

Closing the loop for wind turbine blades

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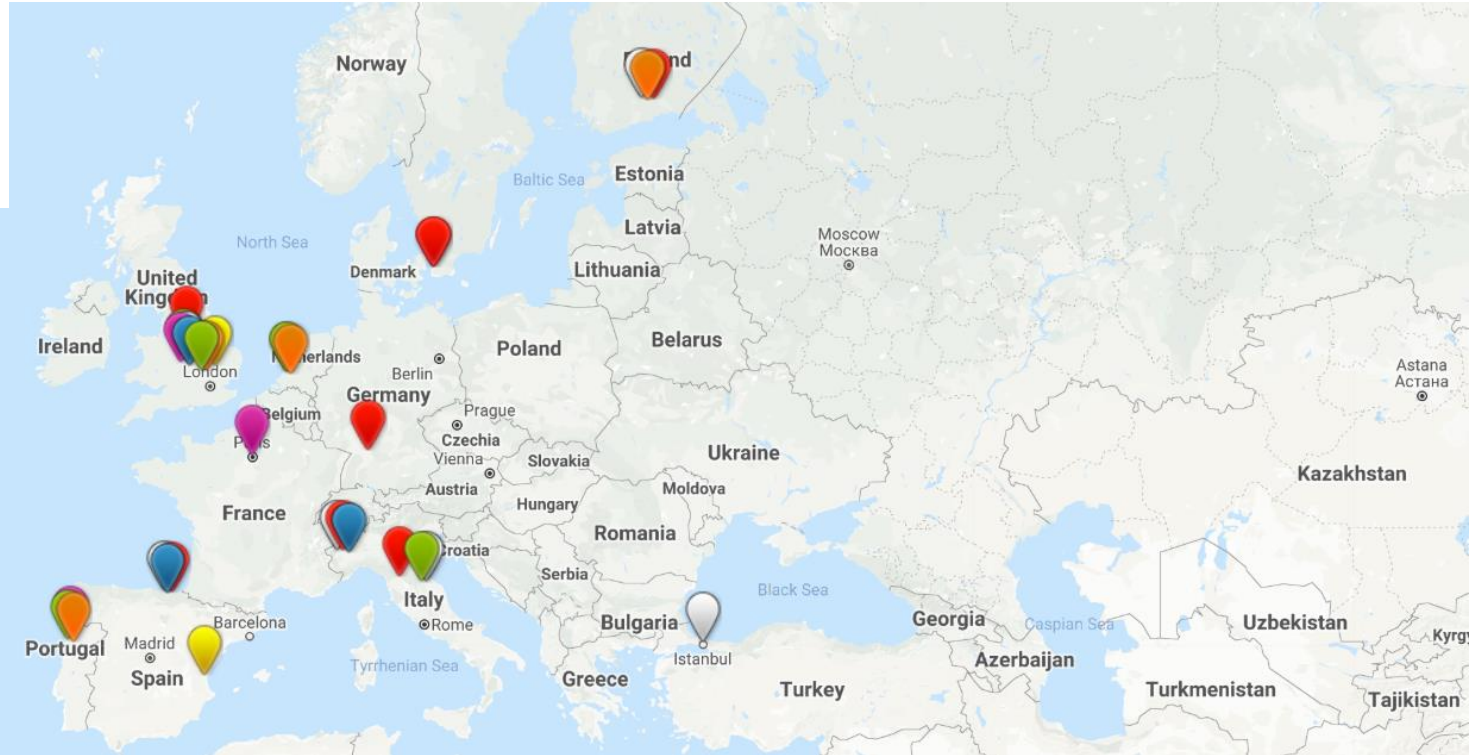
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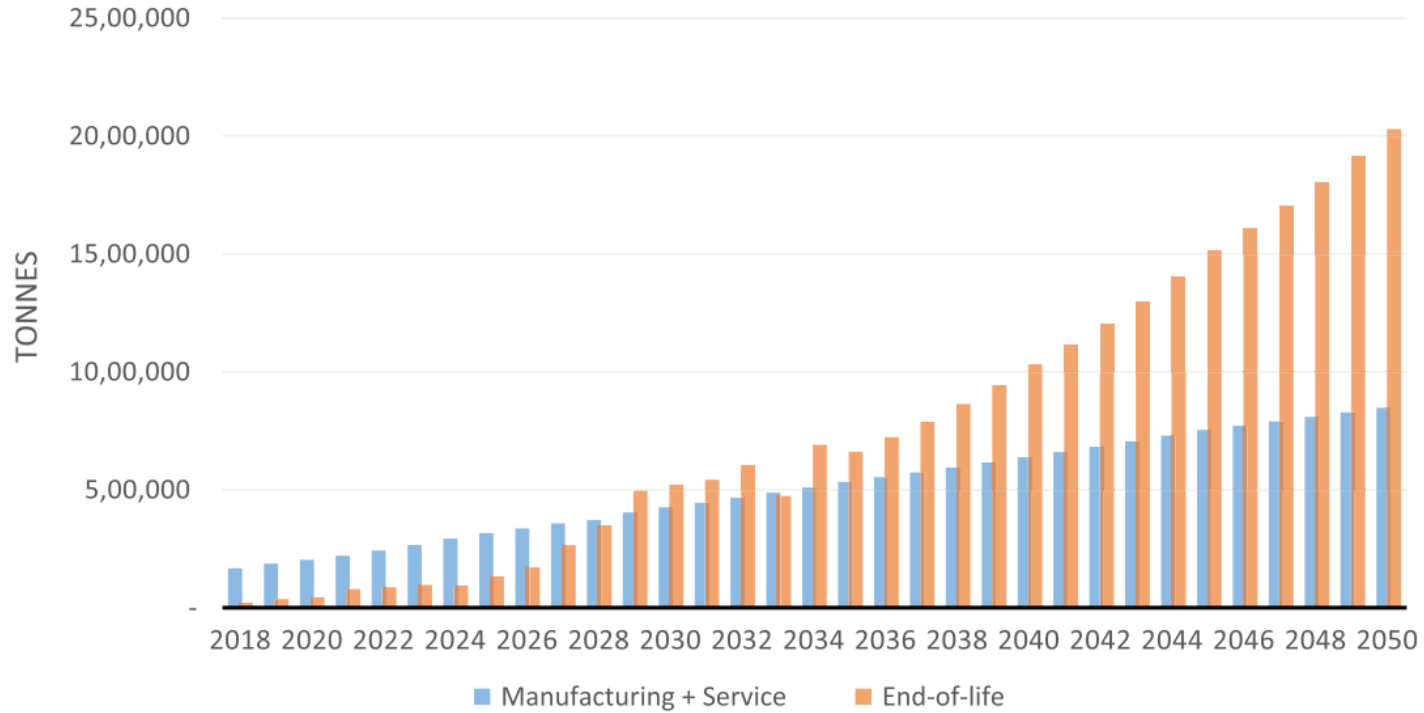
- 2017 – 2021
- 28 beneficiaries
- 12,2 M€
- Automotive
- Furniture
- Construction



Circularity of turbine blades is a must

- End of Life (EoL) considerations
 - 20-25 years life
 - Limited options for blades
 - Extended Producer Responsibility
- Public attention
 - Green energy vs. EoL problem
 - Global attention to plastic waste

Expected growth

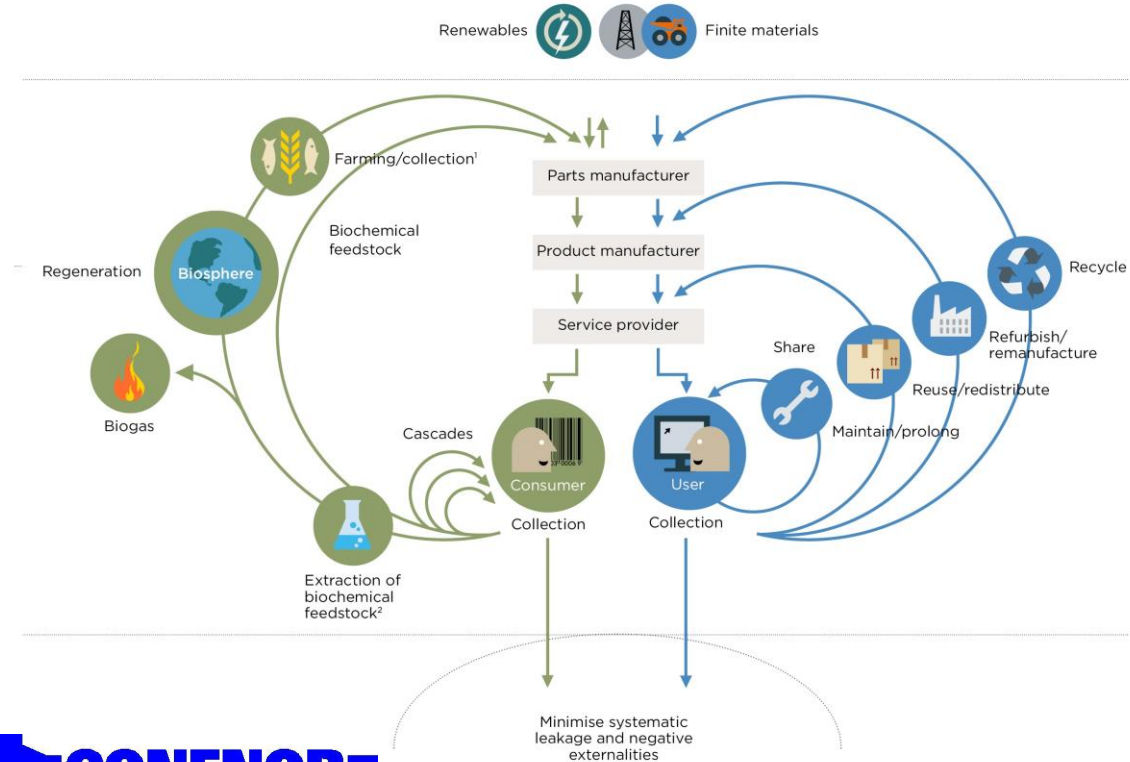


Current EoL solutions

- Reuse
- Recycle
- Landfill
- Incineration



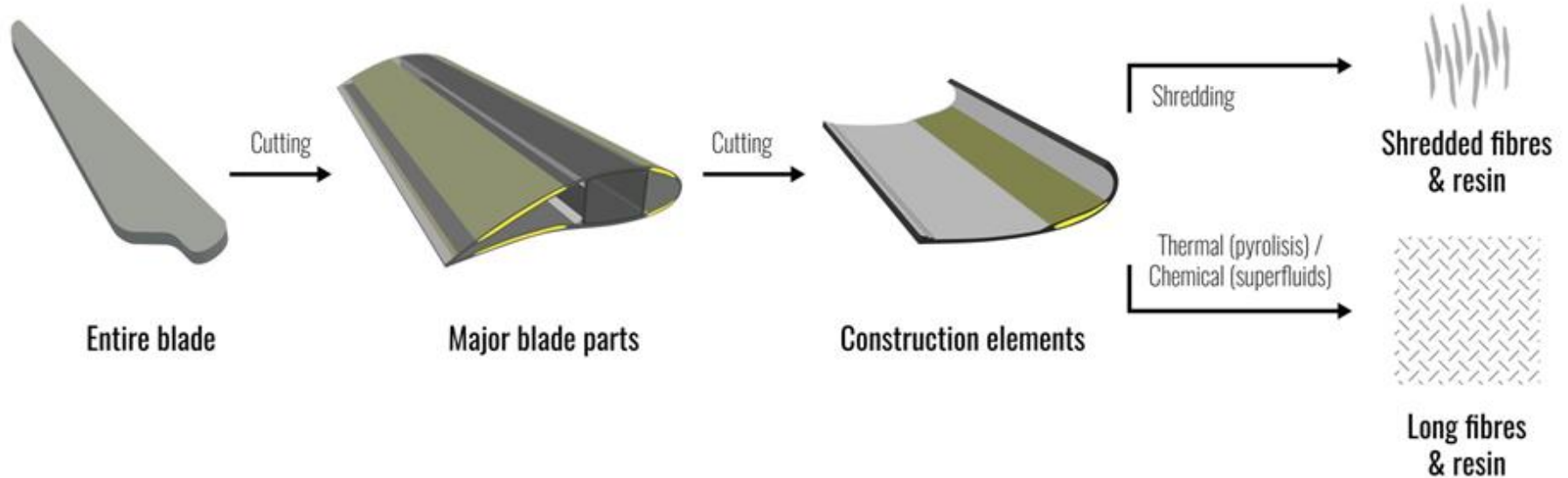
Circular economy



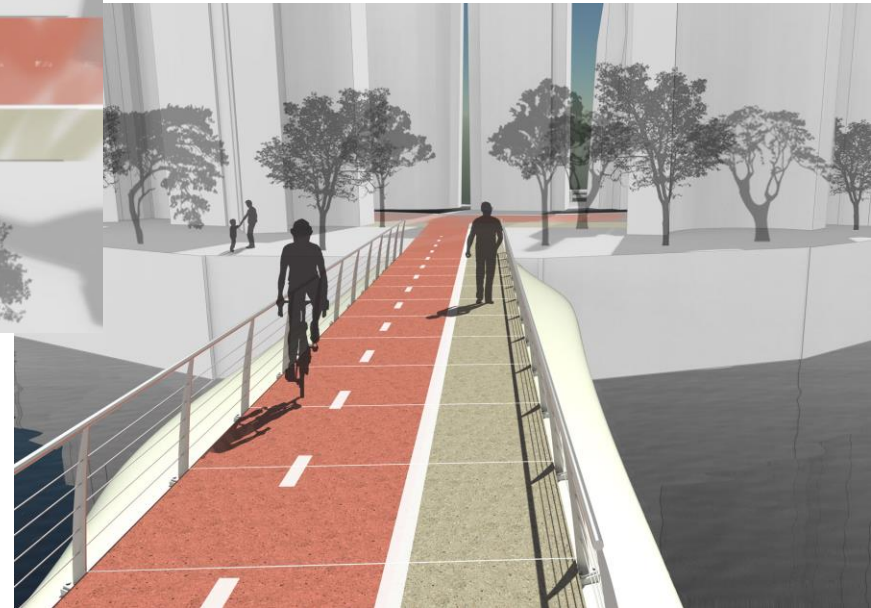
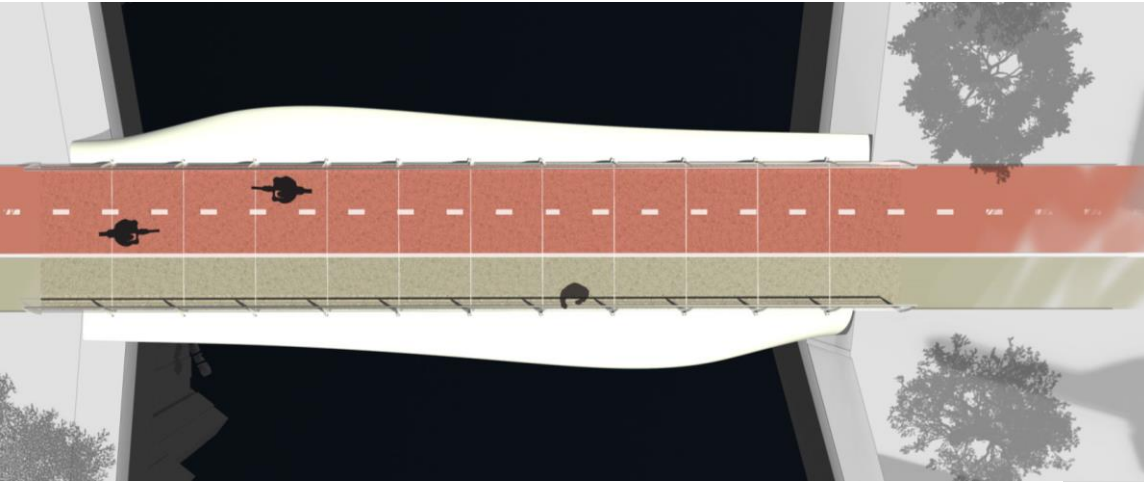
Recovery levels

Circular product design			
Design for product integrity			Design for recycling
Products and components			Materials
Long lifetime	Extended use	Product recovery	Recycling

Recovery levels



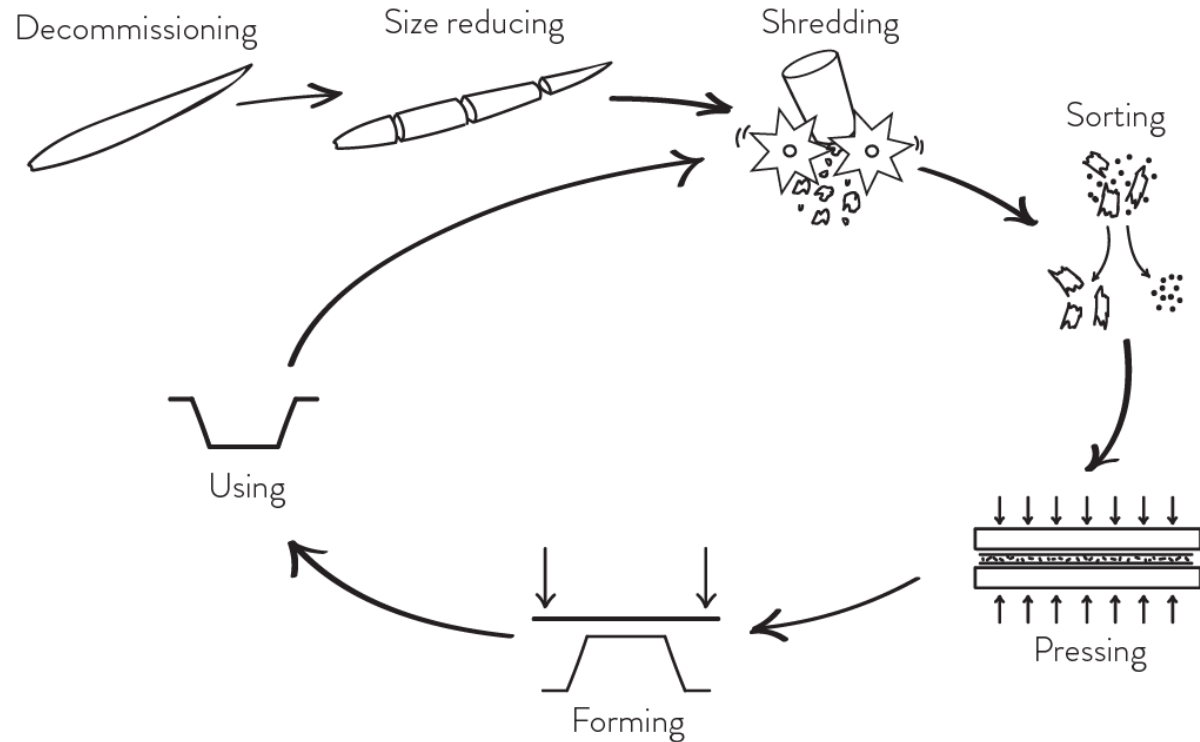
Design study: structural reuse



Design study: structural reuse

- Market potential
- Segmented construction
- Information
- Logistics

Design Study: Recycling WTB material



Design Study: Recycling WTB material

- Value
- Information
- Recyclability



Conclusions from design explorations

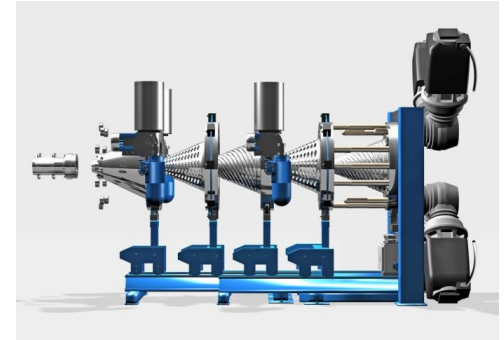
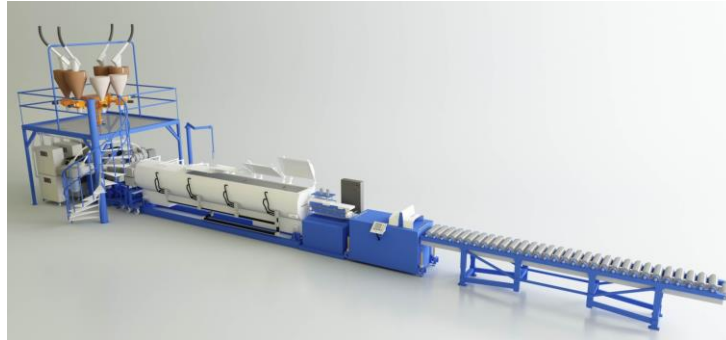
- Address EoL in design stage
- Conflicting requirements
- Opportunities for value preservation

About Conenor Ltd

- SME since 1995 developing innovative extrusion solutions
- Inventor of unique conical extruder CONEX[®]
- Providing outsourced R&D services in composites to industrial clients
- Participation recently in 4 EU-funded major R&D-projects – 2 ongoing
- Not a manufacturer but technology developer & provider

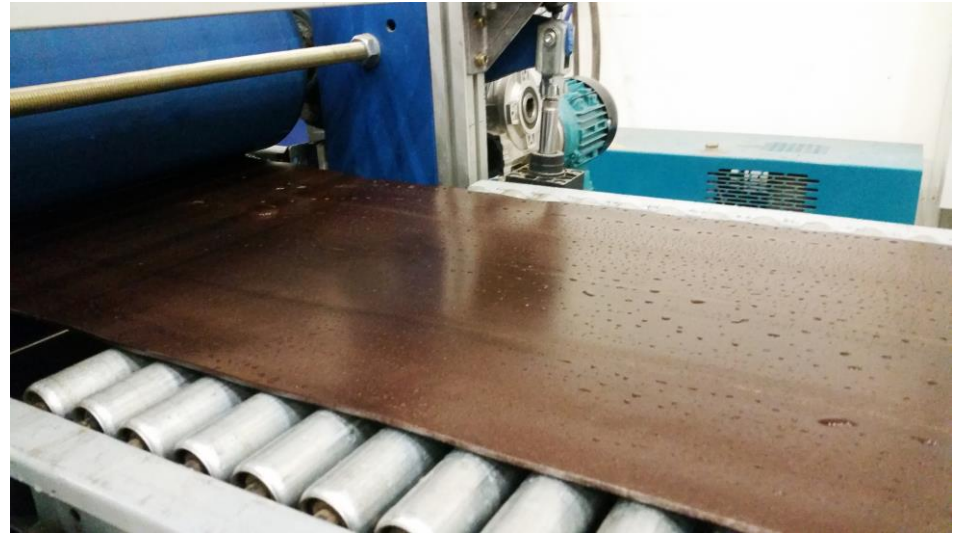


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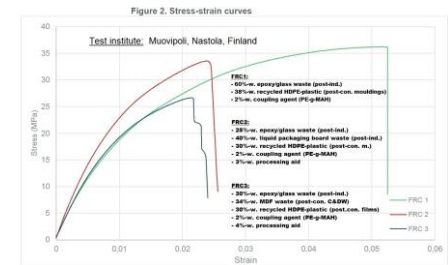
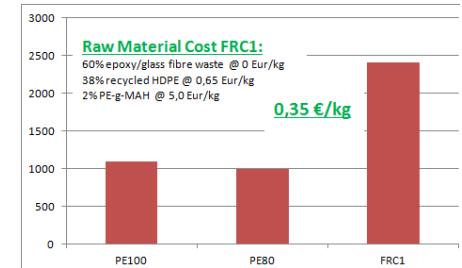
Recycling GFRP waste into thermoplastics

Extrusion of Multilayer Profiles & Panels



Recycling GFRP waste into thermoplastics

- Simple and low cost thermo-mechanical process invented by Conenor (*patent pending*)
- Applicable together with common thermoplastics (waste – recycled - virgin)
- Allowing other volume waste material fractions to be combined e.g. from construction and demolition
- Utilizing manuf. waste (clean) and EoL waste (cont.)
- Proven with dozens of formulations in Ecobulk
- Initial lab test results available and testing ongoing



Recycling WTBs into thermoplastics

Processing in 3 main steps

- 1) Downsizing blades by cutting and shredding including metal separation
- 2) Production of material formulations by hot mixing ;
 - agglomerates for extrusion
 - granules for injection moulding and other
- 3) Extrusion or injection moulding or other



Recycling WTBs into thermoplastics

Typical Material Formulation (%-w.)

- WTB waste 35%
- Recycled HDPE 30% (e.g. from packaging)
- Wood waste >25% (e.g. from demolished buildings)
- Fillers & Additives <10%

Recycled & waste material content >90% !



Recycling WTBs into thermoplastics

Synergy with commercial LFTs

- LFTs are widely used in various industries
- Fibres embedded in a thermoplastic carrier
- Sold at high prices – available worldwide
- In recycled WTBs the cured thermoset (epoxy etc.) serves as a filler and carrier for producing GF-reinforced recycled thermoplastics

... AND the price becomes much much lower !



Recycling WTBs into thermoplastics

Stronger and stiffer at lower cost

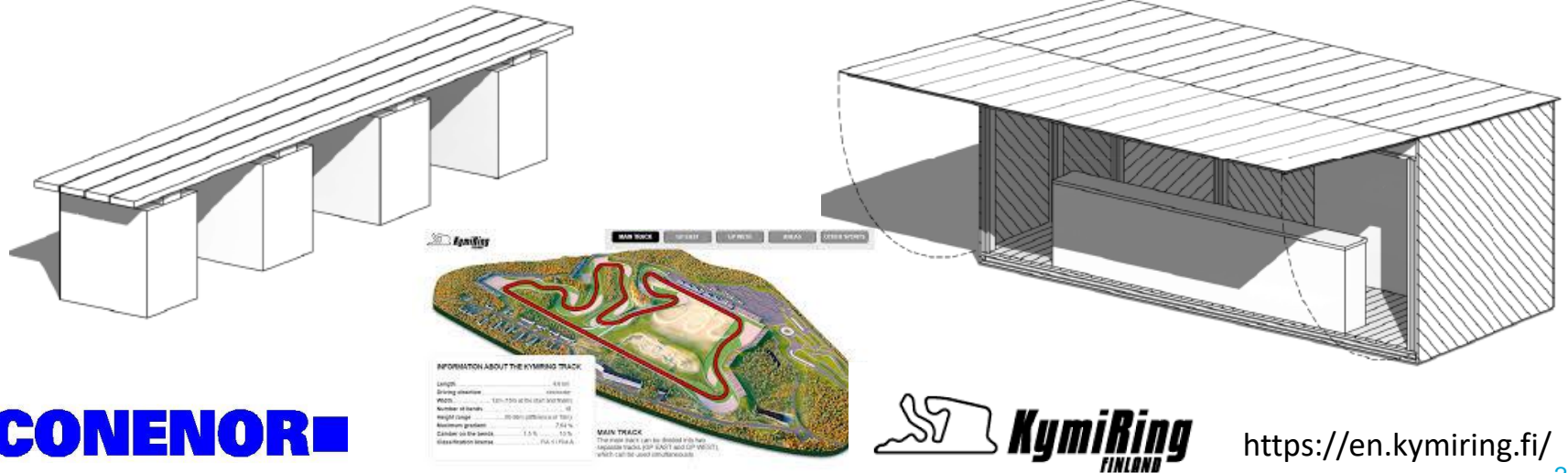
- reinforcement in mechanical properties from glass fibres
- stronger and stiffer thermoplastic recyclates can be used in higher added value structural applications where they are today non-compatible
- new reinforced and low cost plastic material from waste enables profitable new volume business
- specific characters e.g. fire retardancy applicable



Recycling WTBs into thermoplastics

Applications in outdoor infrastructure (examples)

- shelters, storages, cabins, huts, benches, signs etc.



Recycling WTBs into thermoplastics

Market Exploitation

- ❖ Ecobulk provides an excellent R&D platform with multiple large scale demos and international publicity for proof of concept
- ❖ Conenor being a technology provider aims to license the material manufacturing technology worldwide to anyone interested



Recycling WTBs into thermoplastics

Example Volume Calculation

- weight of one blade 5ton – in formulation @35%
- medium size extrusion plant 10 lines @2000ton/a
- annual consumption of WTB-waste 7000ton/a equals recycling 1400 blades/a
- 5 good size extrusion plants having 20 lines would be recycling 14.000 blades/a

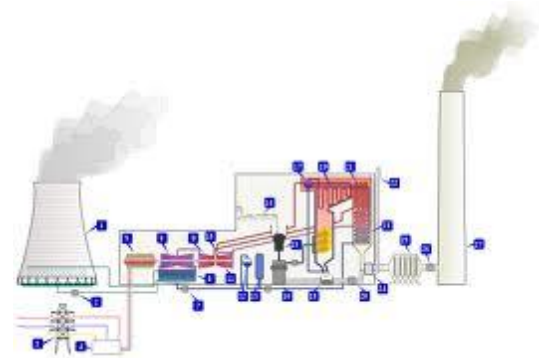


Recycling WTBs into thermoplastics

More attractive at incineration - EoL

Incineration of one blade @ 5ton

- blade materials; ~ glass fibres @59% + polymers etc. with caloric value @39% + 2% metals etc.
- direct incineration provides 1950kg of materials with caloric value
- recycling blade first into thermoplastics @35% provides 5200kg - more than double energy !



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