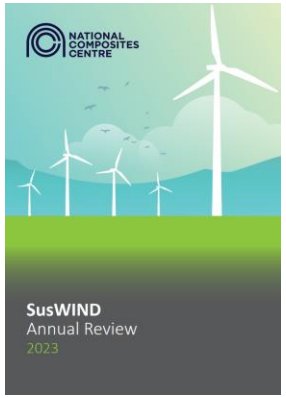


Figure 8 - Coupling the carbon footprint of various EoL solutions with a measure of circularity gives insight into the potential for alternative materials to reduce GWP and boost circularity.

Example analysis (from SusWIND)

Developing plans for Industry consultation & deep dive waste reviews

To build the business case to support investment and usage of c supply chains



- Process maps for generic x-sector products
- Identify key roadblocks inhibiting circular supply chains
- Aggregate common roadblocks for maximum intervention
- Expand Geospatial mapping

THANK YOU FOR YOUR ATTENTION

Tim Young

Tim.young@nccuk.com

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