



A new generation of smart, sustainable wind turbine blades

Eolian Webinar

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www.eolian-project.eu

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The EOLIAN project

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

10 partners

5 countries

42 months

€3.6 million

Project coordinator: Proplast, Italy

Granting authority: CINEA

Start date: 1 June 2024



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The EOLIAN partners

Learn more
eolian-project.eu/partners



The challenge

A sustainable future for wind energy

Circular economy strategies

Extend the lifespan of turbines | Improve their recyclability | Minimise waste

Up to 90% of a wind turbine's mass is already recyclable, but **blades** present significant end-of-life challenges → limited recycling options for glass fibre reinforced thermoset composites.

By 2030, Europe is expected to generate over 50 kt of end-of-life blade waste, with around 14,000 blades projected to be dismantled, amounting to between 40,000 and 60,000 tonnes of material. (Source: [WindEurope](#))

What's needed?

- ☐ New materials and technologies that facilitate **reuse and recycling** of end-of-service blades.
- ☐ Blades that **operate reliably for longer**, that can be **repaired faster, more easily**.



The EOLIAN solution

An innovative smart, recyclable blade

The goal of EOLIAN project is the development of wind blades with **longer lifetime, maintainability and reliability**, together with higher **sustainability and recyclability**.

This goal will be reached by using in synergy, **biobased reparable and recyclable vitrimer composites** with **basalt fibres**, with the integration of **advanced recyclable sensors and actuators** which will perform a structural health monitoring of the blades. All the design phases will be supported by an **advance multiscale modelling** to ensure the highest performance level, and by **LCA-based environmental analysis** to guarantee constantly the best choices in terms of carbon footprint and sustainability.



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Technical objectives



Develop a bio-based vanillin-based polyimine vitrimer suitable for manufacture of composites using the vacuum infusion process



Develop a vitrimer-based composite suitable for wind turbine blades:

- *performance at least equal to traditional thermoset composites;*
- *incorporating bio-based (vitrimer) and natural (fibre) content.*



Enable seamless integration of recyclable sensors and heater actuators into composite materials using in-mould electronics:

- *formulate optimisation and control methodologies for sensor-actuator systems on wind blades.*



Manufacture a sensor-assisted vitrimer composite wind blade:

- *processing technology and cycle time comparable to traditional blades, but with lower environmental impact.*



Demonstrate the ability to reuse and recycle vitrimer composites by developing second-generation composites:

- *using the vacuum infusion process and recycled fibres and vitrimer obtained from chemical recycling;*
- *using sheet mould compound (SMC) produced using mechanically recycled materials.*

Bio-based vitrimers

Vitrimers - a new class of polymer that enables **recyclable** composite materials.

'Self-healing' - possible to repair minor blade damage on-site through localised heating of the composite.

Basalt fibre – a **natural fibre** reinforcement to replace synthetic glass fibre.



Basalt fiber composites

New composite materials

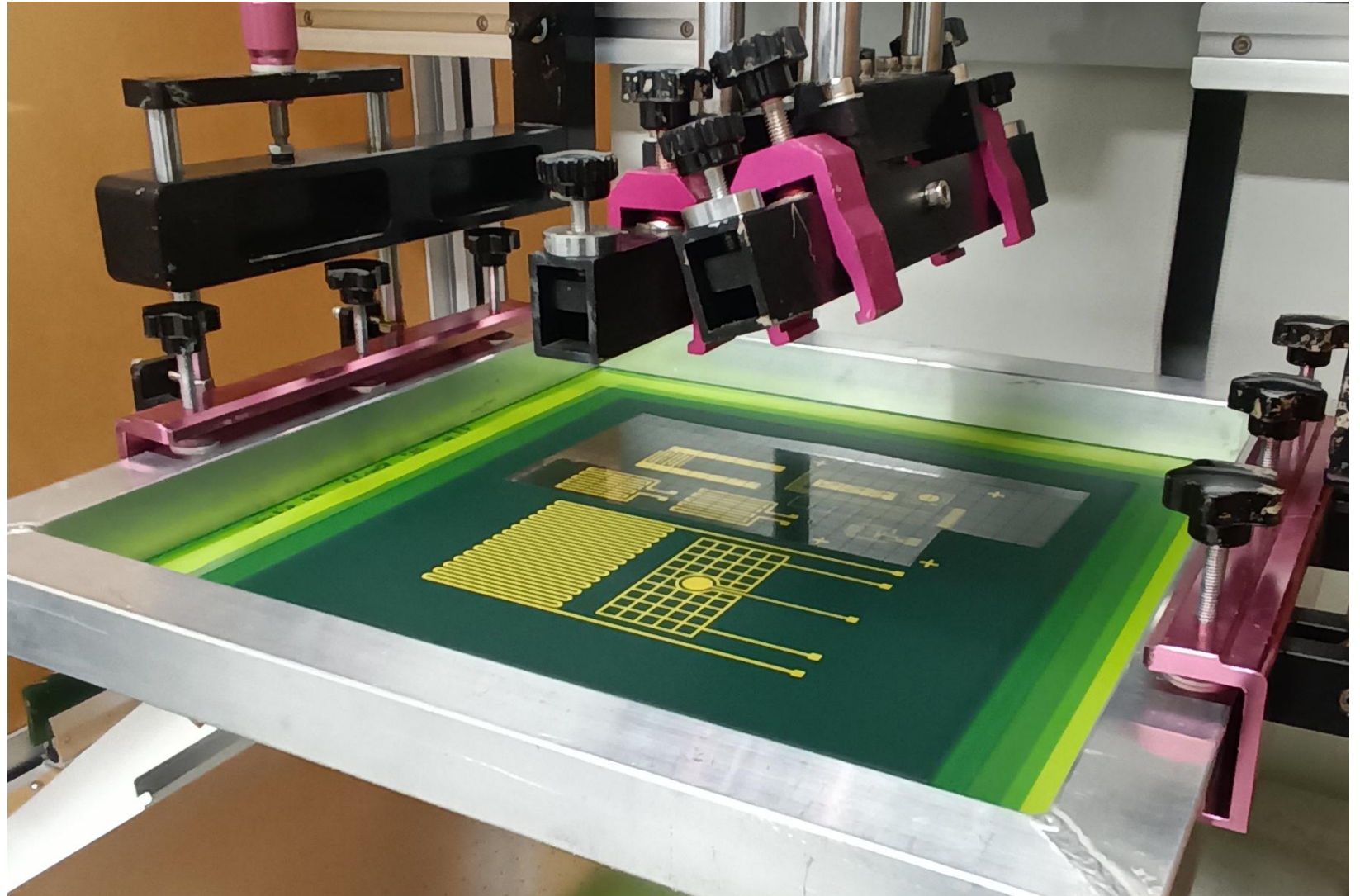
EOLIAN will develop sustainable composite materials based on novel **bio-based vitrimer polymers** combined with **basalt fibre reinforcements**.



Sensors and actuators

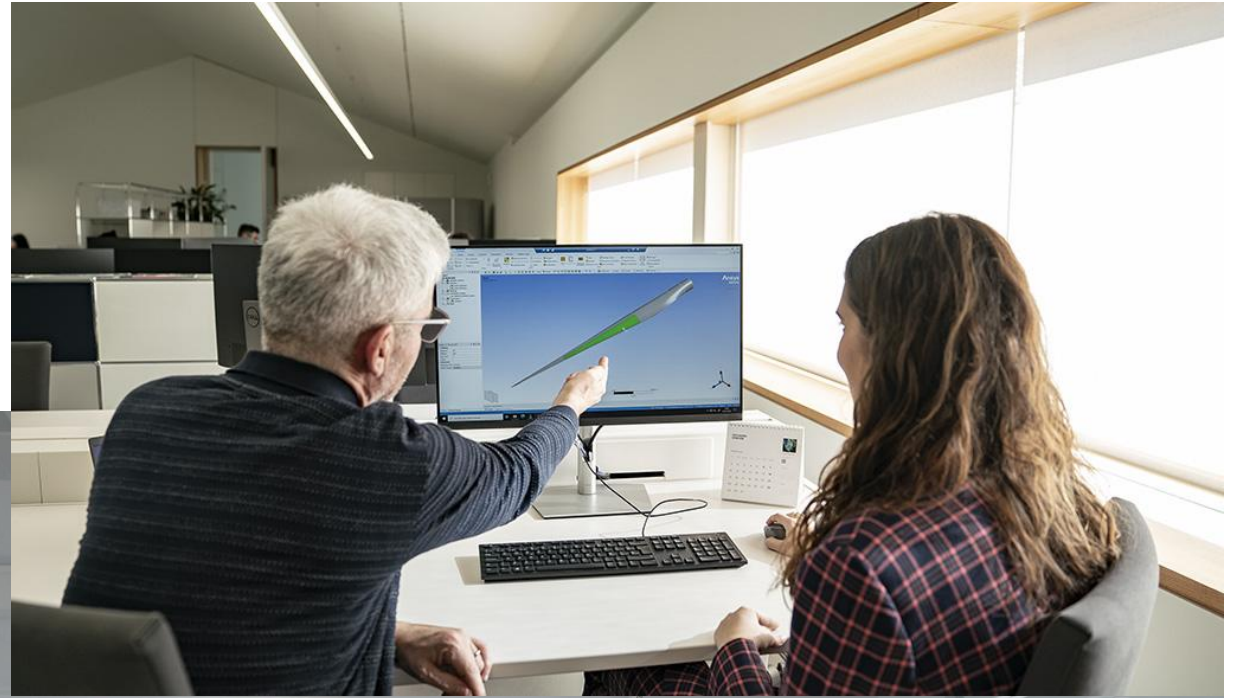
In-mould electronics

- ☐ Structural health monitoring
- ☐ Heating system



The EOLIAN blade

A sensor-assisted vitrimer composite blade 14 m in length.



End-of-life solutions

Reuse

Vitrimer composites can be reprocessed after cure → reuse of parts through thermoforming (heating and re-shaping).

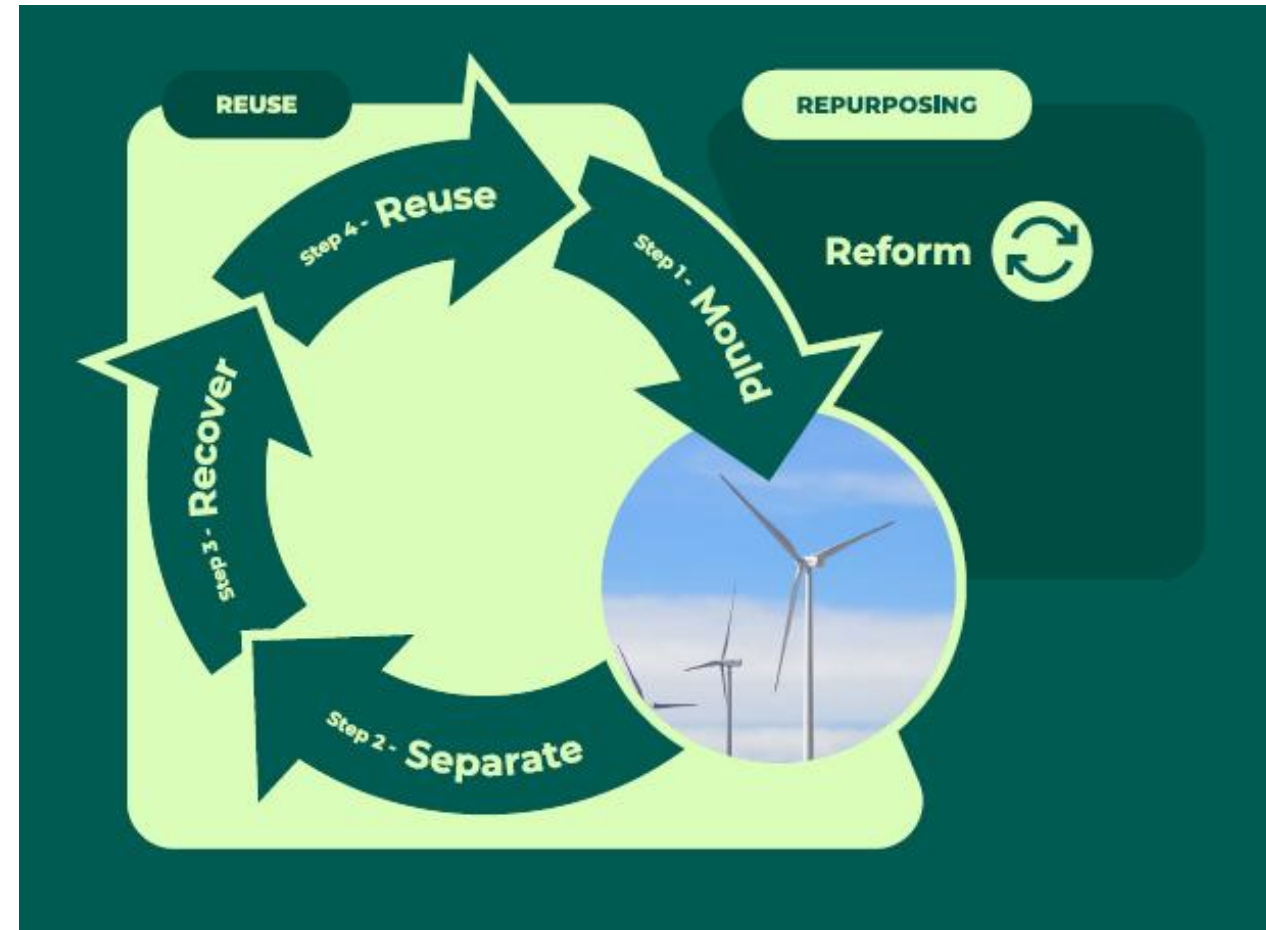
A vitrimer composite blade could be reformed into a shape suited to a new application, e.g. a component for a wind turbine nacelle.

Recycling

Chemical recycling → separate vitrimer matrix and reinforcing fibre.

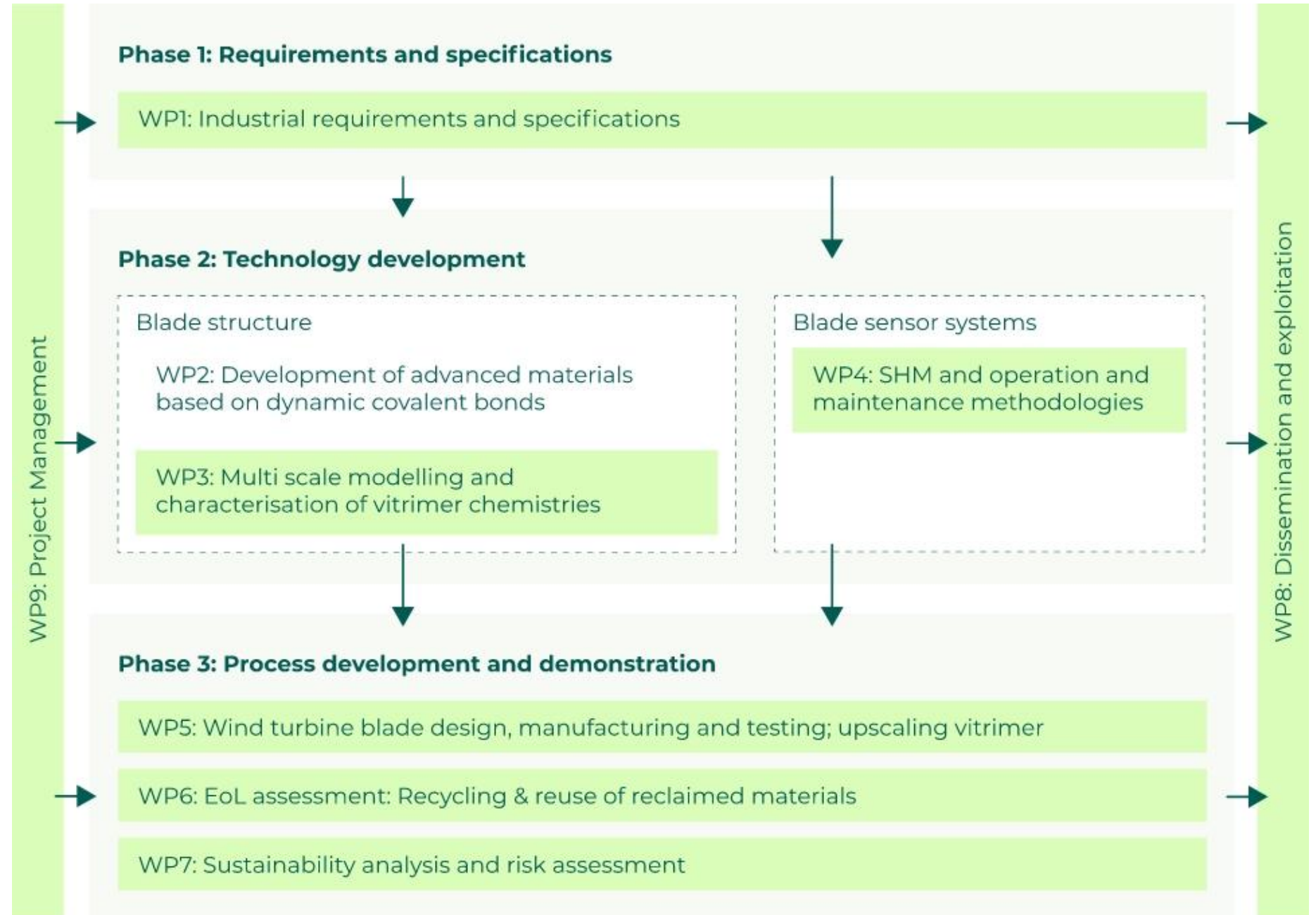
The recovered materials could be used to manufacture new composite parts for wind energy and other applications.

If these options are unsuitable, **mechanical recycling** is also possible, with the resulting materials used to form new parts.



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Work packages





Thank you for your attention!

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