

Converting composite plastic  
waste into circular recycled  
materials and products



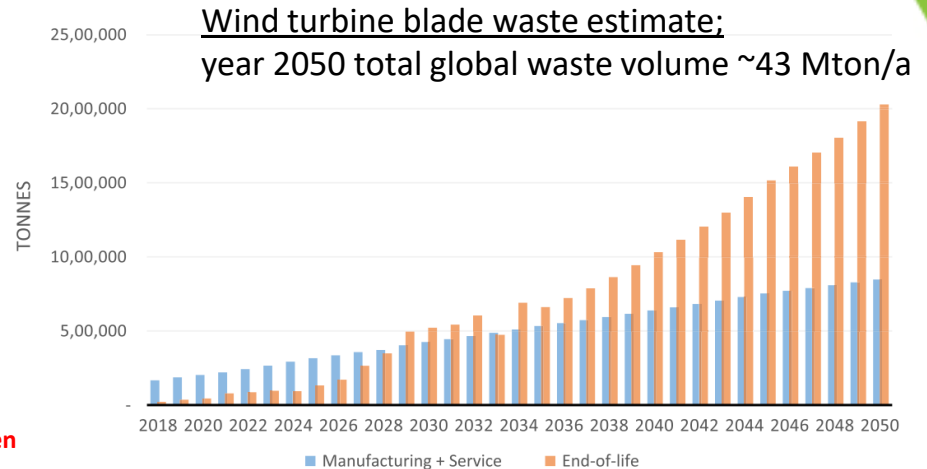
# Problem

**Glass- and carbon fibre reinforced plastics (FRP) from wind turbines, marine, automotive, infrastructure etc. are not recyclable and create a massive global environmental problem and total waste of resources**



**Zu geringe Recyclingkapazitäten für Rückbau von Windenergieanlagen  
UBA-Studie betrachtet Umweltaspekte des Recyclings alter  
Windenergieanlagen**

<https://www.umweltbundesamt.de/presse/pressemitteilungen/zu-geringe-recyclingkapazitaeten-fuer-rueckbau-von>



# Blade recycling is a top priority for the wind industry

## News from Wind Europe 12 February 2020



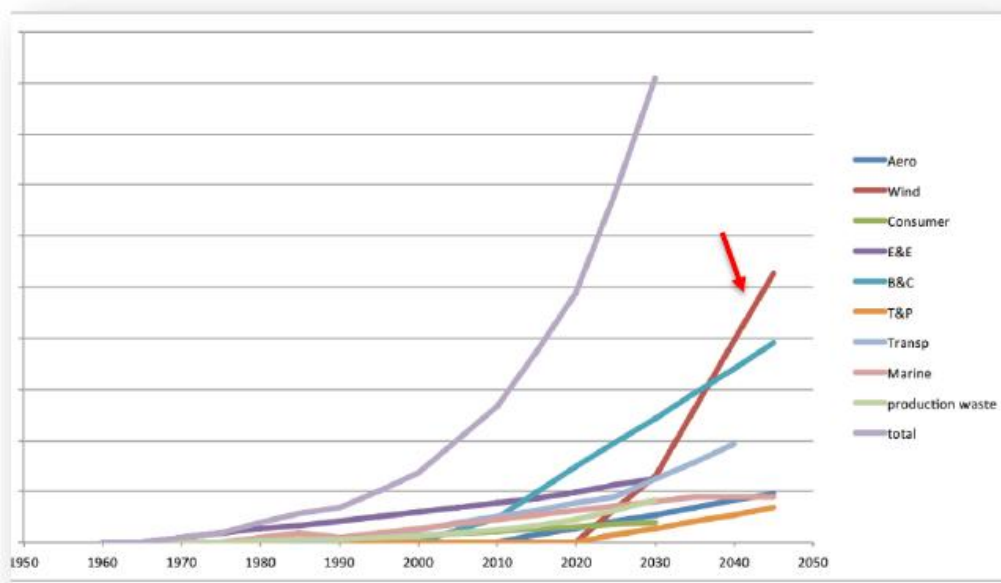
<https://windeurope.org/newsroom/news/blade-recycling-a-top-priority-for-the-wind-industry/>

Making turbines 100% recyclable is an important task for the wind industry as the EU heads towards a circular economy.

But turbine blades represent a specific challenge. Wind turbine blades are made up of composite FRP-materials that boost the performance of wind energy by allowing lighter and longer blades. Today 2.5 million tonnes of composite FRP-material are in use in the wind sector globally.



# The Problem is not only with the blades..



Many other industries face the same problem how to recycle annually rapidly growing amounts in millions of tons GFRP-waste sustainably ;

- Aero
- Marine
- Construction
- Consumer goods
- others

# ”Recycling” with thermosets is not a solution

- ❖ GFRP-waste is **not recyclable** “ as is” because of its crosslinked polymer chain matrix which makes the material **cured thermoset** in contrast with **thermoplastics** which can be recycled and re-molded several times into new products
- Re-manufacturing technologies utilizing **virgin thermoset resins** e.g. polyester, epoxy, polyurethane are not solving the GFRP-waste recycling but **are creating another even bigger and much more complex recycling problem for the next generations which is totally non-acceptable**
- ✓ Equally as recent developments in creating a circular thermoplastic based GFRP materials like Elium® by Arkema, the current **GFRP-waste problem from the past materials must become recycled sustainably with recycled thermoplastics** e.g. PE/PP that are circular materials



# Disposal in cement kiln is not recycling

Ref. SusChem; Polymer Composites Circularity – White Paper <http://www.suschem.org/publications>

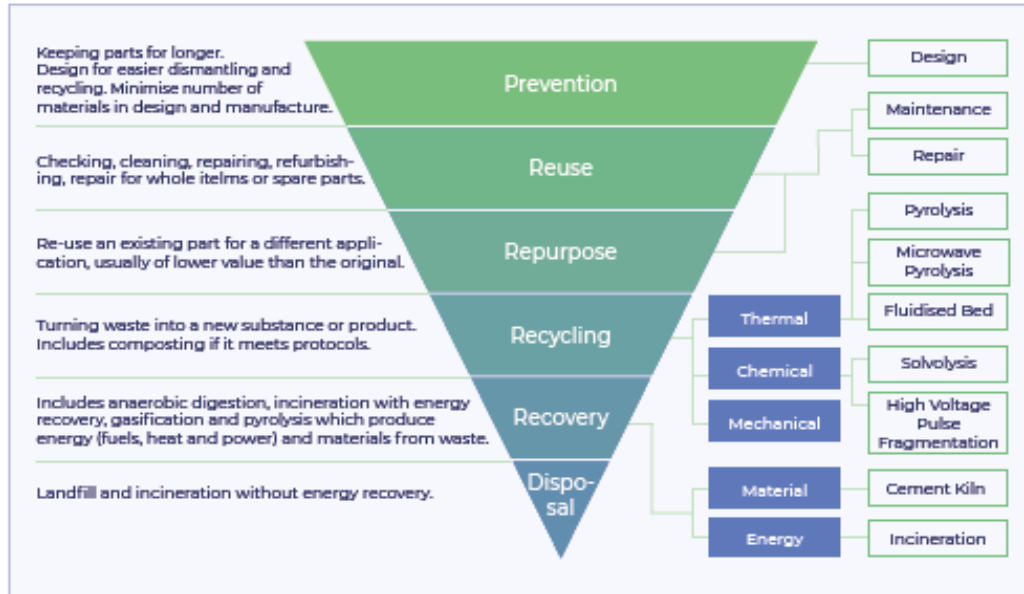


Figure 4. Waste management categories hierarchy

## Waste management hierarchy

Disposal of GFRP-waste in cement kiln is a co-process for energy and material recovery.

The outcome is not circular.

# Solution

Patented low cost agglomeration technology to utilize FRP-waste as reinforcement in circular composite construction materials and products

**stop landfilling**



[photo by Bloomberg Green \(USA\), 2020](#)

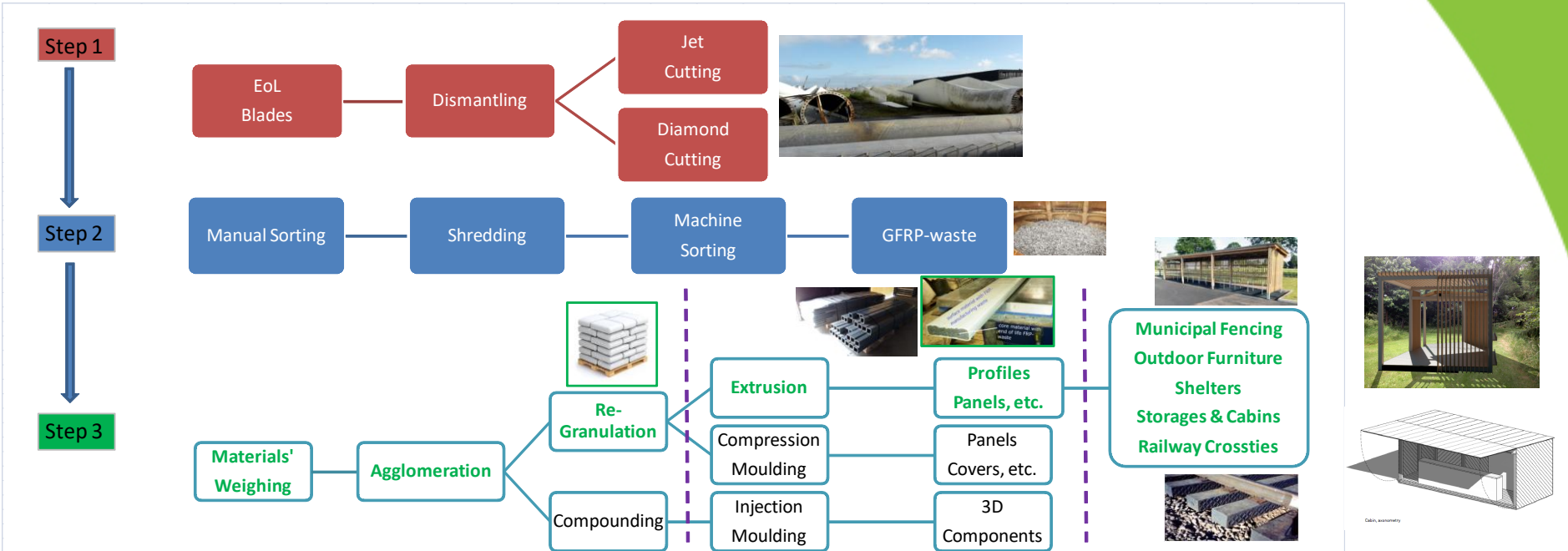


**recycle FRP-waste**



# Solution

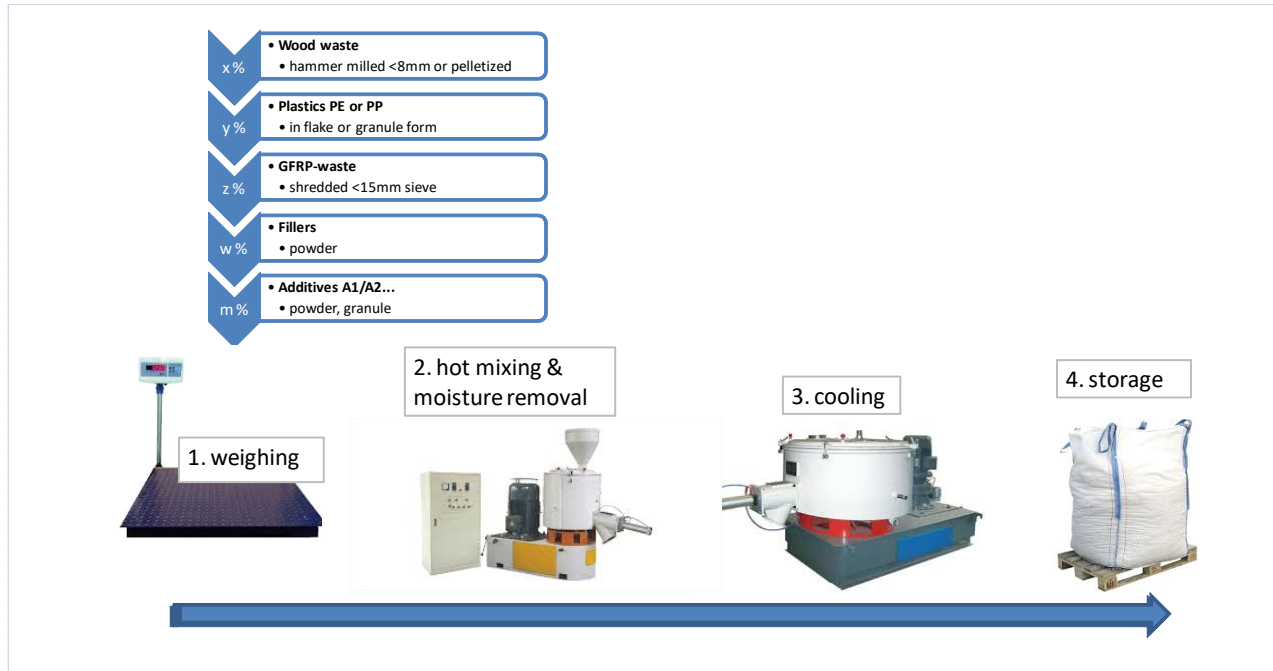
Patented low cost agglomeration technology to utilize FRP-waste as reinforcement in circular composite construction materials and products





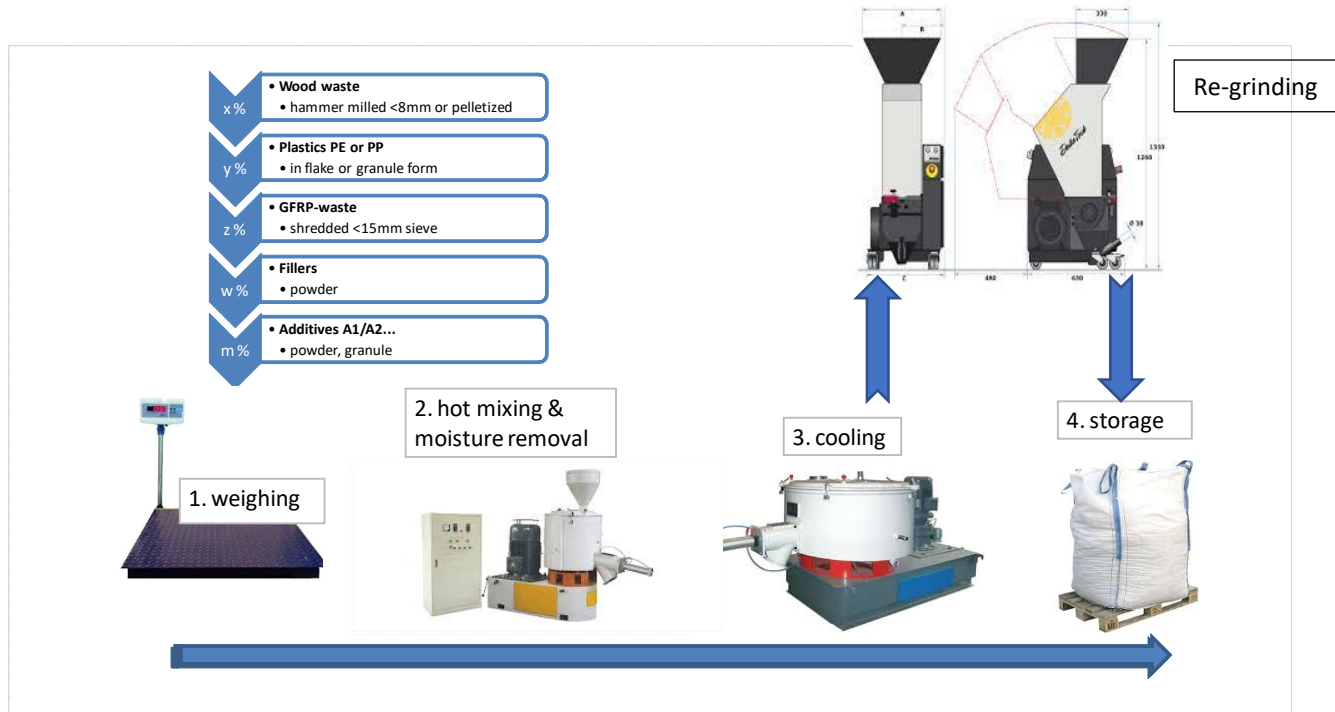
# The Key - Agglomeration Process

”Produce random sized thermoplastic agglomerates with FRP-waste”



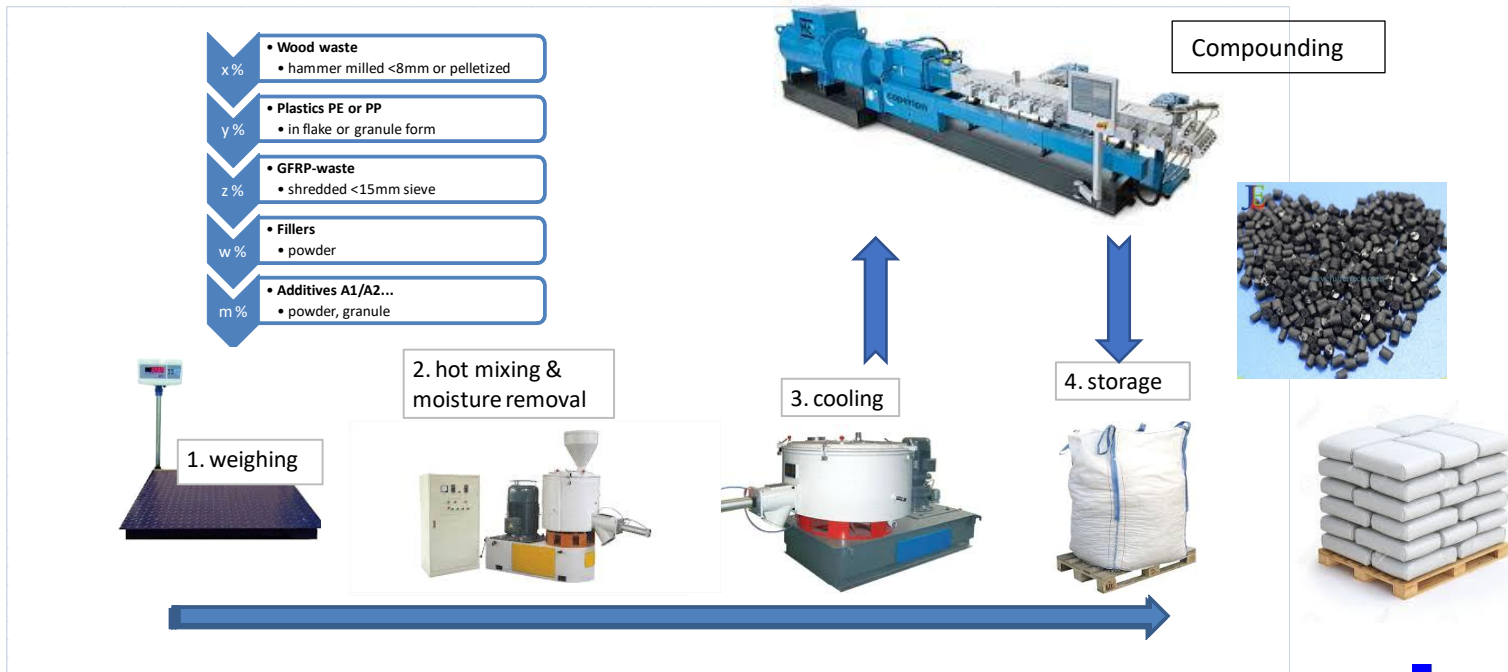
# Re-grinding Agglomerates

”Produce 90% dust free molten lumps and re-grind small”



# Compounding Agglomerates

”Produce dust free homogenous standard sized granules/pellets”



# Strategic partnerships

## European Patent on the Agglomeration Process EP 3159127 B1



### Manufacturing

- Agglomerates
- Re-grinded agglomerates
- Agglomerates compounded in pellets



### *Business Strategy*

Market entry in collaboration with selected plastic processing equipment manufacturers for GFRP-waste shredding companies enabling their new business with added value raw materials

# International Patents – Material Processing



**Canada – granted**  
*(CA 2994054)*



**USA – granted**  
*(US 10,843,382)*



**China – pending**  
*(grant expected Q4/2020)*

# International Patenting – Multilayer Products



Following the material processing patent, another **product patent** application WO 2020/148484 A1 filed January 13<sup>th</sup> 2020;

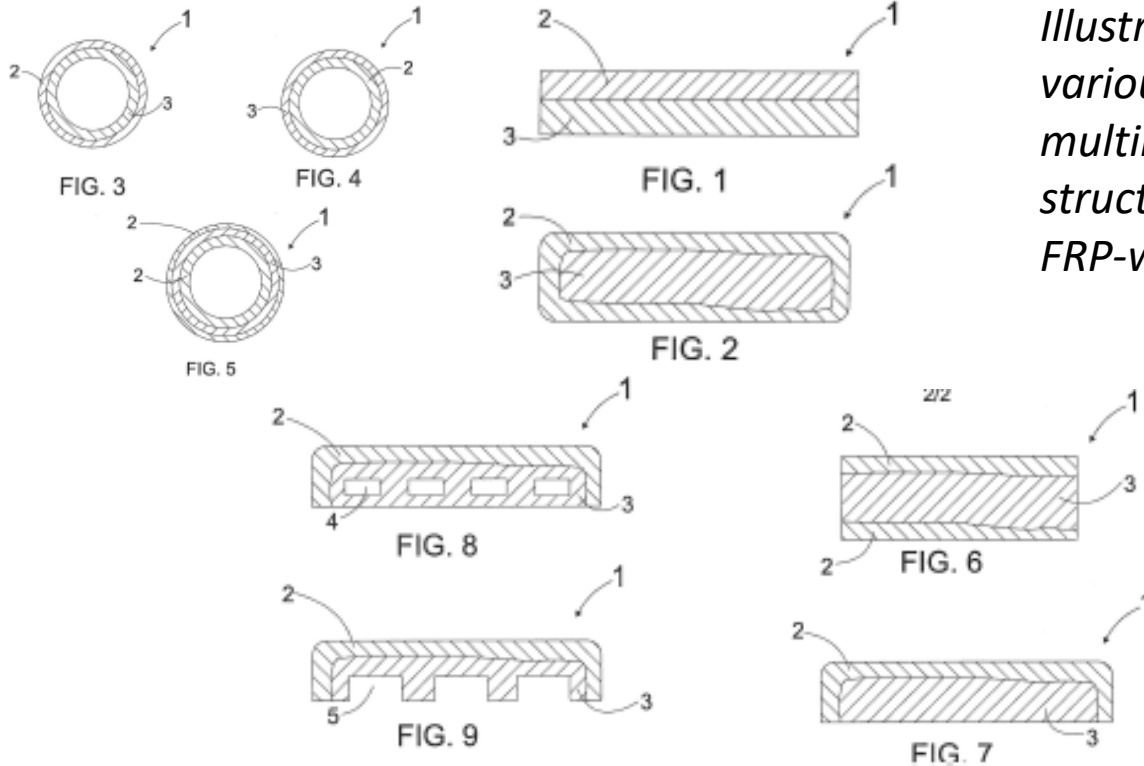
*“MULTILAYER PRODUCT AND METHOD OF FORMING A MULTILAYER PRODUCT”*



“A multilayer product, characterized in that the multilayer product has at least two layers, at least one of which consists of End of Life waste of fibre reinforced thermosetting plastic or discarded production waste of fibre reinforced thermosetting plastic combined into a thermoplastic matrix, ...”



# Multilayer Product Structures (*pct application*)



*Illustrations of various shapes of multilayer product structures with FRP-waste...*



# in Finnish Media

Head line news at  
Tekniikka&Talous  
3.12.2019  
Internet version

29.11.2019 Sivut 1 | 39 | 2019 | Tekniikka&Talous

Liikkuva sääsuojia turvaa puurakentamisen | Robotti hioo vielä melko kehnosti | Korkeakoulutettujen tarve kasvaa hurjaa vauhtia

# 39 Tekniikka & Talous

29.11.2019 83000 LUKIJAA | HINTA 4,30 EURA | WWW.TEKNIKKATALOUS.FI



Click page


## ONGELMA-JÄTETTÄ

Tuulivoimaloiden lapojen uusiokäyttö aiheuttaa päänvaivaa. Ratkaisu saattaa löytyä pienestä suomalaisverstaasta.

**TilaaJoo**  
40 miljoonaa tonnia ongelmajätettä yhäältä: Maa ilma hukkuu tuulivoiman lapoihin - Ratkaisu voi löytyä pienestä suomalaisverstaasta 12:00

**Uusimmat**  
Näin "kännyssäväkiden" toimitukset kalliivat ensi vu 13:00

**TILAAJILLE**  
40 miljoonaa tonnia ongelmajätettä yhäältä: Maa ilma hukkuu tuulivoiman lapoihin - Ratkaisu voi löytyä pienestä suomalaisverstaasta 13:00



**Risto Siilasmaa lähtee Nokian hallituksesta - Sari Baldaufista seuraaja puheenjohtajana** 15:12 | **UUTISTAVAINEN**

**Näin Nokian Siilasmaa helkutti terveysteknologian: "260 miljardin markkina" - nyt harkinnassa luopuminen** 15.2.2019 | **TEKNIKA**

**He ovat vahvimmita Suomen seuraavaksi pääministeriksi - "olen vasemmistolainen sosialidemokraatti"** 15:16 | **PUHEKKA**

**Pääministeri Rinne jätti eronpyyntönsä - Presidentti hyväksyi eron** 13:38 | **PUHEKKA**

100 TOISEKSI | TILAA RAKENNUSLEHTI | TILAA UUTISKIRJE | TOIMITUS

# tuulivoima

Koulutus ja tutkimus | Energiatieteiden tutkimuskeskus | Rakennustuote uutiset

## Ongelmajätteeksi jääneestä tuulivoimaloiden lujitemuovista syntyy komponentteja rakentamiseen

Orimattilalainen Conenor on kehittänyt menetelmän lasikuidulla lujitetun kertamuovin kierrättämiseen.

Assi Orenmaa | 22.3.2018 | 5



Click page

<https://yle.fi/uutiset/3-9923884>

<https://www.delete.fi/deletelehti/artikkelit/kierrattamalla-uusiomateriaaliksi/suomen-vanhin-tuulivoimalapuisto-purettiin-ja-materiaalit-kierratettiin?origin=item6>





# Presentations at wind industry conferences

## Wind Turbine Blade Manufacture, Dusseldorf, Germany

- [year 2018 presentation](#)
- [year 2019 presentation](#)



## International Energy Agency (IEA), Rome, Italy

- [presentation 2019](#)



## + News in international press, WMW, 2018-03-20

<https://waste-management-world.com/a/european-circular-economy-project-researches-wind-turbine-blade-recycling>



# ECO-INNOVATION in the EU Environment Action Plan

The screenshot shows the European Commission website for the Eco-innovation Action Plan. The header includes the European Commission logo and the text 'ENVIRONMENT Eco-innovation Action Plan'. A breadcrumb trail reads: 'European Commission > Environment > Eco-innovation Action Plan > Eco-innovation in practice > Research & Development > Tackling the toughest circular economy challenges'. Navigation menus for 'Home', 'About us', 'Policies', 'Funding', 'Legal compliance', and 'News & outreach' are visible. A search bar and a 'NEWSLETTER' sign-up button are also present. The main heading is 'ECO-INNOVATION at the heart of European policies'. A horizontal menu below features icons for 'Start', 'Policy and Funding', 'Eco-innovation in practice' (which is highlighted), 'Country profiles', 'Eco-innovation indicators', 'ETV Environmental Technology verification', 'News & events', and 'Community platform'. The main content area is titled 'TACKLING THE TOUGHEST CIRCULAR ECONOMY CHALLENGES' with a sub-header 'CIRCULAR ECONOMY' and a date '30/03/2020'. An image shows a factory interior with machinery. The text below the image states: 'Some materials fit more easily into the circular economy than others. Nearly all food and drinks cans and other steel packaging, for example, are recycled. But some materials present a much tougher challenge. Fibre-reinforced plastic (FRP) is a composite of plastic and glass, carbon and other fibres, used in numerous applications including vehicle components, doors, bathtubs and wind turbine blades. From an environmental point of view, FRP offers significant benefits because it is light, strong and long-lasting. For example, FRP components reduce the weight of vehicles, cutting their fuel consumption and thus their greenhouse gas emissions. FRP is vital for the ever-larger blades of wind turbines.'

[https://ec.europa.eu/environment/coap/about-eco-innovation/research-developments/tackling-toughest-circular-economy-challenges\\_en](https://ec.europa.eu/environment/coap/about-eco-innovation/research-developments/tackling-toughest-circular-economy-challenges_en)

# Awards – Enel Green Power

## EGP's Sustainable Challenge: New Life for Wind Turbines Opened on Wednesday, 12 December 2018

ma 20.5.2019 19.35

- Markku Vilkki;
- ENEL Open Innovability Challenges <[enelopeninnovabilitychallenges@innocentive.com](mailto:enelopeninnovabilitychallenges@innocentive.com)>

Dear Markku,

It gives me great pleasure to let you know that the review of your submission *Reinforced thermoplastic material from GFRP-waste to the Enel Open Innovability Challenge Recycle and Reuse of Wind Turbine Blades* led to a favorable evaluation. You will be awarded \$10,000!

**AN IMPORTANT NOTE:** The final award for this Challenge is contingent upon satisfactory completion of the verification process. A member of InnoCentive's operations team will be in touch with you shortly to assist you through the verification, solution transfer and payment processes.

Congratulations, and thank you for your participation on this Enel Open Innovability Challenge!

Sincerely,  
Renato

Renato Vasconcelos, *PhD*  
*Senior Principal, Challenge Design and Development*  
[InnoCentive](#)



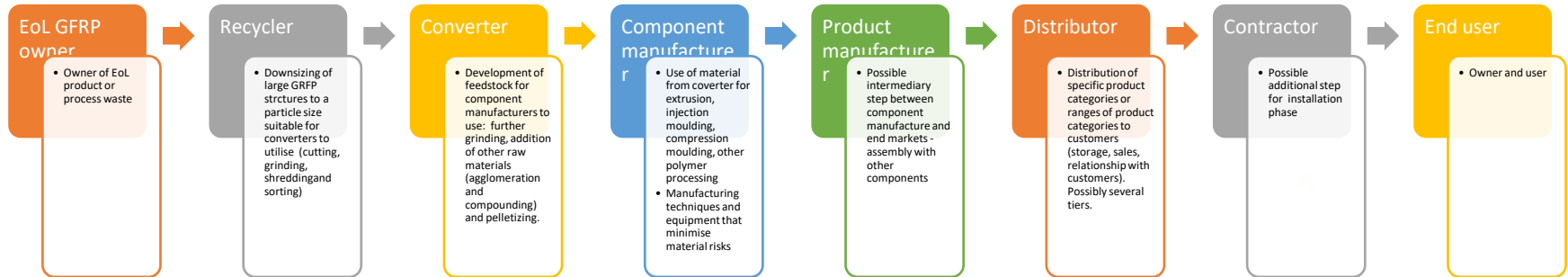
[https://www.enelgreenpower.com/  
media/news/d/2018/12/recyclabe-  
wind-turbine-thanks-innovation-  
and-circular-economy](https://www.enelgreenpower.com/media/news/d/2018/12/recyclabe-wind-turbine-thanks-innovation-and-circular-economy)

# Conenor role and offering in value chain

## Technology Provider & Licensor to Converters and Component Manufacturers

- materials, additives, formulations
- process technique
- equipment purchase
- product design and properties
- start-up training

In collaboration with chosen process Equipment Manufacturers worldwide



# Material characteristics with 35-45%-w. GFRP-waste

## Analysis of GFRP-waste containing products

Analysis of the Conenor developed GFRP-waste reinforced circular composite PE/PP-materials and extruded products have been undertaken within ECOBULK by CNR in Italy, Muovipoli Ltd in Finland and through a Masters research project at University of Eastern Finland (UEF):

- ✓ **Compared to quality commercial WPC decking boards:** ECOBULK hollow boards (140x28mm) with GFRP-waste are stronger and stiffer vs. quality commercial WPC decking boards in dry as well as wet conditions
- ✓ **Compared to commercial plywood panels:** ECOBULK composite panels 390x10mm with GFRP-waste remain stronger and stiffer vs. quality commercial plywood panels when getting into contact with water (EN-water soaking test method)

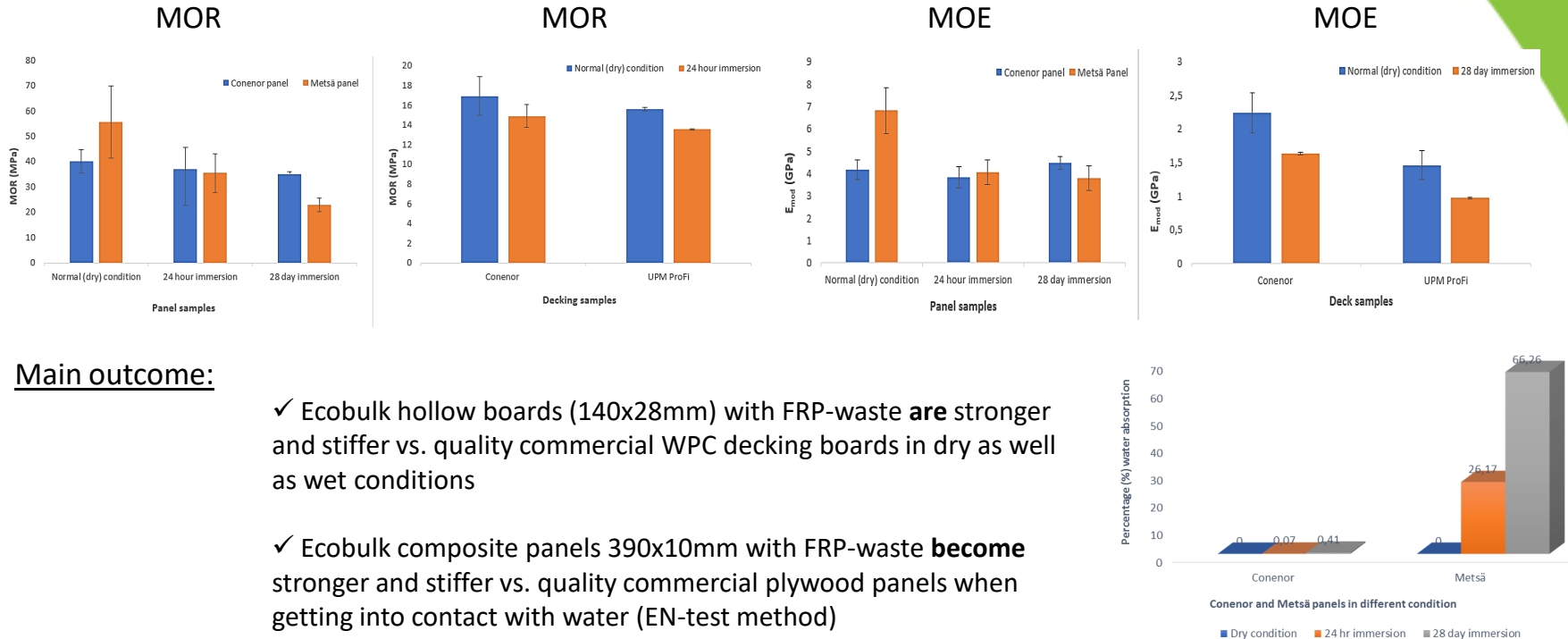


### Typical material values:

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

# Materials and products for moist conditions

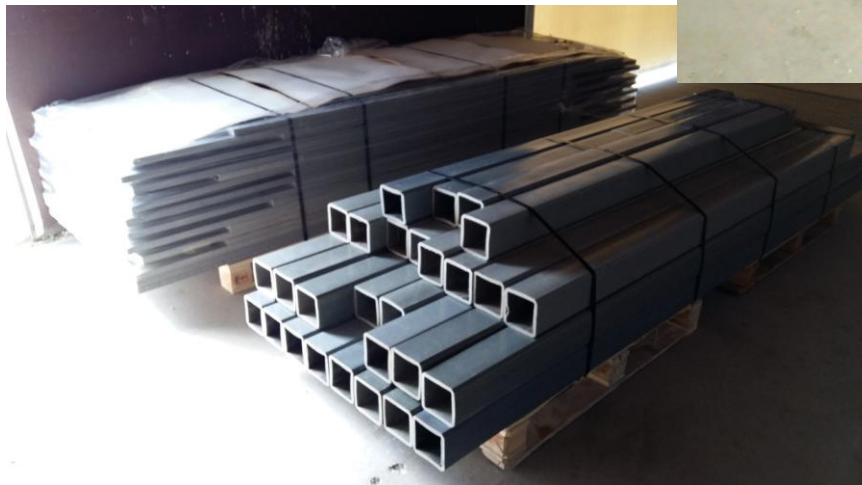
Master thesis by Mr. Ramji Pandey at University of Eastern Finland (UEF)



## Main outcome:

- ✓ Ecobulk hollow boards (140x28mm) with FRP-waste **are** stronger and stiffer vs. quality commercial WPC decking boards in dry as well as wet conditions
- ✓ Ecobulk composite panels 390x10mm with FRP-waste **become** stronger and stiffer vs. quality commercial plywood panels when getting into contact with water (EN-test method)

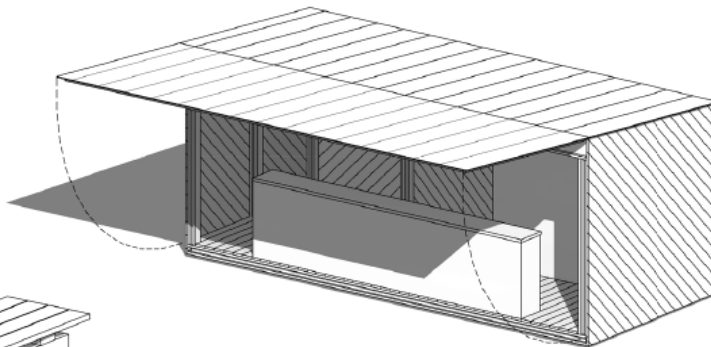
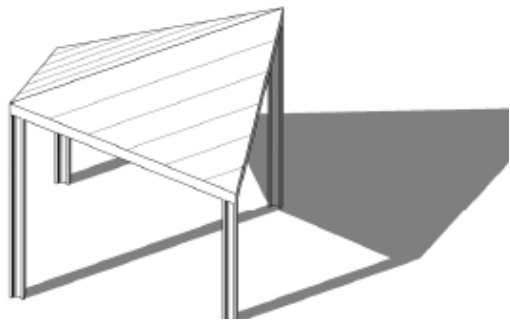
# Volume scale piloting with GFRP-waste in FI/UK/PT



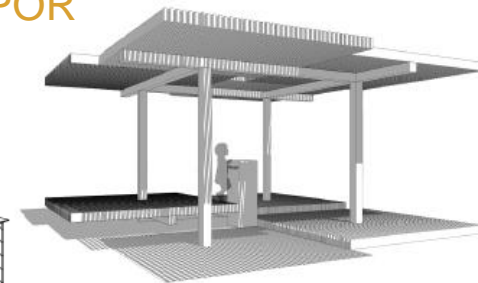


# User applications being demonstrated

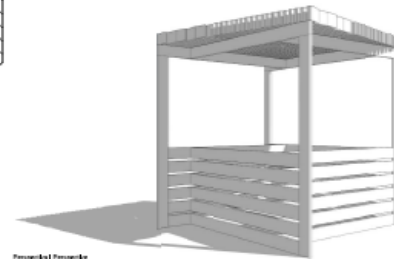
H2020 project **ECOBULK** demos in WP4; FIN-UK-FRA-POR



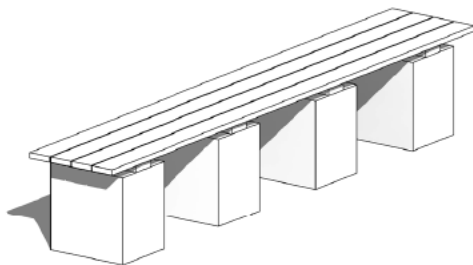
axonometry



Rendering Perspective



Rendering Perspective



Bench, axonometry

[www.ecobulk.eu](http://www.ecobulk.eu)

<https://www.ecobulk.eu/wp-content/uploads/2018/12/D4.4-Demonstration-plans.pdf>

Programme under Grant Agreement No. 730456 – WP4 Task Leader Conenor



# User applications at LIPOR park in Portugal

## Construction

Rest place around a tree



Drinking fountain

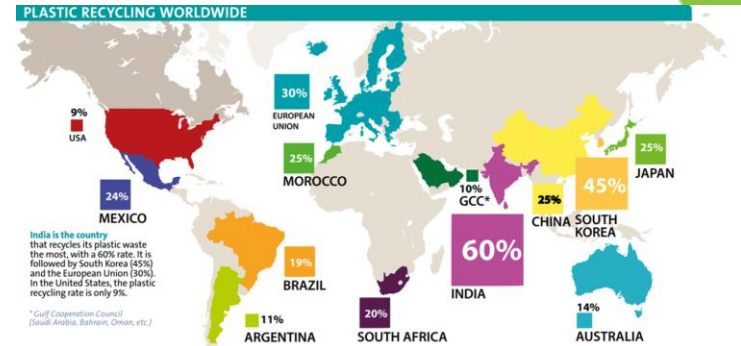


Recycling bin shelter

# Enhancing plastics recycling

## Stronger and stiffer recycled materials 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
- specific characters e.g. fire retardancy applicable
- new reinforced and low cost plastic material from waste enables profitable new volume business in constructions



# The European Green Deal Investment Plan

## SUSTAINABLE FINANCE



Major private and public investments are needed to transform the EU economy to deliver on climate, environmental and social sustainability goals, including the Paris Agreement and the UN Sustainable Development Goals (SDGs). Sustainable Finance is an important component of the European Green Deal.



Sustainable finance makes sustainability considerations part of financial decision-making. This means more climate neutral, energy- and resource-efficient and circular projects. Sustainable finance is needed to implement the Commission's strategy towards achieving the SDGs.



Integrating sustainability considerations will mitigate the impact of natural disasters as well as environmental and social sustainability issues that can affect the economy and financial markets.



## OTHER ONGOING INITIATIVES



### INTERNATIONAL PLATFORM ON SUSTAINABLE FINANCE

Platform to exchange and disseminate information to promote best practices in environmentally sustainable finance.



ARGENTINA



CANADA



CHILE



CHINA



EUROPEAN UNION



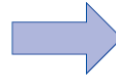
INDIA



KENYA



MOROCCO



45%  
OF GLOBAL GHG EMISSIONS



40%  
OF GLOBAL GDP



40%  
OF WORLD POPULATION