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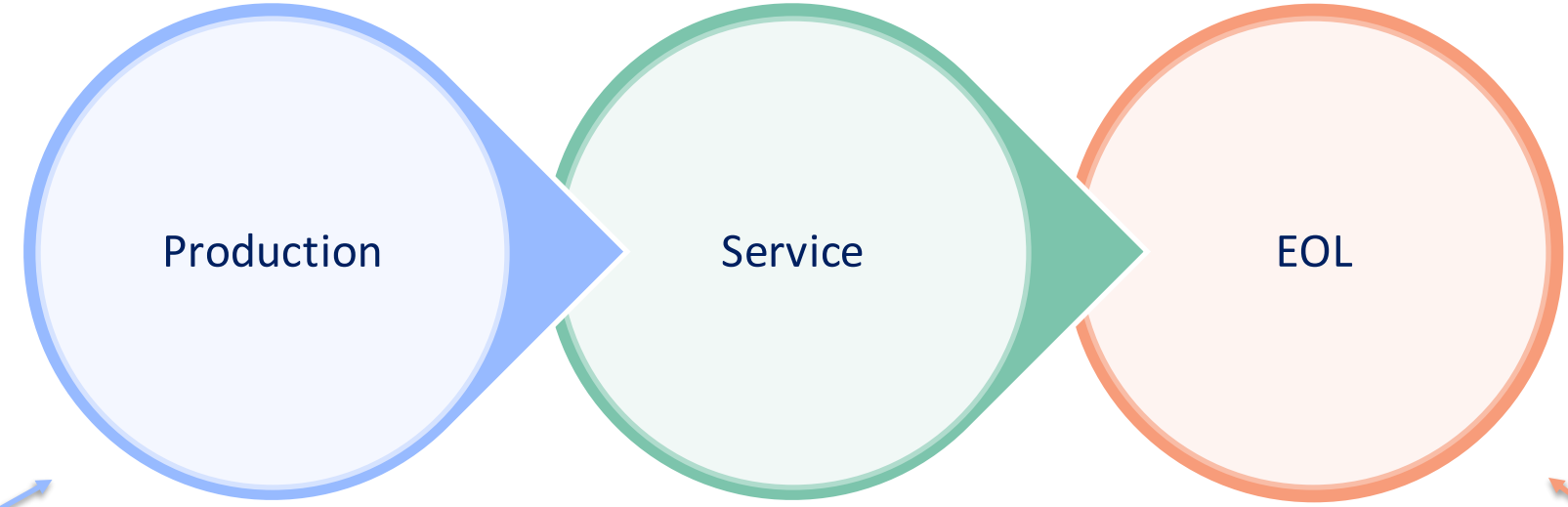
Composite recycling: **does the goo have value?**

The composite lifecycle has three main phases…

Lightweight and durable, **advanced composites offer a low impact, economically valuable service life**



The enviro. impact of composite production is often high. Problem areas include manufacturing waste and carbon fibre production…

Landfill, incineration neither look good…
Commercial recycling is still in its infancy, mostly handling 'easier' manufacturing waste—**challenging economics…**

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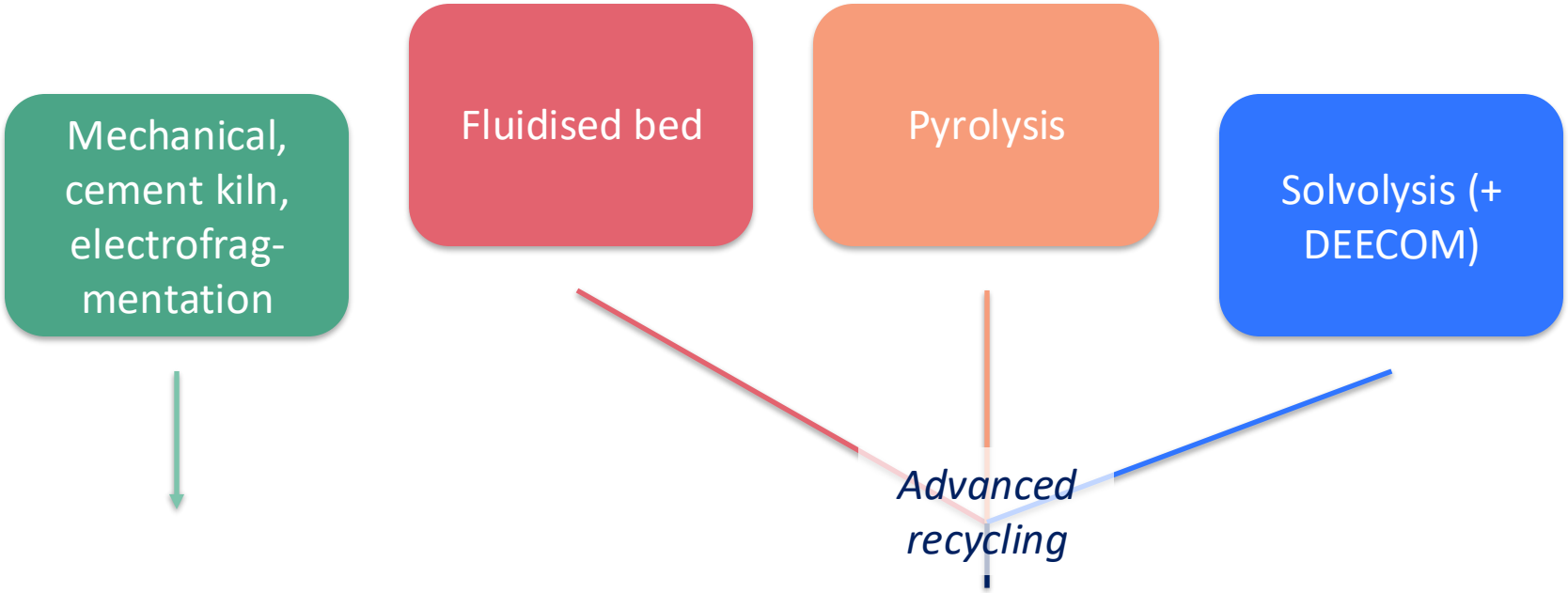
Composite (FRP) recycling

EOL



- Processes composite into ‘granulates’ of limited value, not fibre reclamation methods
- Low cost

- Fibre reclamation techniques
- Relatively expensive
- **Also produces chemical products from the degraded polymer**

i.e. they often produce matrix recyclates, or crudely, some ***goo***

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Why?

Open Access Article

Lifecycle Assessment of Strategies for Decarbonising Wind Blade Recycling toward Net Zero 2050 †

by **Kyle Pender** *, **Filippo Romoli** and **Jonathan Fuller**

National Composites Centre, Bristol and Bath Science Park, Emersons Green, Bristol BS16 7FS, UK

LCA data—insight on scenarios where various recycling approaches 'balance the books'

Key info—'valorising' the chemical recyclates (goo) means *it isn't burned*

Good for the environment

Opportunity to create more economic value $

Composite type	Recycling type	Total	C term (recycling emissions/energy)	D term (displaced emissions/energy)	Comment
	Mechanical	Bad	Low	N/A	Doesn't produce rCF
	Advanced	Good	High	High	rCF displaces vCF
	Advanced + chemical recovery	Better	Moderate	High	rCF displaces vCF *and* chemicals have 2nd life
	Mechanical	Good	Low	N/A	Doesn't produce rGF
	Advanced	Bad	High	Low	Produces rGF but likely worse than vGF
	Advanced + chemical recovery	OK	Moderate	Low	Chemical recovery may make advanced recycling of GFRP feasible

For *carbon* composites we must use advanced recycling processes—recovering chemical products *helps*

For *glass* composites, in the short-term, mechanical methods are better but the size of the potential market for shards/granulates may be limited…

…but advanced recycling of GFRP isn't viable *unless* chemical recyclates are valorised

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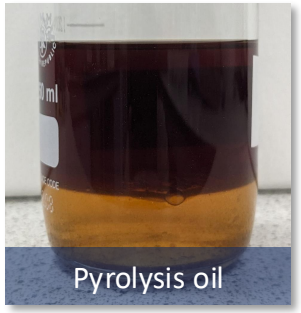
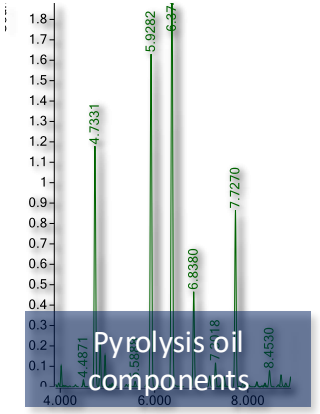
Why -> What?

These by-products are complex chemical mixtures

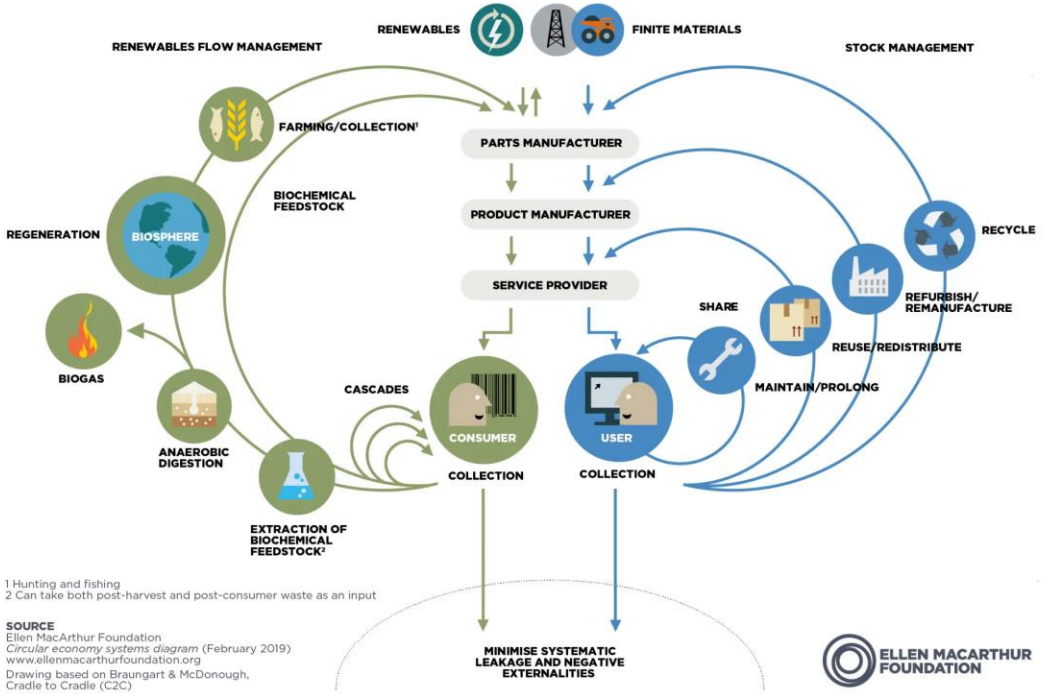
- Epoxies -> phenols
- Polyesters -> styrene
- Thermoplastics, e.g. Elium or Nylons -> *monomers*
- Can we purify these chemicals?
- Can we upgrade them into even more valuable chemicals?
- This is ugly and difficult, but is a real opportunity

Waste -> wealth; a key part of circular economics


Pyrolysis oil



Pyrolysis oil components



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Concluding remarks

- Composites are not very sustainable, a large part of this is their end-of-life
- There are various recycling methods that are at varying levels of commercialisation
- **Chemical by-products, matrix recyclates, or goo are an under-researched but increasingly important aspect of advanced recycling processes**
- **Incinerating these chemicals rather than valorising them can compromise the benefits of doing the recycling in the first place**
- **Furthermore, this goo can have value**
- The NCC is currently working on a couple of projects to understand the relationship between (a) material input + (b) process conditions, and (c) the resultant chemical products
- There is a lot more to be done in the wealth-from-waste space, and it isn't just composites

Valorise the goo, make composite recycling greener and more cost effective

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THANK YOU FOR YOUR ATTENTION

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