



Recycling of GFRP composite

Developing viable products from waste GFRP

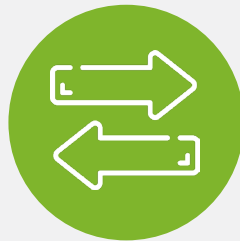
Current context



A growing waste problem

- Significant stocks of composite materials exist within the transport, construction, energy and marine industries. Within wind turbines alone there is a stock of 2.5 million tonnes of GFRP.
- In 2017, the European market for GFRP was over 1.1 million tonnes and demand and applications for composite products is growing.
- In Europe an estimated 304,000 tonnes of composite waste was generated in 2015.

This is a growing problem with a long tail before any new composite design developments make materials more recyclable.



What are the current alternatives?

- Currently most GFRP composite waste is landfilled or incinerated.
- Thermal and chemical recovery – experimental and focused on carbon fibre recovery and reuse.
- Cascading – repurposing of large scale assets (e.g. wind turbine blades as bridges).
- Regrind as fillers and/or reinforcements.
- Alternative fuel in cement kilns.

We need to find higher value and circular outcomes for end of first life GFRP.



Changing contexts

- The EU 'A new circular Economy action plan' 2020 – highlighted plastics and the construction as sectors where greater focus is needed.
- Upcoming developments: EU Strategy for a Sustainable Built Environment including revision of the Construction Product Regulation (possible introduction of recycled content requirements for certain construction products).
- Development of extended responsibility legislation, taxes and public/corporate commitment to encourage recyclability and use of recycled materials in products.
- Industry needing alternatives to landfilling (bans, lack of space, taxes) and seeking solutions higher up the waste hierarchy.

The composite industry and its customers need to consider and start responding to these pressures.

About ECOBULK

- EU H2020 funded project developing circular economy solutions for bulky composite products.
- It aims to make demonstration products for the construction, furniture and automotive sectors.

ECOBULK and Conenor: Highlights



Customer **demand for effective solutions** to waste GFRP challenges.



High growth rates in end of life GFRP across Europe in key sectors – construction, wind energy, marine, aviation and automotive.



Technical knowhow needs to be developed to scale up this solution.



Conenor has developed low cost process technology to utilise GFRP waste streams as reinforcement in thermoplastic composites.



Product outputs are versatile, practical in nature and fit within growth markets (outdoor furniture, construction products, railway crossties etc.).



With the right labelling and passport system development, the product can be reground and reused – so it could be part of more **circular outcomes** for waste streams arising over the next 25-50 years.



Creates a strong narrative for those organisations looking to find solutions to waste GFRP problems.

ECOBULK is testing the viability of the technology at pilot scale through demonstration projects, economic and environmental analysis.

Outputs

Profiles

Outputs can be panels and other construction beams ranging in size and shape. They have up to 50% waste GFRP:



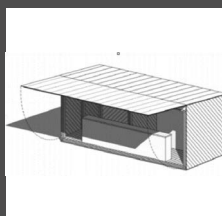
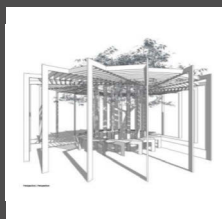
Single layer or multilayer



Solid or hollow

Demonstration products

Outputs can be used for a range of structures. The examples here have been developed as ECOBULK demonstration products:



Other potential products

The same processes could also produce a range of products for use within municipal infrastructure, transport and other sectors, for example:

- Bollards, kerbstones, posts. Pillars, fence panels and guardrails.
- Decking and other flooring.
- Railway sleepers and other railway infrastructure.
- Outdoor furniture.
- Panels for use in marine environments e.g. docks, retaining walls and tidal defence structures.

About the material

Production Process

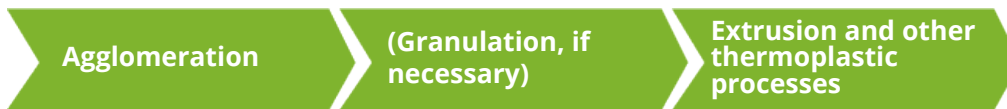
Pre-processing of input composite waste

Tasks undertaken before the cured thermoset GFRP-waste can be used depend on the type of waste being recycled. Post production clean waste, for example, will require less pre-processing than a End-of-Life large wind turbine blade.



Production of profiles & panels

The challenges of extruding contaminated GFRP-waste are managed through the use of multilayer product structures made in co-extrusion and the correct specifications of components within the agglomeration process. Clean and higher quality sorted waste can be used to produce single layer products.



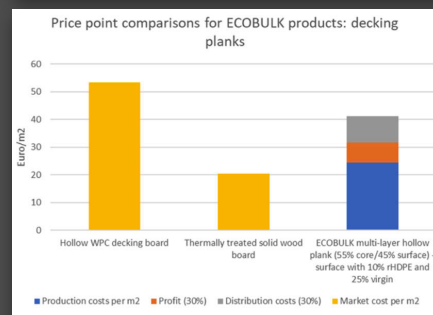
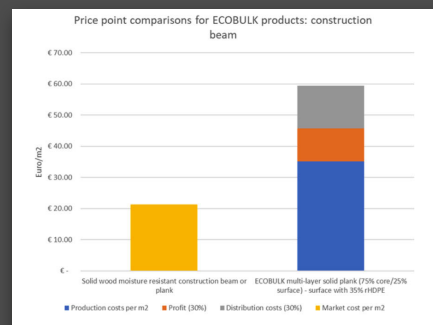
Economic and Material Analysis

Compared with market equivalent products, ECOBULK products are within the range of some product types but slightly higher for others (e.g. some wood alternatives).

Full life cycle costing will be undertaken as part of ECOBULK. Reduced maintenance and surface treatment, plus longer lifespans when compared to wood alternative will influence full life cycle costings.

Please note:

- Waste composite particles have zero cost to the process.
- Economies of scale have not been costed in for the ECOBULK products.
- No gate fee for waste disposal, costs of downsizing to the 'particle' size needed or transport costs are included.
- No CAPEX or depreciation costs are included.
- Profit and distribution costs have been added separately (grey/orange bars) allowing alternative analysis of costs.



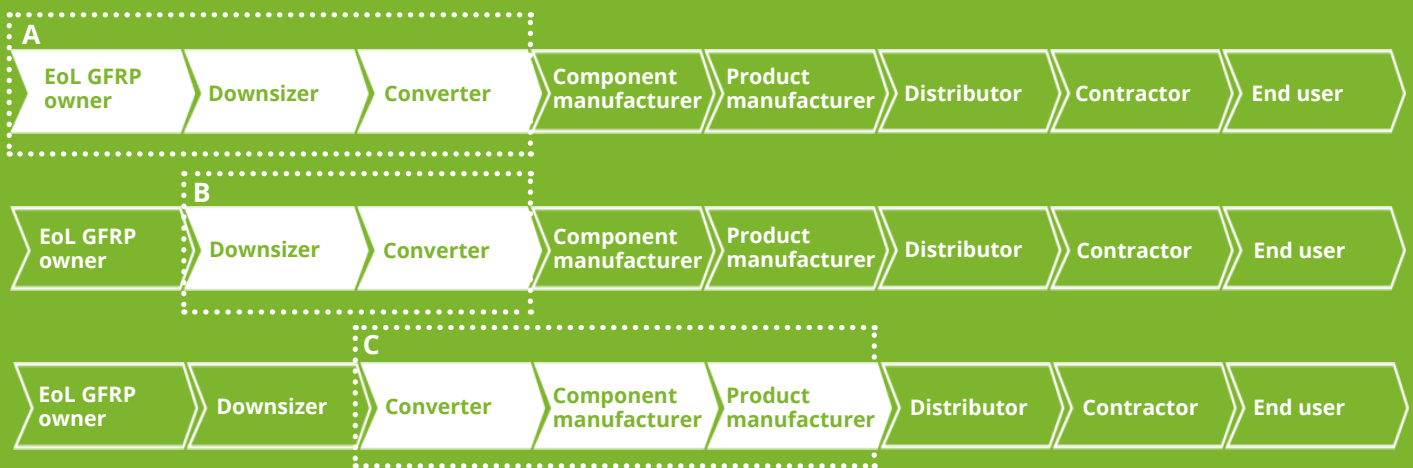
Compared to quality commercial WPC decking boards: ECOBULK hollow boards (140x28mm) with FRP-waste are stronger and stiffer in dry as well as wet conditions.

Compared to commercial plywood panels: ECOBULK composite panels 390x10mm with FRP-waste remain stronger and stiffer when getting into contact with water (EN-test method).

Typical material values:

- density 1.2 - 1.4 g/cm³.
- flexural modulus (MOE) 3-5 GPa.
- moisture absorption & dimensional swelling (28d water soaking) +/- 0%.
- EN fire rating class B-d0-s2 (optional).
- surface hardness Brinell (HBS 10/3000) 60-100.
- no rotting, no mould growth, no leaching, pesticide free, formaldehyde free.
- flexural strength (MOR) 30-50 MPa.

Application of this solution



Collaboration within the value chain

- Economically challenging aspects of the chain (e.g. downsizing and transport) need to be considered and supported within the value chain. Closer collaboration with fewer separate stakeholders would increase the commercial viability of this proposition. Options A, B and C (opposite) demonstrate where greater value chain collaboration would secure better outcomes.

Development of end markets

- Producers and other beneficiaries of composite markets MUST support the further development of recycled materials, products and new applications or the outputs of the recycling process.

Financial support from the industry

- Support with the development of the value chain and infrastructure to enable the application of solutions.

Regulatory intervention

- Removing cheaper, less sustainable disposal routes and imposing obligations (e.g. tax or producer responsibly) to encourage other end of use options.

For further information on ECOBULK:

please see the project website: www.ecobulk.eu and sign up for the newsletter.



For further information from Conenor:

please contact [Markku Vilkki \(markku.vilkki@conenor.com\)](mailto:Markku.Vilkki@conenor.com) or see the website www.conenor.com

For further information from Oakdene Hollins:

please contact [Olivia Bertham \(Olivia.Bertham@oakdenehollins.com\)](mailto:Olivia.Bertham@oakdenehollins.com) or [Rachel Waugh \(Rachel.Waugh@oakdenehollins.com\)](mailto:Rachel.Waugh@oakdenehollins.com) or via the website: www.oakdenehollins.com

Disclaimer

This document is not a prospectus. The economic information presented in this report is indicative only. There are number of variables and assumptions made in undertaking this economic assessment. Where possible these have been made clear. This information should not be used as the basis of any commercial decision making without independent evaluation. These costings have been undertaken by Oakdene Hollins for the EU H2020 project ECOBULK. We do not accept or assume responsibility for any other purpose or to any other person to whom the results are shown or into whose hands it may come, save where expressly agreed by our prior consent in writing.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730456