



CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

CSIC



Centro Nacional de Investigaciones Metalúrgicas

CENIM

TRC

THERMAL RECYCLING OF COMPOSITES

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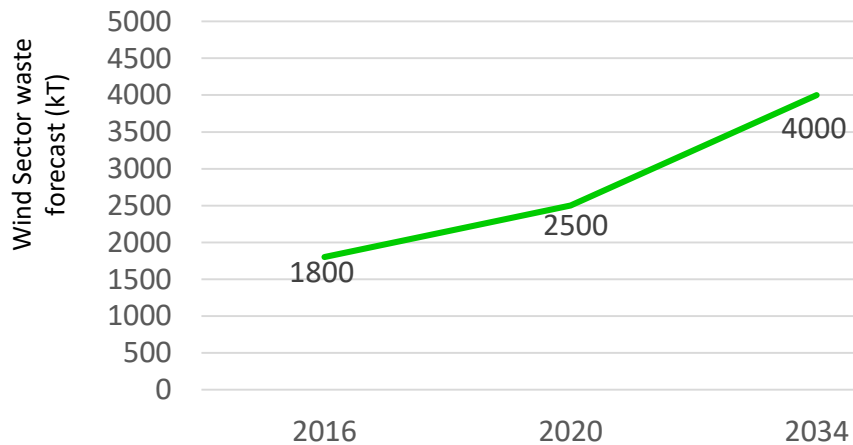


Climate-KIC



EDP
STARTER

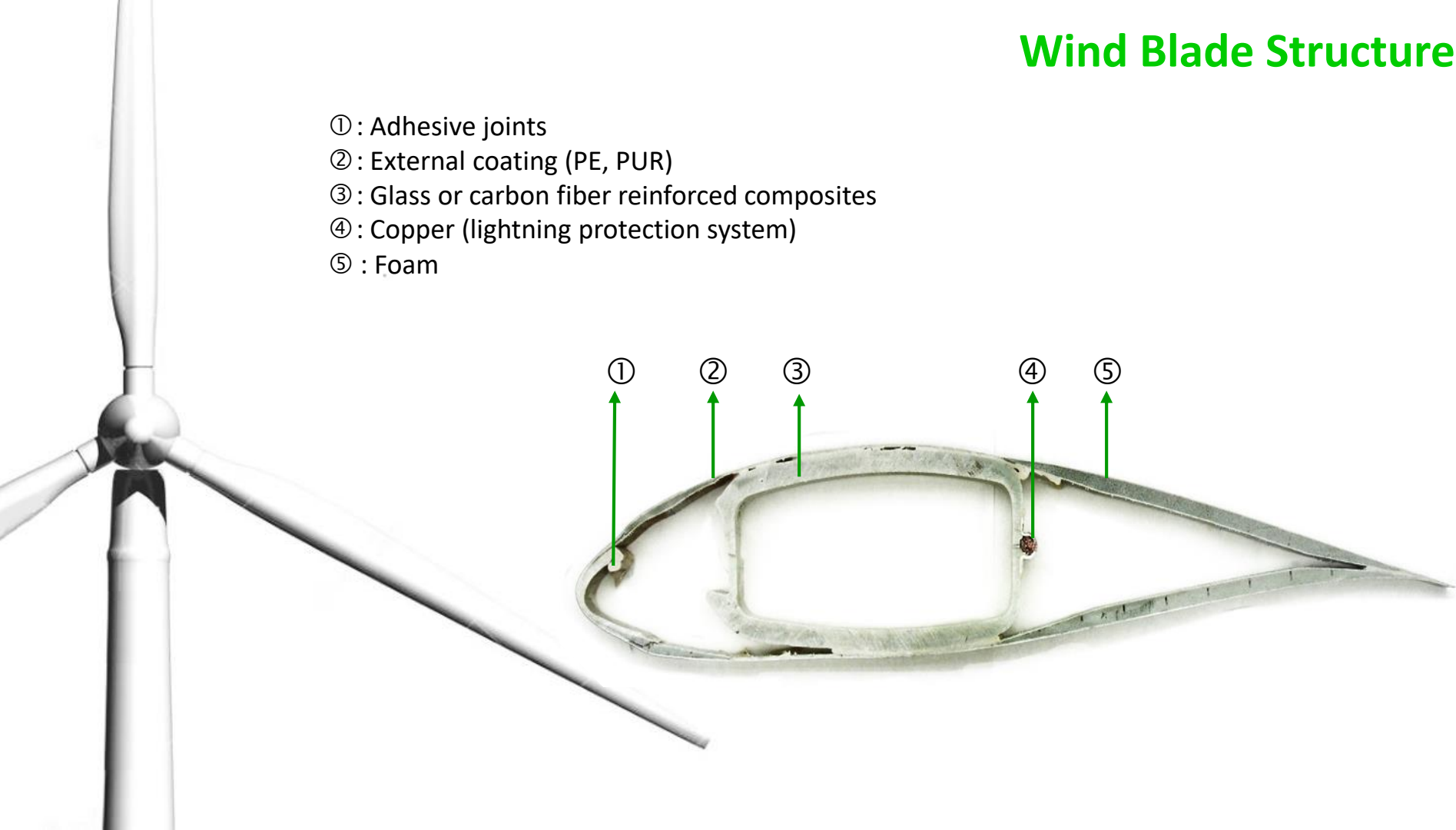
WIND WASTE IN EUROPE



Source: An update for wind turbine blade waste inventory. P.Liu & C. Barlow. University of Cambridge. European Premier Wind Energy Event (EWEA), Paris, 2015

Wind Blade Structure

- ① : Adhesive joints
- ② : External coating (PE, PUR)
- ③ : Glass or carbon fiber reinforced composites
- ④ : Copper (lightning protection system)
- ⑤ : Foam

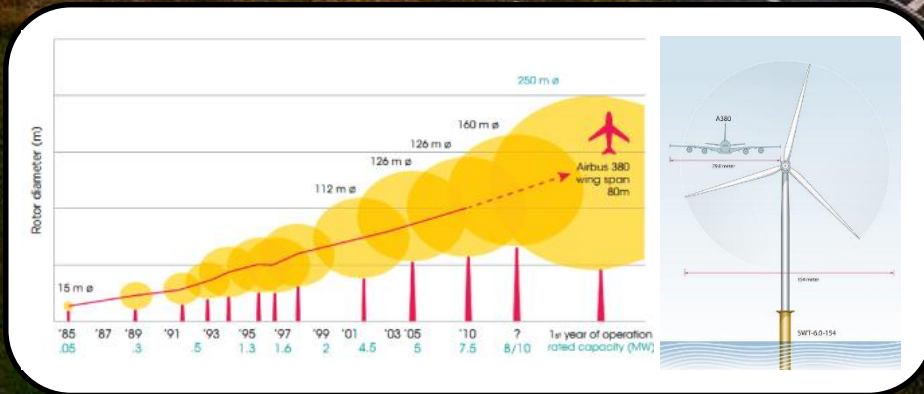
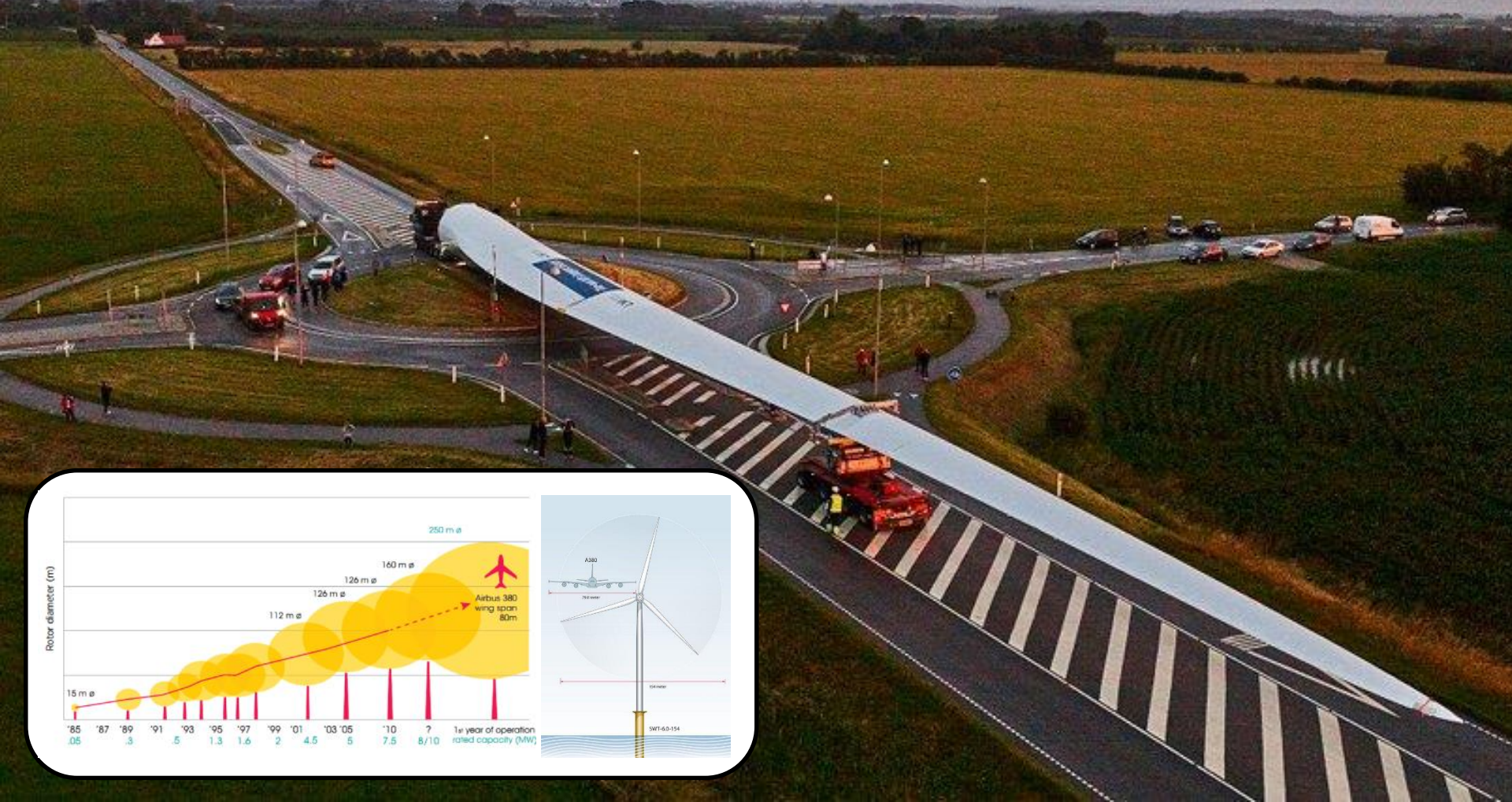




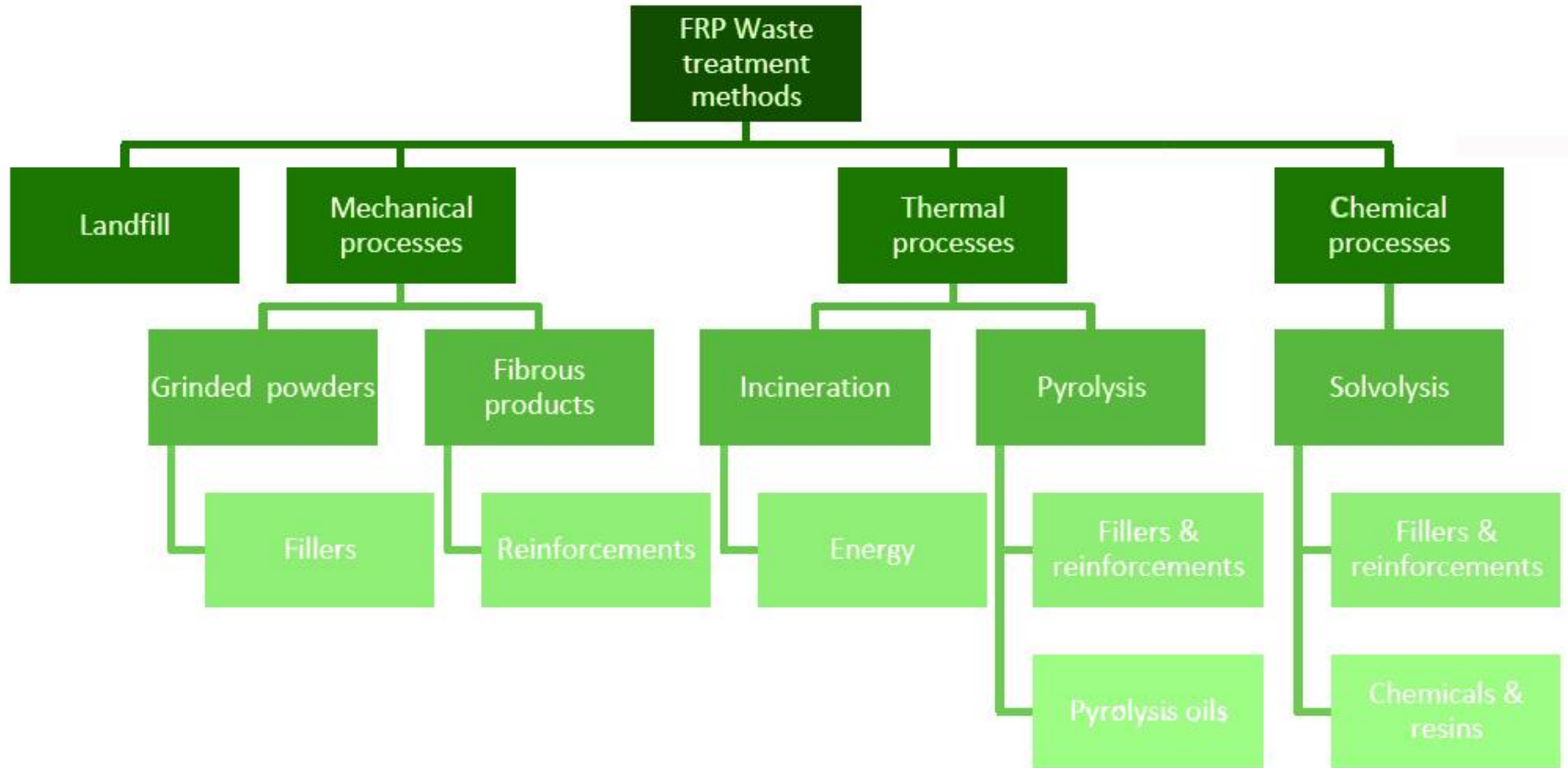
Material characteristics to take into account to recycle

- High strength
- Thickness
- Same material in different ways (unidirectional fibers, multi-axial knitted, pre-preg...)

Material characteristics to take into account to recycle



Recycling Technologies



Disadvantages



Storage/Buried

- High environmental impact
- High cost
- Waste of valuable materials)

Crushing

- High energy cost
- High cost due to depreciation of cutting blades
- Resins and fibers are mixed

High temperatures

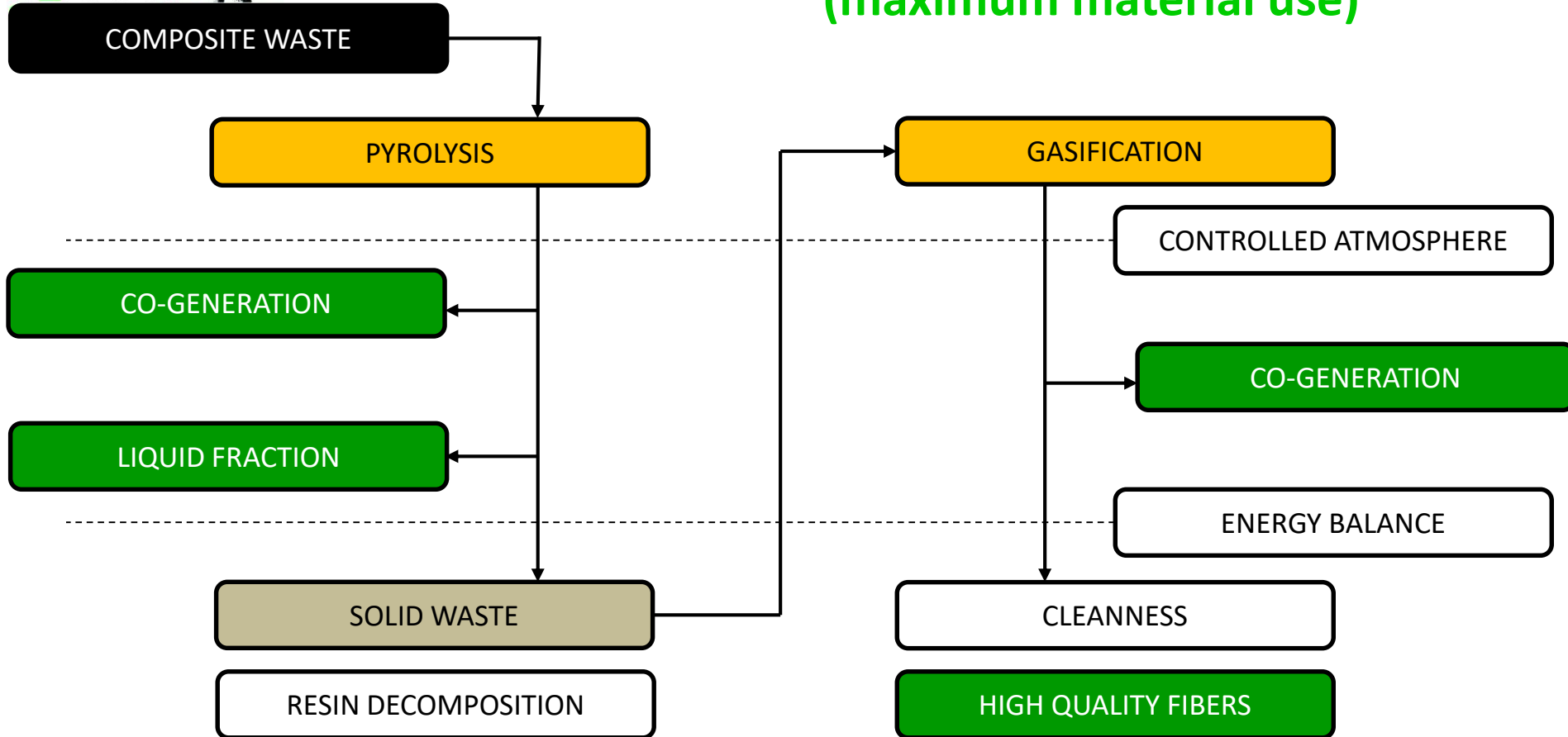
- High energy cost
- High emissions
- Mass waste (low calorific power)
- Decreasing fibers properties

Chemical compounds use

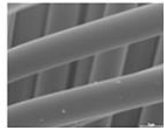
- High cost
- Environmental issues (hazardous liquid waste)



R3FIBER: New Recycling Concept (maximum material use)

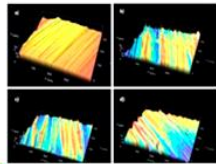


Background



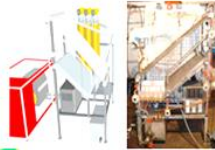
2008

- idea/concept



2010

- First results



2012

- Prototype construction



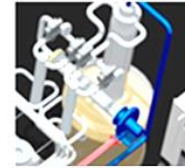
2014

- Pilot plant



2015

- Pilot plant improvement
- Application new composite waste



TRC
THERMAL RECYCLING OF COMPOSITES

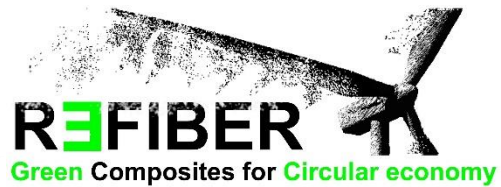
2016

- TRC Constitution
- industrial secret
- pre-industrial plant design



2017

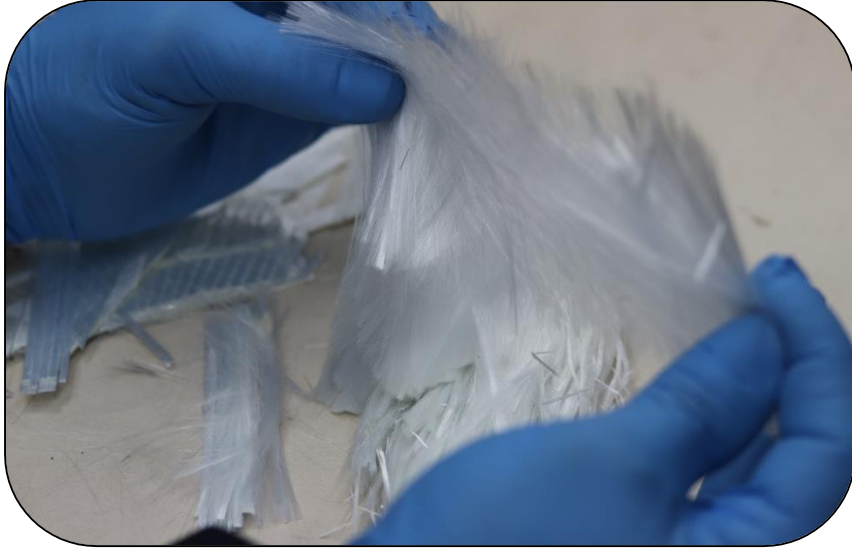
- Start construction preindustrial plant
- First sales management
- Contract EDP
- management First wind blade
- Several recognition



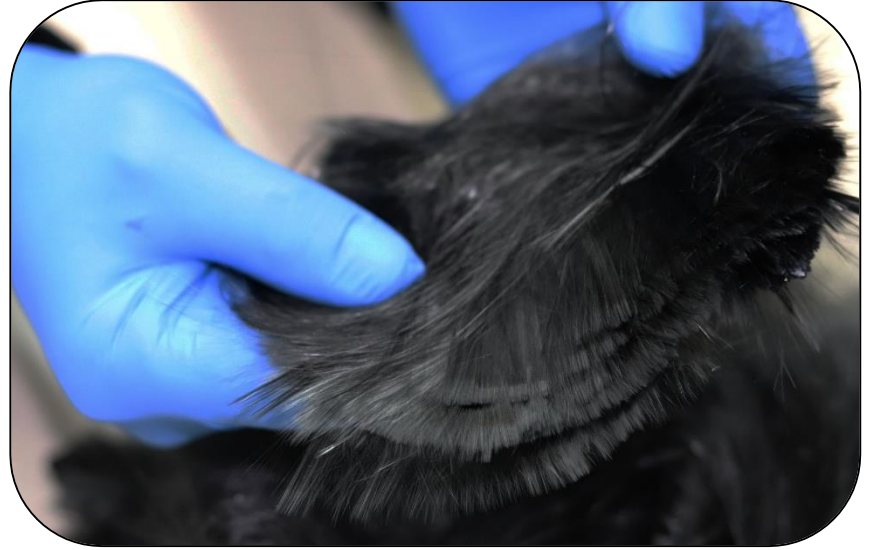
Disruptive · Efficient · Clean · Protected · Scalable · Versatile



Versatility of the technology



Glass Fiber



Carbon Fiber





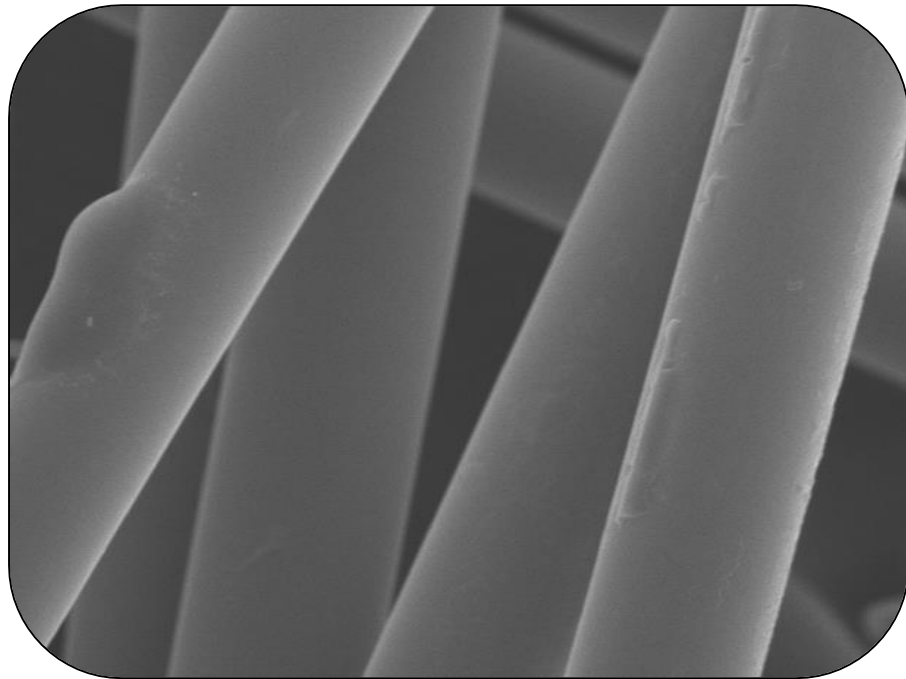
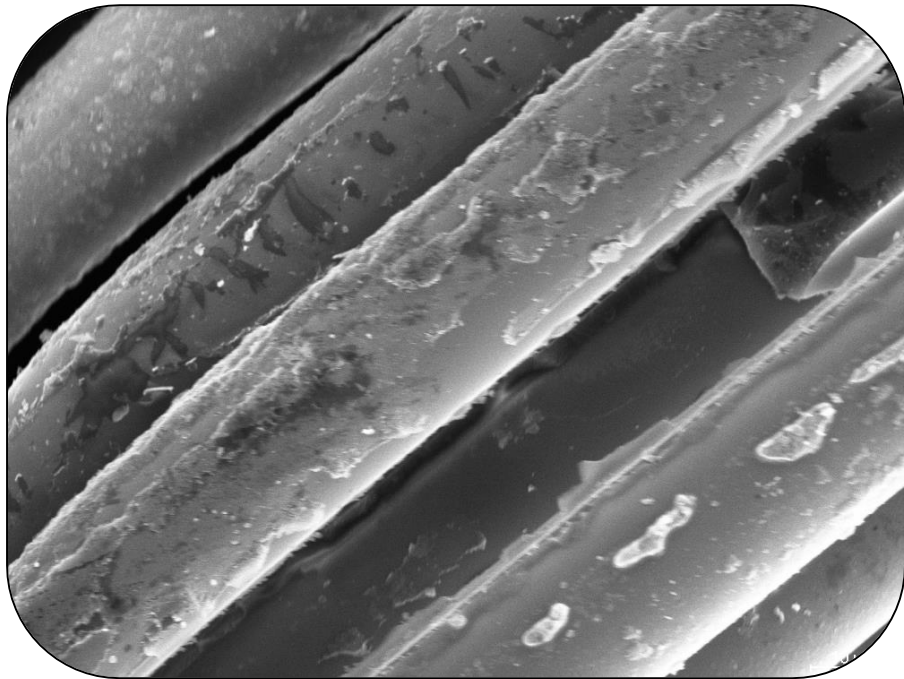
Technical properties

Commercial success



REINFORCED PLASTICS WITH CARBON FIBER

- 12% annual growth
- Excellent mechanical properties



R3FIBER



Properties

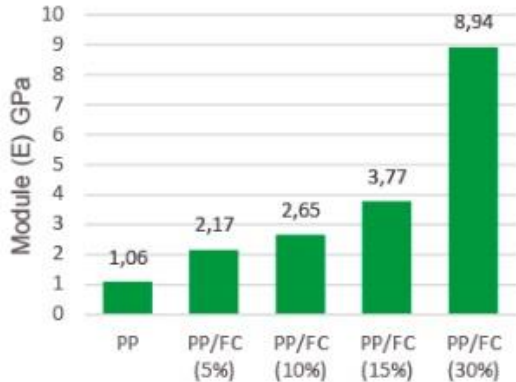
Medium diameter	0,009 mm
Density	0,02 g/cc
Length	According to customer needs
Max. Length	800mm
Traction resistance	328 Mpa (speed 5mm minute)

Properties recycled fiber vs the original fiber

Nominal diameter	100%
Tensile strength	88-93%
young module	85%

REINFORCED PLASTIC (PP)

- Multiply by 9 original stiffness
- Triple the tensile strength



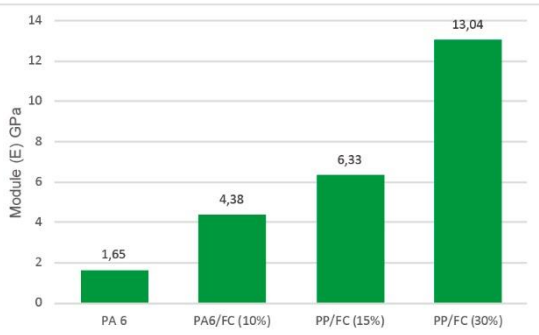
Material	Module (E)	Resistance
	GPa	MPa
PP	1,06	28,77
PP/FC (5%)	2,17	31,74
PP/FC (10%)	2,65	39,9
PP/FC (15%)	3,77	46,14
PP/FC (30%)	8,94	75,66



REINFORCED PLASTIC (PA6)



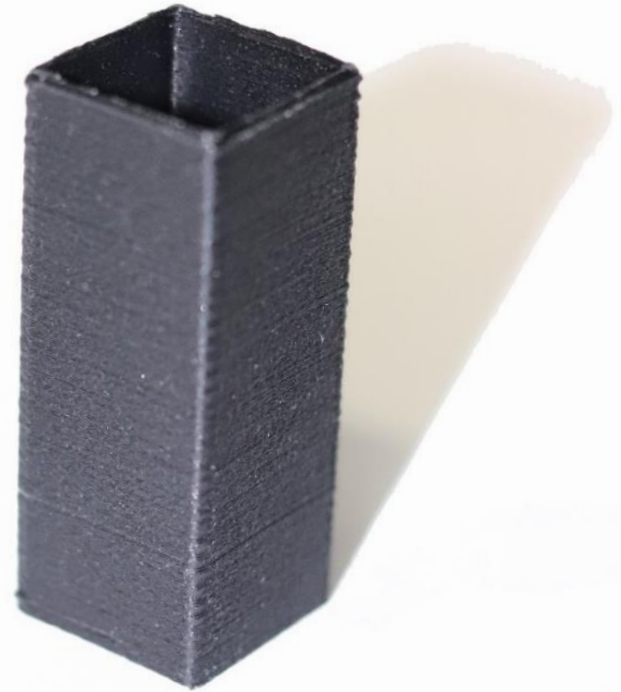
- Multiply by 9 original stiffness
- Triples the tensile strength



Material	Module (E)	Resistance
	GPa	MPa
PA 6	1,65	53,02
PA6/FC (10%)	4,38	83,22
PP/FC (15%)	6,33	100,22
PP/FC (30%)	13,04	155



3D TECH



NON - WOVEN



↓ Management cost

↓ Production cost

↓ Carbon Footprint

Circular Economy



A close-up, low-angle shot of a white wind turbine blade against a clear blue sky. The blade is positioned diagonally from the bottom left towards the top right. The hub and another blade are visible in the background.

26 MTn CO₂

save/5 year

Glass fiber

2.9 kg CO₂/kg fiber

10.2 KTn CO₂ save/blade

Carbon fiber

19.3-21.3 kg CO₂/kg fiber

74.5 KTn CO₂ save/blade

WITH THE SUPPORT OF



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 809308.



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STARTER**

RECOGNITIONS

NAUTIC TECH
INTERNATIONAL INVESTMENT FORUM



compete for
a sustainable future



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Interdisciplinary Platform for Sustainable
Plastics towards a Circular Economy