

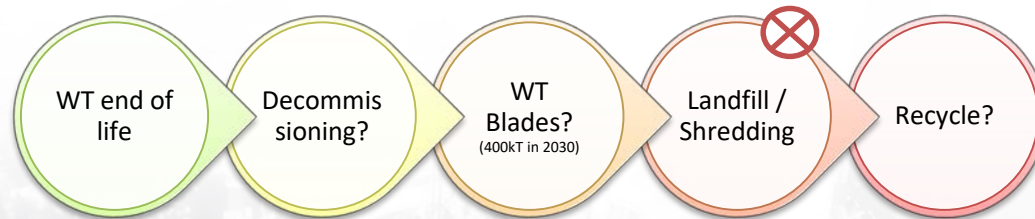
Opportunities for Recycling of Wind Turbine Blades



TKI WIND OP ZEE
Topsector Energie

Wind: Europe's future energy supply

PROBLEM



- › **No recycling possibilities exist for wind turbine blades**, except landfill, shredding and incinerating them for energy and filler material recovery used in cement industry.
- › By 2030, yearly volume of composite material is 400kT, double in 2050.
- › Policies are towards banning the disposal or towards recycling (for material and energy recovery)
- › Several recycling technologies exist for composite materials:
 - › High energy demand,
 - › Low quality of recycled materials,
 - › Issue in economics & logistics of recycling large composite parts

Blades on installed turbines

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APPROACH

Blade de-installation

- Logistic (removing, cutting, transport) modelling
- Cost evaluation
- Strategy optimisation
- Using ECN Install

Recycling Technology

- Good separation between the fibres and resin
- Options: mechanical, incineration, chemical, **thermochemical**
- Experiment & plan design

LCA

- Assess economically and environmentally
- Recycling technique
- Ranking of end-of-life options for glass fibre reinforced composites

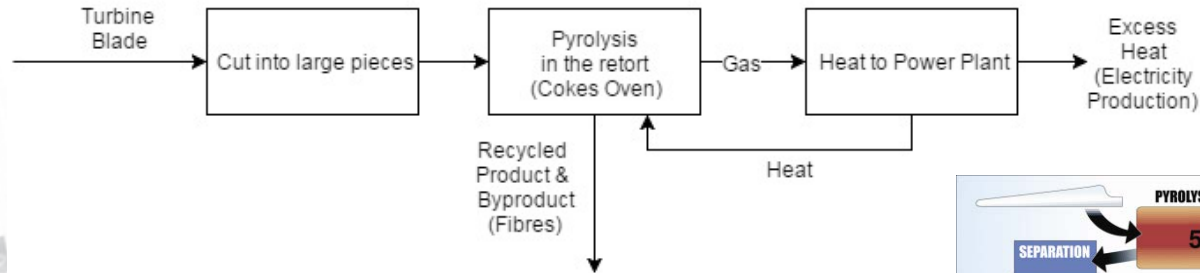
Involvement:

Research institute, project developers / owners, contractors, recycling / waste management companies

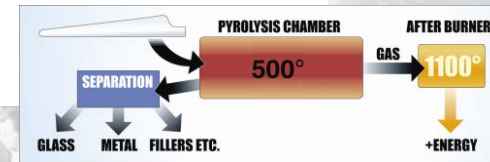
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BLADE RECYCLE PLAN

- › Conceptual design of full-scale pyrolysis plant and technology development plan
- › Environmental and economic benefit compared to landfill



- › Main advantage
 - › Experiment facility in TNO, Petten
 - › No shredding, process as large parts
 - › Plan for both a stationary and mobile plant, including the products usage



Blades for future turbines



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Waste hierarchy

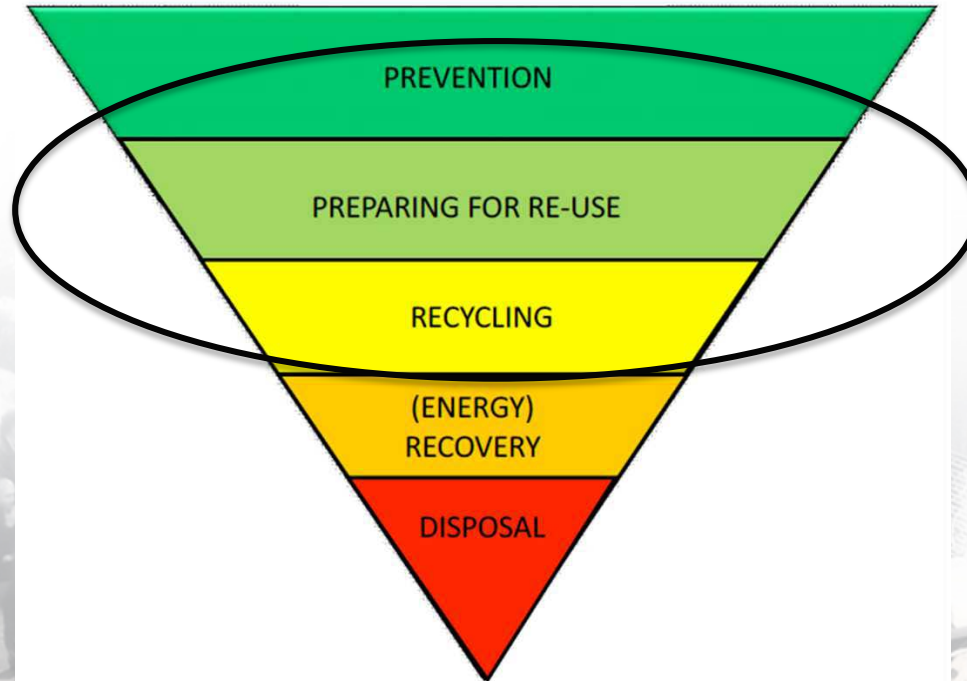
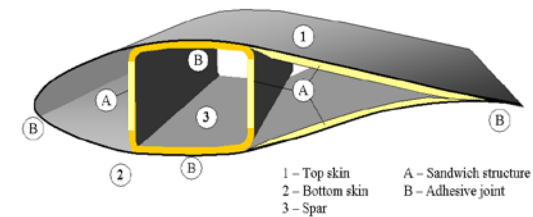


Figure 1.1. Waste Hierarchy, Source: European Commission



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APPROACH

Blade materials

- Load-carrying part out of current materials
- **Selection of shell materials** based on compatibility, processability, recyclability, costs
- **Cost & recyclability/re-use** evaluation

Blade design

- **Structural and aero design** of fairing with new materials
- Additional **benefits** of design & material selection: improved AEP
- **Cost & recyclability/re-use** evaluation

Blade manufacturing

- Study on **manufacturability** of fairings for future recycling/re-use
- Study on **joining and disassembly** of fairings and load carrying part (dissimilar materials)
- **Cost & recyclability/re-use** evaluation

Involvement:

University, Blade designer and manufacturer, research institute, material suppliers, Wind farm owners

Wind farm's future energy supply

FUTURE BLADES

- › New **blade concept**
 - › **Load-carrying structure** out of current materials
 - › **Shells** out of re-usable, more recyclable materials
 - › Design for aerodynamic performance, improved waste management, costs and manufacturability
 - › **Demonstration** of the hybrid blade technologies for a relevant blade section
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- › Main advantage
 - › Re-use of shell parts possible
 - › More AEP during lifetime
 - › Maintenance benefits
 - › Shells can be joined and disassembled from load-carrying structure



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Opportunities for wind turbine blades at end-of-life



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END-OF-LIFE SOLUTION FOR BLADES: NOW AND IN THE FUTURE

- Improved **waste management of blades:**

- Cost reduction
- Lower environmental footprint
- Economically viable

How?

- Efficient and effective **recycling technologies**
- **Hybrid blades** with improved recycling and even re-use
- **Economic framework** for recycling of blades

Interested to join this initiative?

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Thank you for your attention



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