RECREATE Conference: EU Composites Advantage Unveiled
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New developments for sustainable wind blades

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www.eolian-project.eu

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The problem

A few numbers

- **19%** of European energy consumption was met by wind energy production in 2023 (8% worldwide)
- Over **130.000** active wind turbines in operation across Europe
- Average lifespan of a wind turbine: **20-25 years**
- It is expected that up to **5.700** wind turbines per year will be decommissioned in Europe by 2030
- **85-90%** of wind turbines are easily recyclable
- The challenge is the **remaining composite WTBs**
- **12-15 tons** of composite waste per MW of installed capacity

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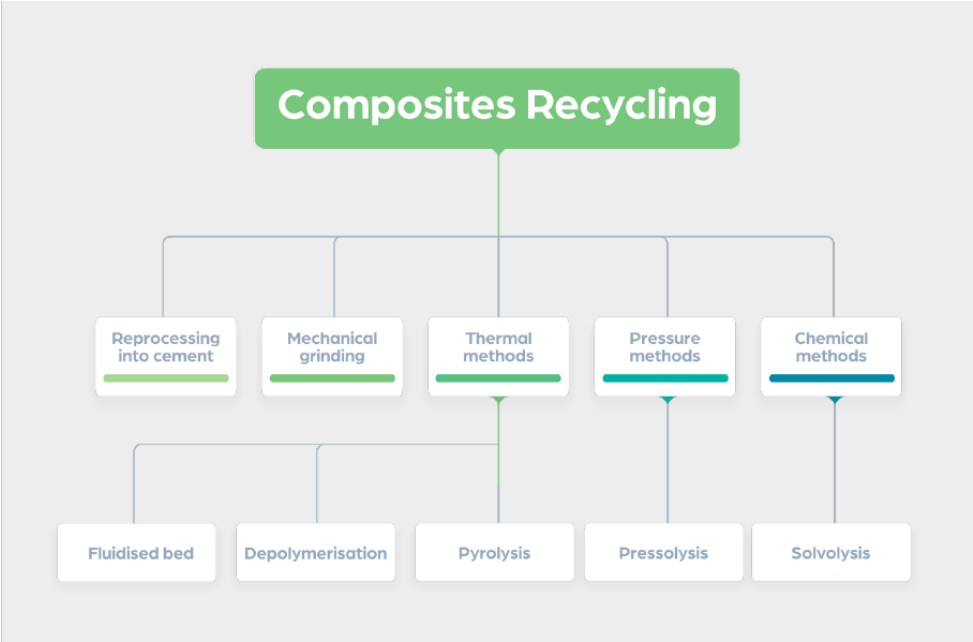
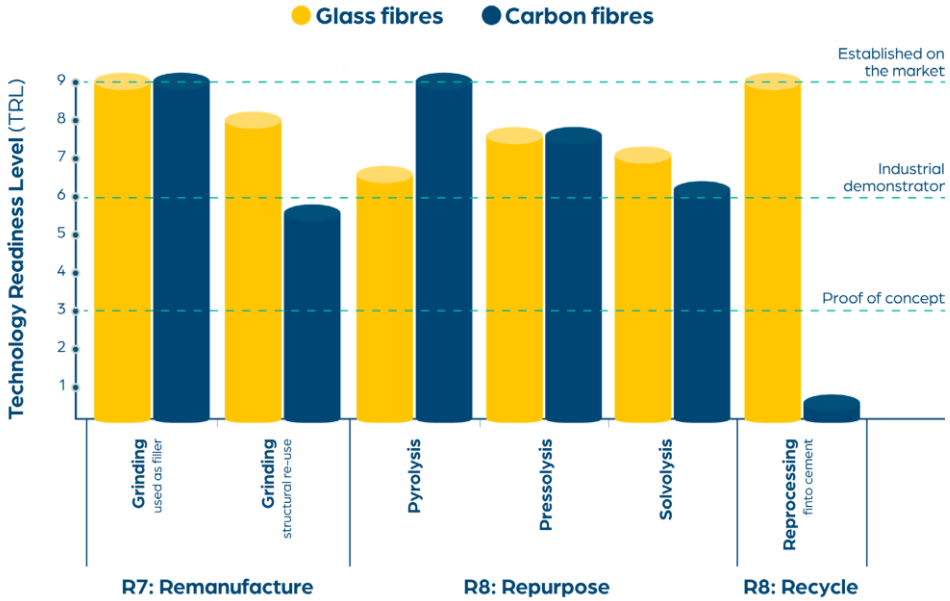
https://www.mdpi.com/1996-1944/14/5/1124

Circular technologies





- Several technologies being explored at different TRLs
- Implemented as soon as they become technically & economically competitive

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"Composites are circular materials", EuCIA publication (2025)
https://www.vestas.com/en/sustainability/environment/zero-waste

Recent examples of circularity

Acciona

Waste2Fiber recycling plant in Lumbier (Navarra, Spain). Proprietary thermal method, processing capacity of 6,000 tons per year. Recovery of fibres. Expected reduction of the carbon footprint: -66% for glass fibres / -95% carbon fibres.

https://www.acciona.com/updates/news/acciona-build-pioneering-wind-blade-recycling-plant-navarra

Iberdrola

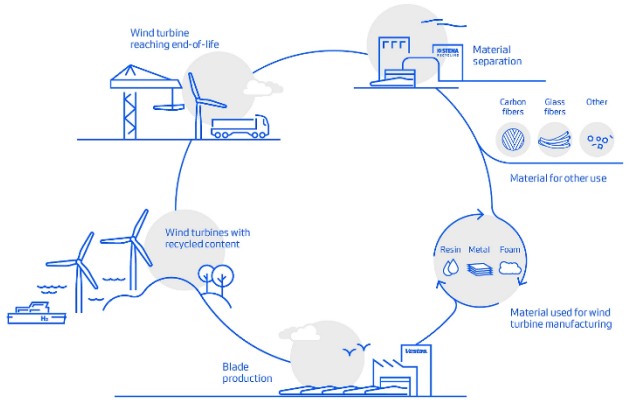
EnergyLoop blade recycling in Cortes (Navarra, Spain). 139 wind turbines, 417 blades, > 800 tonnes.
Recycling target: 50% by 2025, 100% by 2030.

https://www.iberdrolaespana.com/press-room/news/detail/241211-iberdrola-espana-awards-energyloop-the-contract-for-blade-recycling-and-waste-management-from-repowering-its-first-two-wind-farms

Vestas

Recycling through a novel chemical process that can break down epoxy resin into virgin-grade materials (***CETEC project***). Potential to produce new turbine blades made from re-used blade material.

https://www.vestas.com/en/sustainability/sustainability-product-offerings/blade-circularity



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Limitations

of current production and recycling approaches:

- Blades are problematic to repair
- Circular approaches are often associated with downcycling to lower performance applications
- Several solutions are not yet widely available or economically competitive
- The options for direct repurposing end-of-use blades are limited and this is likely to remain a niche market

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Ambition

EOLIAN aims to:

1. Develop **circular-by-design** wind blades considering their **complete life cycle**, exploring the combination of bio-based vitrimers and natural fibres
2. Enable self-repairing of minor damages
3. Extend the lifetime of WTBs
4. Perform a continuous Structural Health Monitoring (**SHM**) and **de-icing** of the blades
    - Early detection of damages → faster repairing
    - Prevention of ice accretion & related issues

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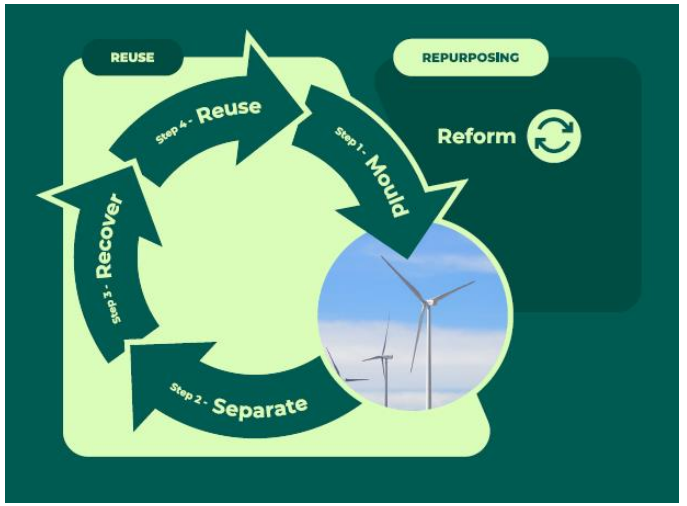
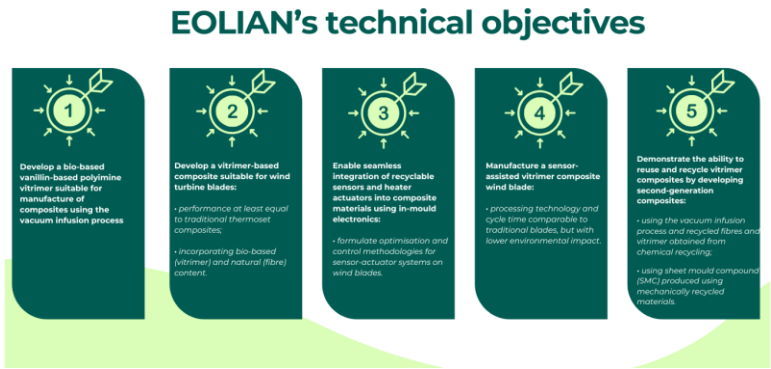
Objectives

1. Develop bio-based vitrimers
2. Develop a vitrimer-based composite suitable for WTBs
3. Enable integration of recyclable sensors and heater actuators using in-mould electronics
4. Manufacture a sensor-assisted vitrimer composite wind blade
5. Demonstrate the ability to reuse and recycle vitrimer composites by developing **second-generation** vitrimer composites





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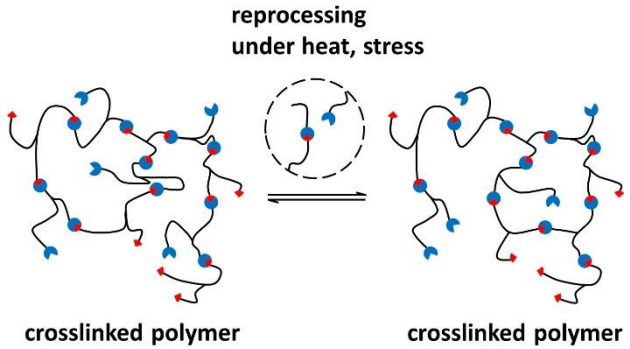
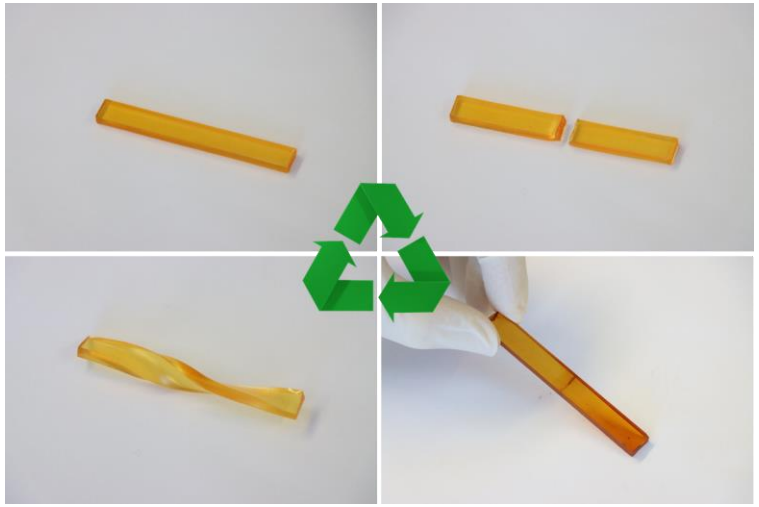
Vitrimers

Thermosetting polymers consisting of **covalent networks** that can **change their topology** via thermally activated bond-exchange reactions (Covalent Adaptable Networks).

- Like **thermosets**, vitrimers can be formulated to crosslink at certain temperatures.
- Like **thermoplastics**, vitrimers can be softened and reformed at elevated temperatures.



"Design of high performance vitrimers for circular economy", ACS 2021



Reprocessing of a cured vitrimer.

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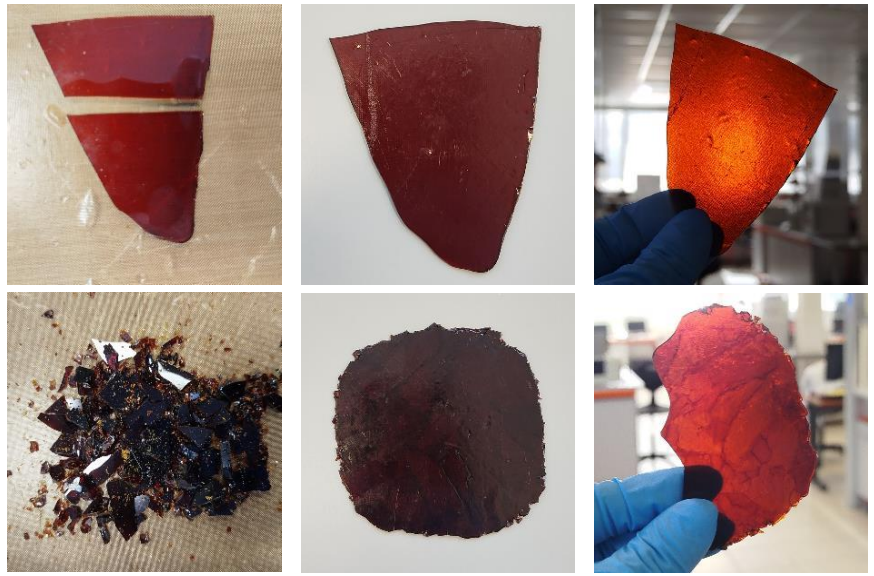
Where are we now?

Synthesis of the vitrimer.



Different ways of reprocessing cured vitrimers.

- Different vitrimeric formulations explored against benchmark systems
- Matching with process and products requirements

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Stay in touch!

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https://www.linkedin.com/company/eolian-project-eu/

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Thank you for your attention!

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