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Vestas towards sustainable end-of-life treatment of legacy blades and novel blades

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Vestas Innovation and Concepts

Wind turbine blades: Large, composite structures, built to last 20+ years

Sustainable solutions for end-of-life legecy blades

Why is there not already a value chain for blade recycling?

What are the volumes and materials?

- Specifications
- Logistics
- Material flow analysis

How to process blade material?

- Mechanical shredding
- Pyrolysis
- Cement co-processing

How sustainable is the value chain?

- Life cycle assessment
- Technoeconomic analysis
- Market uptake

DecomBlades: Recycling value chain

3-year project (2021-2023), partly funded by the Innovation Fund Denmark

Vision: Provide basis for commercialization of sustainable techniques for recycling wind turbine blades

How can the wind industry support the recycling industry in scaling up sustainable, economically-viable recycling solutions?

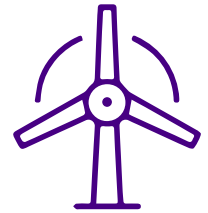
How can the recycling companies build a business case and the value chain for recycling composite materials?

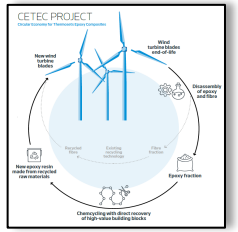
LM Wind Power Siemens Gamesa Vestas Ørsted HJHansen Makeen Power FLSmidth

Technical University of Denmark (DTU), University of Southern Denmark (SDU), Energy Cluster Denmark

Wind turbine blades: recyclable or recycled?

Technological development can not stand alone

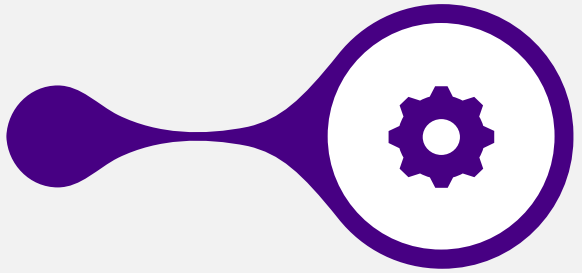




Wind turbines are already 85-90 % recyclable, but aiming for 100 % challenge us to **find and mature** new, radically different technical solutions

Developing a way of bringing fiber composites into a **truly circular material** loop would minimize the footprint of the wind industry and the composites industry at large

A recycling technology is only a **success** if the process leads to **products actually entering a cyclic material loop**.



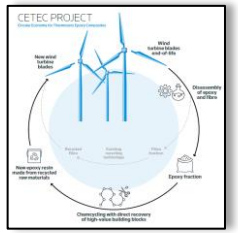
MATURE TECHNOLOGY
The technical challenges have been solved. Requirements regarding energy consumption, transportation, etc. has been addressed

FINANCIAL INCENTIVE
A viable business case is key for engagement of value chain.

BROAD TRUST IN TECHNOLOGY
Large volumes of materials (from multiple sectors) secures a stable supply chain

CETEC – the future of composite recycling

CETEC aims to close the loop and develop **a truly circular** resin-system



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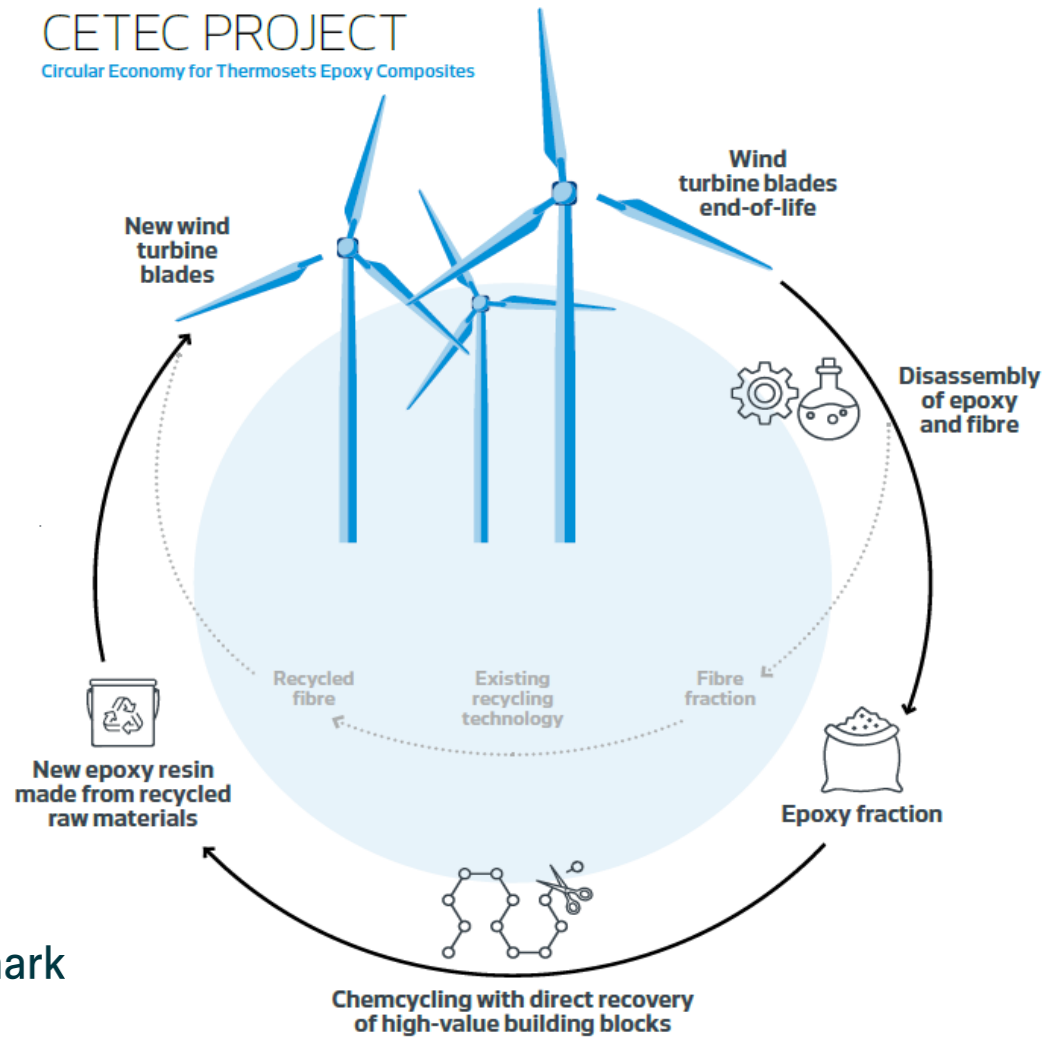
Innovation Fund Denmark



Disassembly

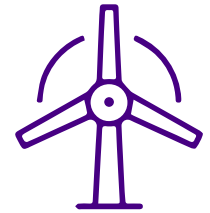
Disassembly and separation of material streams is the **first step** towards a circular system

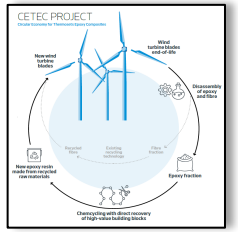
Modifications cannot sacrifice **mechanical performance** of composite

Disassembly rely on **mild conditions** reducing the energy consumption

Disassembly, material recovery and associated requirements

Commercial and technical development is closely linked





Technical challenges - commercial impact

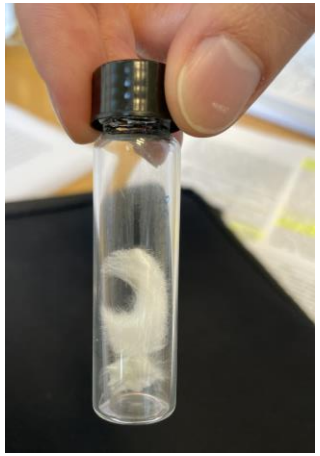
Essential for business case and LCA:
Tough requirements for

- value of recycled material (fibers AND resin)
- energy consumption
- environmental properties of process
- potential for local handling

Recovery

Recovering the resin through chemcycling is key

- Resin represents a **high value** product
- Potential for **true circularity** → material for new product directly derived from EOL products
- Recycled material displace hydrocarbon-based product
- Mild conditions preserve **fibers of a high quality** enabling fibers to enter parallel recycling paths



Recovered fibers

Value creation

Closing the carbon loop displacing the need for hydrocarbon based raw materials

Ensuring scale and paving the way for other industries to engage into circularity by creating a **commercial recycling pathway**

Value form waste: Harvesting the value from all subcomponents of end-of-life composites

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The solution will need roots across value chain

Energy consumption

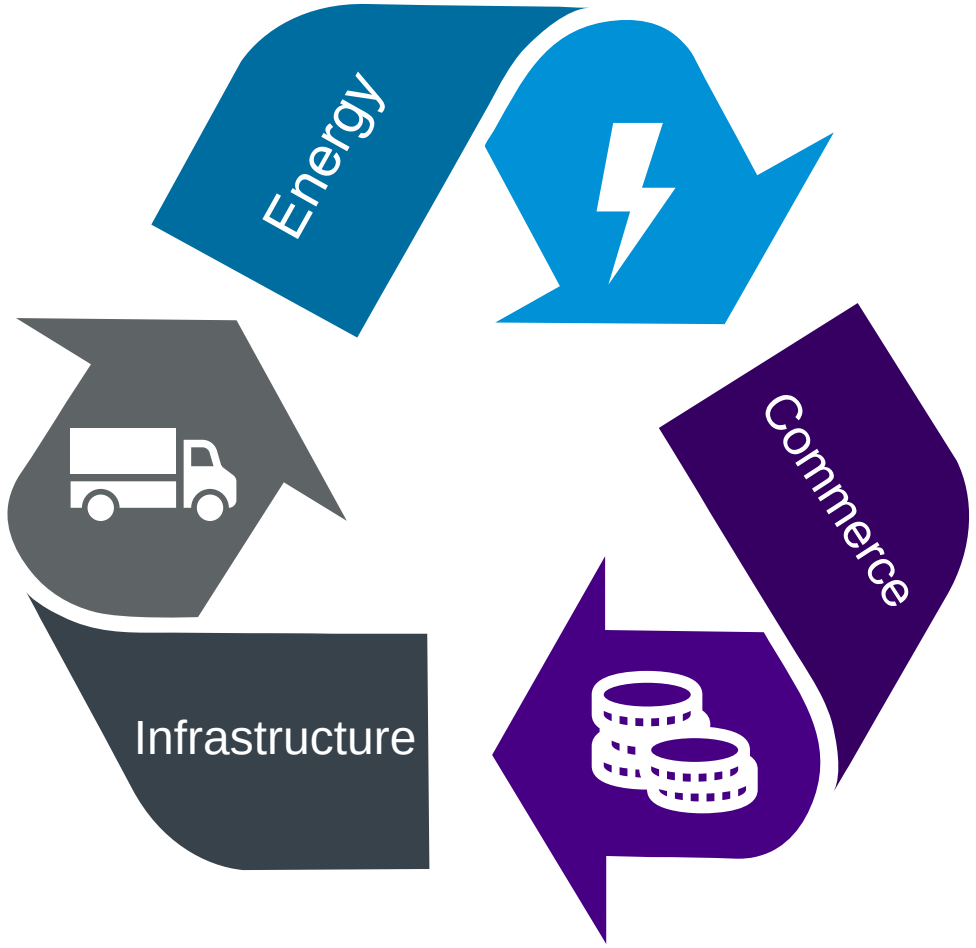
- Transportation, mechanical handling, separation and recovery steps are all restricted in energy consumption as it is crucial for the overall sustainability impact

Commercial incentive

- Valuable chemical building blocks can in addition to the fibers be recovered. This has the potential to transform composite waste into a raw material

Infrastructure

- Decommissioning and recycling must be localized
- The wind industry has the potential to be the frontrunner in the race for recycling composites due tight connections across value chain



Vestas

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Thank you for the attention

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