

ARKEMA

ELIUM®

25 SEPTEMBRE 2025

9H À 17H

LORIENT

Palais des congrès

Inscriptions

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COLLOQUE ORGANISÉ DANS LE CADRE DU PEPR RECYCLAGE



www.univ-ubs.fr

LE RECYCLAGE DES COMPOSITES

Un nouveau cap pour la course au large

Dr Pierre GERARD, Recycling program manager
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Booming of wastes from thermoset composites

✓ **Pleasure boats**

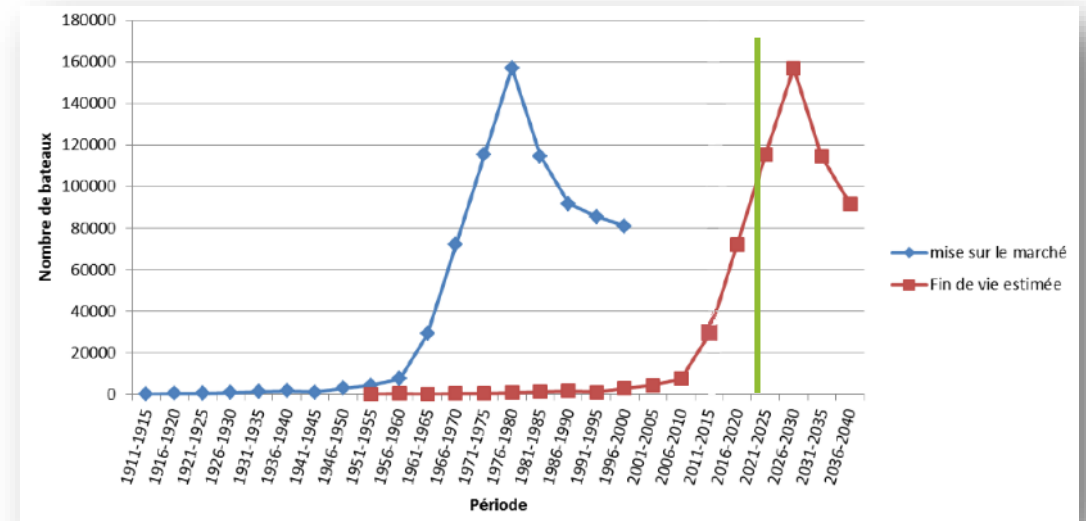
Booming economy sector (+ 12 000 registration each year^[1])

France : international leader of sailboats and multihull recreational craft



✓ **Pleasure boats which are out of use (BPHU)**

- **Composite materials based on conventional thermoset resins derived from petroleum oil (UPR, VE, Epoxy, ...) reinforced by continuous glass fibers (or carbon fibers)**
- **More than 13 000 pleasure boats are due to reach end of life each year^[2]**
- **Estimate of the average service life between 30 and 45 years**
- **2015 : ~ 40% of recreational boats are more than 30 years^[3]**
- **End of life follows the trend of production**



[1] Direction générale des infrastructures des transports et de la mer. La plaisance en chiffres 2017/2018.

[2] ADEME. Étude préalable à la mise en place de la filière de collecte et de traitement des navires de plaisance ou de sport hors d'usage sous la responsabilité des producteurs (REP). 2016

[3] Jaouen B. EcoNav : Quelle politique territoriale pour une gestion viable et durable des bateaux en fin de vie ? 2013

Booming of wastes from thermoset composites

- ✓ End-of-life scenarios
- ✓ Lack of legislation
- ✓ Limited recyclability
- ✓ Lack of technology
- ✓ But fast growing sector



Abandoned ship



Sunken ship



Landfilled



Dismantled

Pleasure boats which are out of use (BPHU)



Upstream

Eco-design

Low-impact alternative raw materials

Resin design for recycling **ELIUM**®

Driven by manufacturing wastes and end-of-life

Extended Producer Responsibility (REP 2019)

Association for Eco-responsible Boating (APER)

Downstream

Recovery

Re-use

Ease of Recycling
(mechanical and chemical recycling)

Definitive ban of landfill

ELIUM[®] the recyclable liquid thermoplastic resin

ARKEMA

A unique solution for manufacturing composite parts using the same methods as those used for standard liquid resin parts, and include the major advantages of recyclability

ELIUM[®]

Liquid

The resin is a liquid polymer diluted in a reactive monomer blend with processing additives

Reactive

Two components are needed : Resin + initiator
The polymerization can be adjusted to fulfill manufacturing process requirements (T°, UV, time)

Thermoplastic

After polymerization, the matrix is a high strength, high toughness, durable and lightweight polymers. Final parts can be thermoformed, overmolded or welded

Recyclable

The obtained high molecular weight thermoplastic reinforced polymer is fully recyclable
Elium® resin is styrene free, BPA free and Cobalt salt free



Recycling PIR : waste management, PCR : end of life

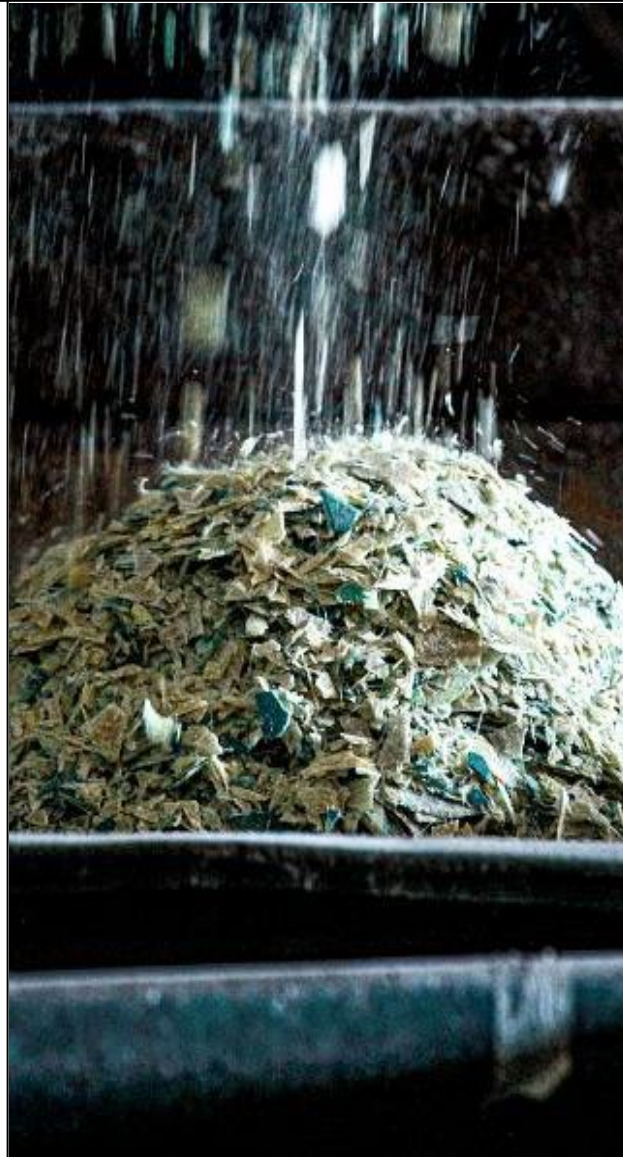
CHEMICAL RECYCLING



RE:build

- Unique property of Elium® resins to be **de-polymerized** by a thermolysis process
- Separation of resin and fiber and collection of recycled monomer
- Rebuild of recycled Elium® resin in a **closed loop** recycling process (better LCA profile, cradle to gate)

Recycled **ELIUM**®



MECHANICAL RECYCLING

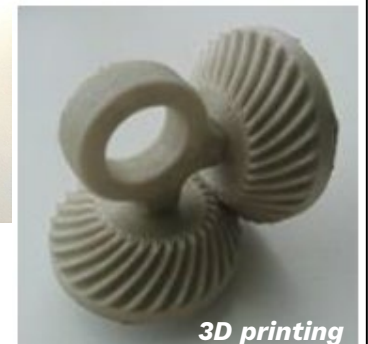
RE:use



- Regrind thermoplastic composite particles
- Compounding step
- Reuse in thermoplastic processes



Door handle: recycled compound of 50% r-ABS and 50% composite CF of GF/Elium®



3D printing

Partnership with



Class 40
(full Elium)



Ocean 50
(Recycled Elium)



Elium-based composite
mold for link arm :
single use !



Chemical
Recycling

Recycled Elium (95%
content): fairing & roof



Mini 6.50 (full carbon Elium)

4th Mini transat
in 2025



The use of 1 kg of Elium®
resin allows the reduce by
4,6 kg the CO2 emissions
of the full like cycle of the
Class 40 (craddle-to-grave)

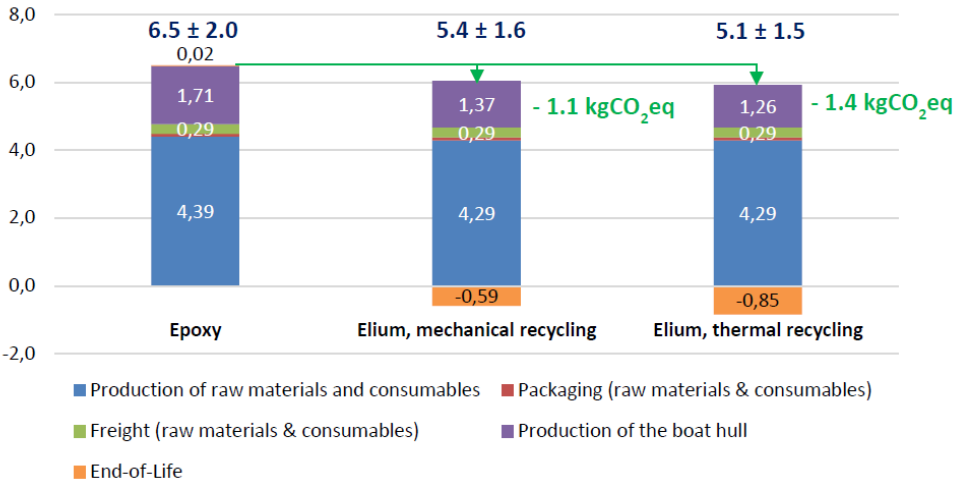


Figure 1: Cradle-to-grave carbon footprint of boat hull, in kgCO₂eq/kg of composites



BENETEAU & ARKEMA Roadmap

**Firt 44e electric propulsion
and more sustainable materials**
(r-PET foam, Iroko and ELIUM®)



2022

2021

Mechanical properties
and processability
assessment



2023



Boat Builder Award for the best Environmental
improvement in manufacturing process

The Arch Mini 6.50

Introduction of flax
natural fibers
BV certification

2024



Oceanis Yacht 60

St Gilles plant,
work environment
adapted to Elium®

Sun Fast 30 OD

Cheviré's plant, dedicated
for ELIUM® boat production
ICNN certification on going

2025

Recycling

Proof of Concept in
Nantes pilot site
(Veolia /Composites Recycling)



Mass production of recyclable resin





Main challenges:

**How to make the solution
simple to use?**

How do you recycle it?

**How to make it
« affordable » or at least
competitive regarding
existing solutions?**

**Recycling
Elium®
composites**

Recycling PIR : waste management, PCR : end of life

→ PIR Post-industrial wastes (manufacturing wastes from VARI process)

- Consumables (vacuum foil, peel-ply, release film, infusion net, tubes, ...) fully thermoplastic (PE/PP, PA) all “contaminated” with Elium® resin (average ~ 50wt%)
- Elium® resin + (Methacrylate) adhesive + dust
- Glass fiber (dry)
- Cut offs (composite)
- Learnings from wind

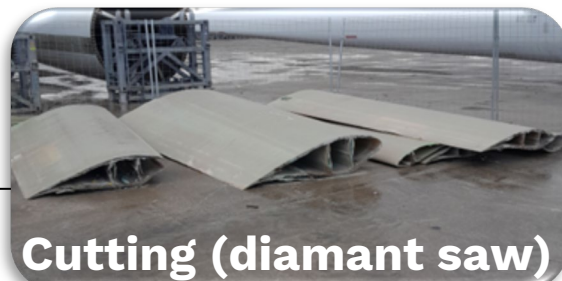


ZEBRA PROJECT
Zero waste Blade ReseArch

→ PCR Post-consumer wastes (end-of-life)

- Extended Producer Responsibility “Pleasure boat”
- Materials involved:
 - Composites (GF/CF – Elium®)
 - (Methacrylate) adhesives
 - (Balsa wood) / PET foam core
 - GC/paints





LM WIND POWER
a GE Renewable Energy business

ELIUM® blades

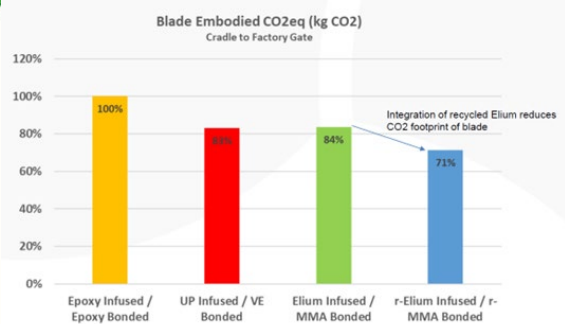
Recycled ELIUM®



PYROVAC

suez

ENGIE



30% reduction in CO₂eq. emissions per blade

— THERMAL RESHAPING FOR REUSE OF ELIUM® COMPOSITES

- Thermoforming thermoplastic spar cap (CSM & NREL)
- From blade to post (TU Delft)
- Thermal reshaping (Edinburgh Univ.)



Fig. 10. A prototypical skateboard fabricated in part by thermoforming an Elium/glass fiber test panel as reinforcement.



— HOT COMPRESSION OF GROUND BLADE

THERMOSAIC process by



- Thermo-mechanical process to make composite panels
- Fully thermo-formable by thermo-stamping process



— COMPOUNDING + INJECTION MOLDING

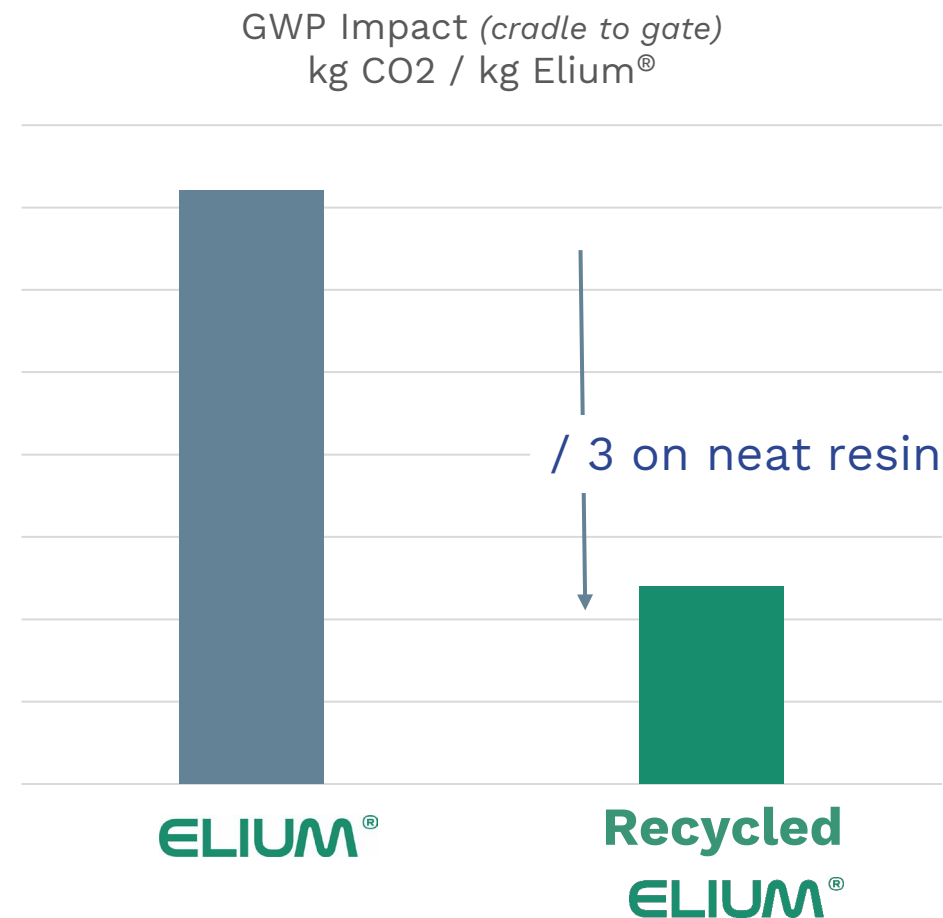
- Compounding with thermoplastic such as PMMA, ABS
- Compound 60% ABS + 40% Elium® composite
The resultant material is then transformed in pellets
- Pellets are processed by standard injection or 3D printing (LSAM for molds)





- Recycled Elium® resin by depolymerization (up to 92% of recycled content)
- The second ZEBRA blade is a world-first in using recycled Elium® resin in the manufacture of a shear web, which is a structurally important component of the blade
- It demonstrates the closed loop for circular economy

Goal of Sustainable Development



Reclaimed fibers after chemical recycling

→ Glass Fibers



- **Re-melting** – thermal recycling unit for waste glass fibers
- After processing (shredder, burning chamber and milling), the recycled glass powder is free of organic particles and refed as raw material into the glass production process on-site (achieving a closed production loop)
- **Glass fiber textiles (replacement of existing non-recycled products)**

CHOMARAT



→ Carbon Fibers

- **Recycled and sorted CF (rCF mat)**
- **Thermoplastic compounding**



rCF reinforced Elium thermoplastic automotive door panel prototype (Recotrans project – courtesy of Gestamp)

- **Tape technology (highly aligned discontinuous fiber composites)**



Closing the Loop: Marine Industry Model



Chemical recycling by thermolysis : partnership with



→ A promising and circular business model

Waste collection

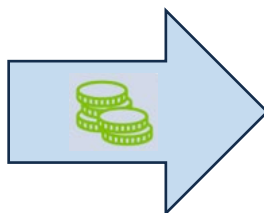
Thermolysis & Post-treatment

Reclaimed outputs

New composites

CR collects
recycling fees

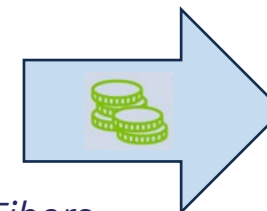
CR sells
reclaimed outputs



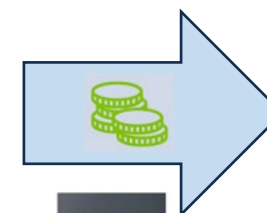
First mobile containerized unit (2T/d capacity)
has been delivered by Swedish supplier
FiberLoop in Dec. 2024 in Britany (Veolia's site)



R-Glass Fibers



SUSTAINA[®] LOOP

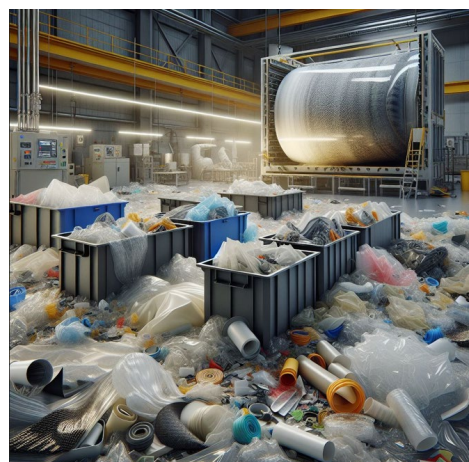


ARKEMA



Thermolysis oil

**Recycled
ELIUM[®]**



PIR: manufacturing wastes



PCR: EoL from wind, marine, transportation, ...

Elium®: Powering the Future of Sustainable Sailing-Join the Circular Revolution

- ✓ The adoption of Arkema's Elium® resin in the nautical industry and offshore racing represents a major step forward in sustainable boatbuilding.
- ✓ Thanks to its unique thermoplastic properties, Elium® enables the production of high-performance, lightweight, and durable composite parts—while also allowing for true closed-loop recycling at end-of-life.
- ✓ This innovation supports the transition to a circular economy for the future of sustainable yachting and ocean racing, reducing environmental impact and opening new opportunities for eco-design and resource efficiency.

