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www.eolian-project.eu



A new generation of smart, sustainable wind turbine blades

Bio-based, repairable and recyclable vitrimer composites and advanced sensors for highly reliable, sustainable wind blades

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A circular future for wind energy

The shift to a circular economy in the wind industry will require strategies to extend the lifespan of turbines, improve their recyclability, and minimise waste. A key area of focus is the turbine blades, which present significant end-of-life challenges.

The blades of the huge turbines being installed globally today are mostly made from fibre reinforced polymers, also known as composite materials. Strong, durable composites enable the manufacture of longer, lighter blades with optimised aerodynamic shape, making it possible to harvest more power from the wind. However, these glass fibre reinforced thermoset composites are challenging to recycle. Technologies to recycle blades exist but these solutions are not yet widely available or economically competitive, and the options for direct repurposing of end-of-use blades are limited.

New materials and technologies that facilitate reuse and recycling of blades at the end of their service life are crucial. Blades that operate reliably for longer, and that can be repaired faster and more easily, will also advance circularity.

Innovative blade materials

The EOLIAN project is developing an innovative smart wind turbine blade manufactured from repairable and recyclable composite materials, with an integrated structural health monitoring system that will detect damage before it becomes a major issue.

Key advantages of EOLIAN blades

-  20% longer service life
-  20% faster to repair
-  75% reduction in ice accretion
-  40% lower recycling cost
-  **15% lower turbine lifetime cost**



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EOLIAN blades use vitrimers, a new class of polymer that enables recyclable composite materials. Vitrimers also exhibit 'self-healing' properties, which will make it possible to repair minor blade damage on-site through localised heating of the composite. The project is also exploring the use of novel bio-based vitrimers combined with natural basalt fibre reinforcements to manufacture highly sustainable composites.

Recyclable sensors and a heating system will be integrated into the EOLIAN blade to allow the detection and fast repair of damage and prevent issues caused by the build-up of ice on the blade. These innovations will contribute to extending the blade's lifespan and ensuring its structural integrity and reliable performance.

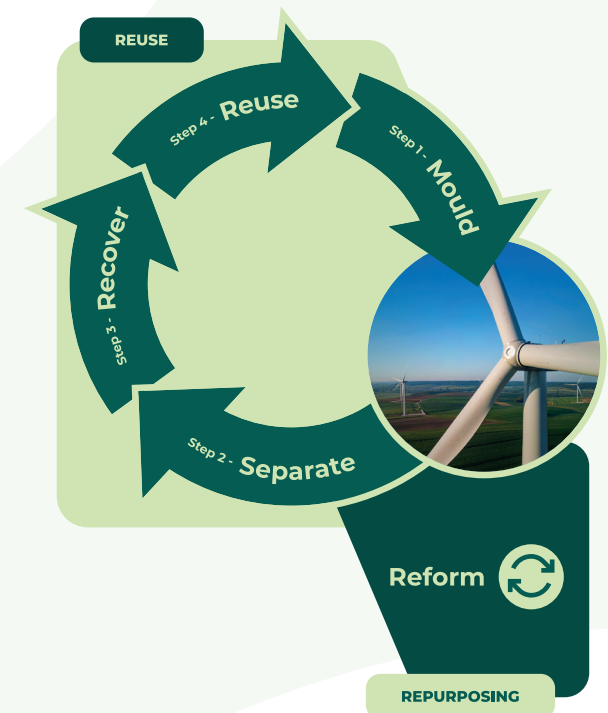
EOLIAN will demonstrate these technologies by manufacturing a sensor-assisted vitrimer composite blade of 14 m in length.

Reuse and recycling

The use of vitrimers will pave the way to different solutions for blades at the end of their service life.

- **Reuse:** Vitrimer composites can be reprocessed after cure, which allows the reuse of parts through simple thermoforming (heating and re-shaping). A vitrimer composite blade could be reformed into a shape suited to a new application, such as a component for a wind turbine nacelle.

- **Recycling:** Chemical recycling can separate the vitrimer matrix and the reinforcing fibre. The recovered materials could be used to manufacture new composite parts for wind energy and other applications.



New sustainable vitrimer composites – reprocessable, repairable, and easily recyclable – will offer a step change in how wind turbine blades are maintained, reused and recycled in a circular economy.