

r-LightBioCom Circularity and Recyclability Innovations

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Open Innovation Workshop

Processes and methods for recycling, reuse, and recovery of advanced composite materials in the transport sector



REPOXYBLE - Depolymerizable bio-based multifunctional closed loop recyclable epoxy systems for energy efficient structures
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repxyble
BIO-BASED MULTIFUNCTIONAL RECYCLABLE COMPOSITES



High-Performance Composites / Low Environmental Impact



r-LightBioCom

r-LightBioCom Circularity and Recyclability Innovations

Reproxyble's 1st Open Innovation Workshop



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r-LightBioCom

New bio-based and sustainable **R**aw Materials enabling Circular Value Chains of High Performance **L**ightweight **B**io**C**omposites

Topic: HORIZON-CL4-2022-RESILIENCE-01-11
Advanced lightweight materials for energy efficient structures

Type of action: Research and Innovation Action (RIA)

Coordinator: AITEX

Start date: 01/01/2023

End date: 30/06/2026

Duration: 42 months

Budget: 4,201,176 €

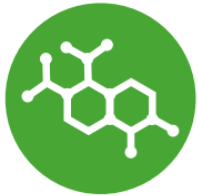
Project no.: 101076868

<https://cordis.europa.eu/project/id/101091691>



Development Areas

Approach



MATERIALS

New advanced bio-based and recycled high-performance materials with inherent recyclability properties



PRODUCTION TECHNOLOGIES

Efficient processing techniques combined with recycling technologies



METHODS & TOOLS

for a standardised, holistic sustainable high-performance composite design, modelling and systematic optimization



Development Areas

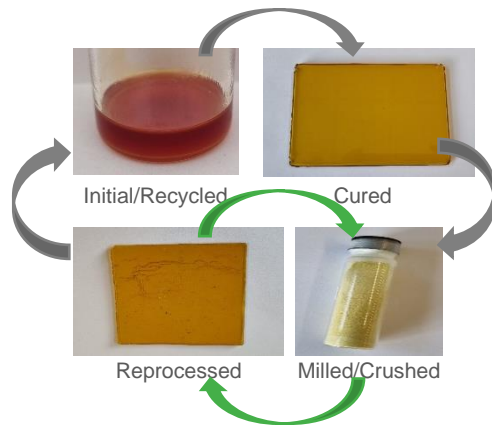


MATERIALS

Development of new bio-based resins, additives and formulations for HPC

New bio-based resins with improved recyclability

- Tailored reactivity
- High bio-based content
- Dynamic thermosets with inherent recyclability
- Application-oriented performance
- Multiple repair, re-processing, re-bonding, recycling, reuse



New bio-based nanomaterials as functional additives

- Low cost
- Low density and weight
- Recyclability / Degradability
- Co-reactivity with resins
- Improved polarity and dispersibility
- Enhanced thermal and mechanical properties
- With tailored functionalities

Enzymatic pre-activation of biomass



Functionalisation and nano-transformation



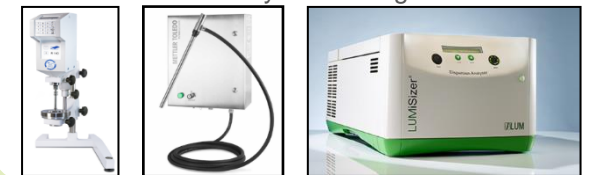
New bio-based resin formulations

- High flexibility of modular dispersion line
- Optimized compounding and dispersion processes
- Dispersion quality monitoring
- Adjustment to related processing technologies
- Fulfilment of application requirements

Dispersion modules



Quality monitoring



Development Areas



MATERIALS

New HPC components based on sustainable textile products and bio-based resins

New Sustainable Fibres

Recycled Fibres

r-CF, r-GF, r-Aramid



Natural Fibres

Basalt, Flax, Hemp



Adaption of processing technologies

- Carding
- Spinning



New Sustainable Textiles

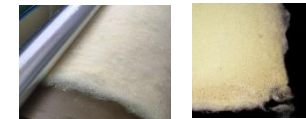
Non-woven fabrics



r-CF + PA6/PP



r-GF + PA6/PP

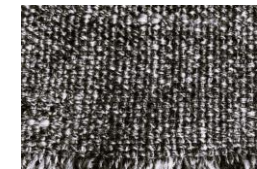


r-Aramid



Natural fibres

Hybrid fabrics with recycled fibres



r-CF + p-CF + PA6

Roving with recycled fibres and basalt



r-Aramid + PA6



r-Aramid + Basalt + PA6

Staple fibre yarn with recycled fibres



r-CF + PA6

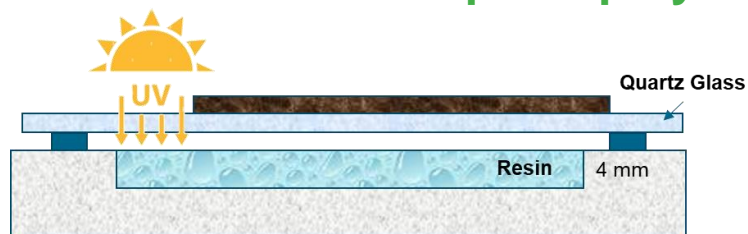


Development Areas

PRODUCTION TECHNOLOGIES

New rapid curing technologies

1. RTM + Frontal photopolymerization

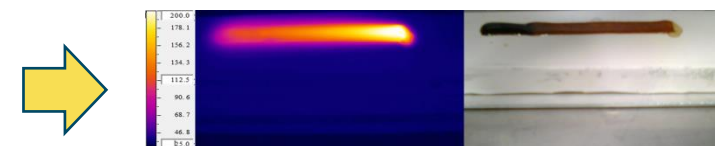


UV activation



$t=t_0$ (after UV radiation)
 $t= 90$ s UV radiation

Polymerization propagation



$t=120$ s (without UV radiation)

2. Vacuum infusion + microwaves

Infusion process



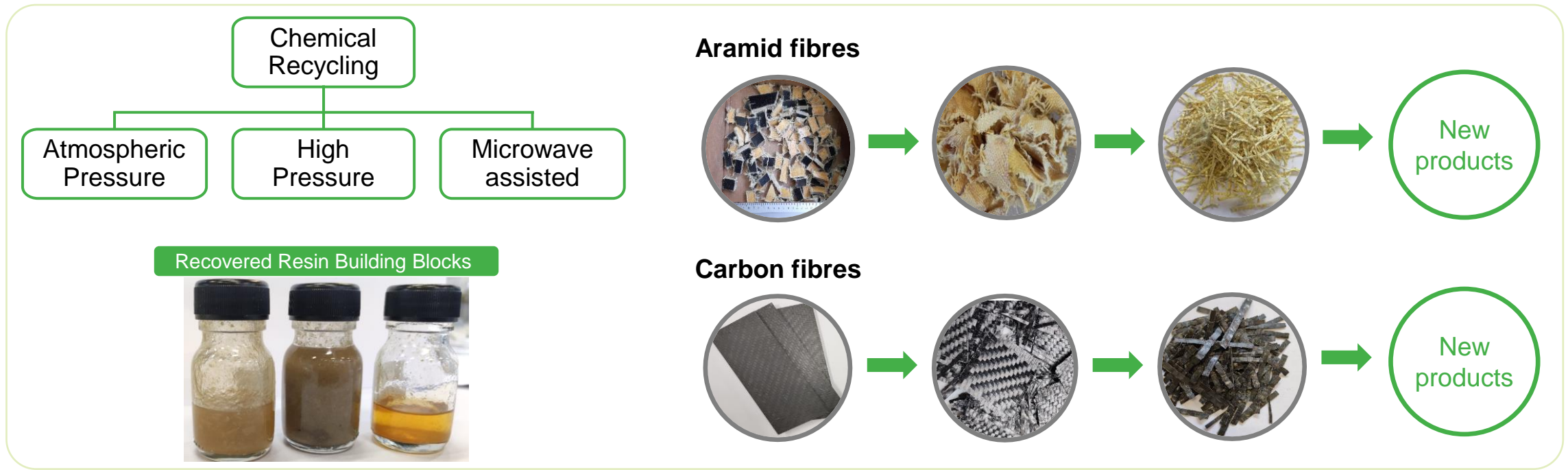
Development Areas



PRODUCTION TECHNOLOGIES

Novel recycling technologies for the high-performance composite components

- Thermoset composites recycling into its components: resin building blocks and reinforcing fibres
- Application of newly developed recycling process to bio-resins and bio-composites



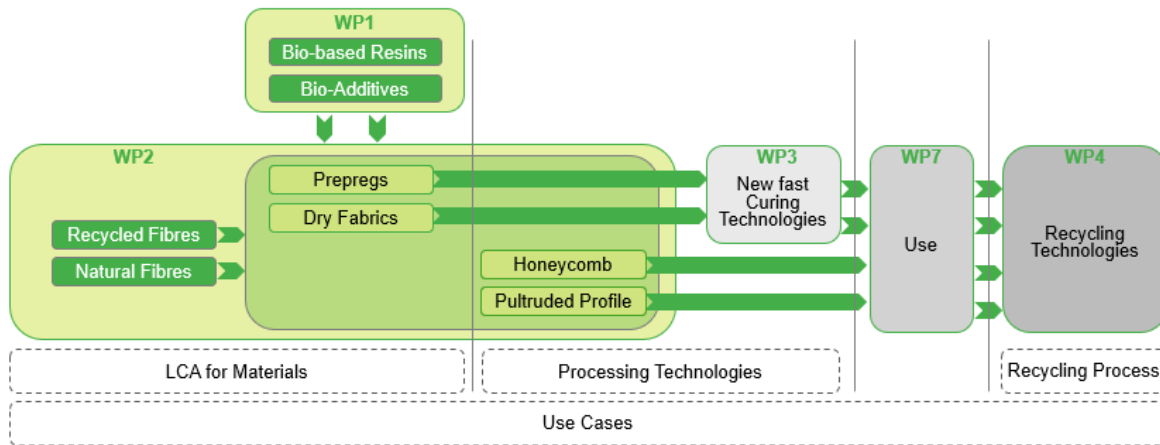
Development Areas



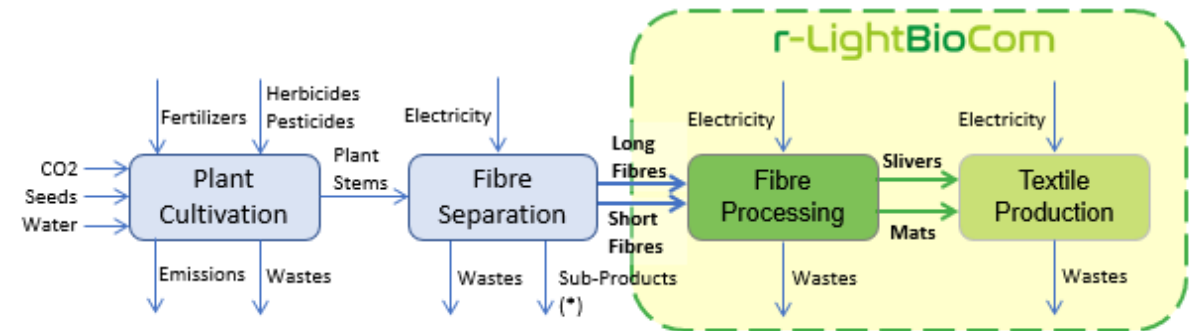
METHODS & TOOLS

Life Cycle Assessment (LCA)

- Environmental impact of r-LightBioCom solutions (materials, curing technologies and recycling processes)
- Comparison against conventional products and processes
- Decision making to choose eco-friendlier alternatives



r-LightBioCom's LCA



Natural Fibres Processing Stages for LCA



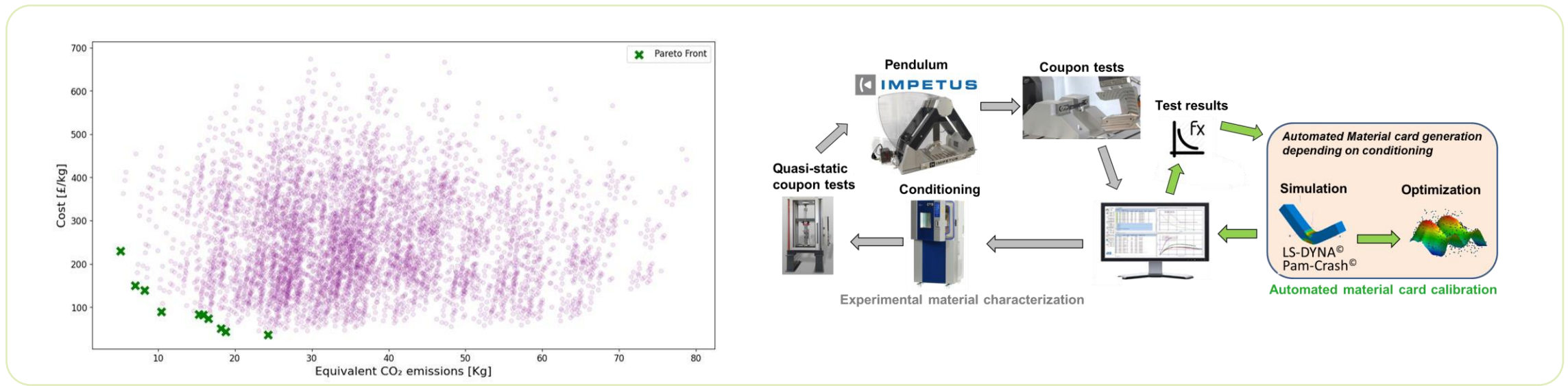
Development Areas



METHODS & TOOLS

Optimization framework for composite modelling, sustainability and validation

- Development of a **Coupled Ecological Optimization (CEO) Framework** to facilitate the implementation and impact of the sustainable material solutions.
- Optimized r-LightBioCom solutions relating to production cost, structural integrity and environmental impact will be developed through the advanced CEO.
- Automated material characterization and calibration utilizing digital twin, Reduced Order Modelling, homogenization and automated reporting will aid structural optimization and analysis

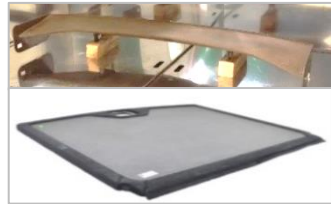


Validation via Use Cases

r-LightBioCom's results will be validated in use cases.

a) Automotive sector:

- Application 1: Spoiler (exterior)
- Application 2: Trunk floor (interior)



b) Infrastructure sector:

- Application: Composite pultruded profiles for tunnel lining



c) Aeronautical sector:

- Application: Leading Edge (movable surface)

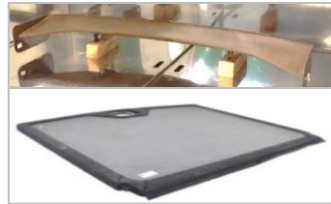


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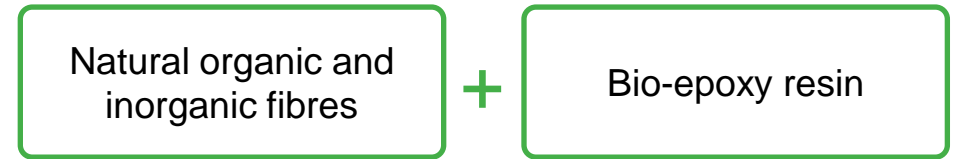
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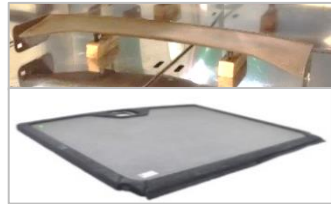
Manufacturing via
Hand Lay-up

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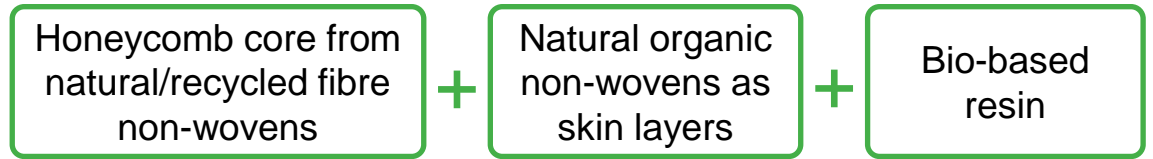
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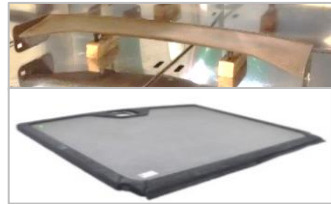
Manufacturing via Semi-automated Pultrusion

Validation via Use Cases

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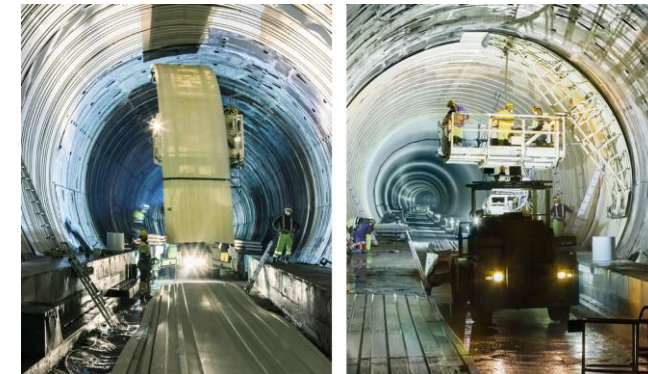
- Application: Leading Edge (movable surface)



r-Aramid + Basalt
fibre and/or r-CF +
PA6

+

Bio-benzoxazine
and/or bio-epoxy
resin



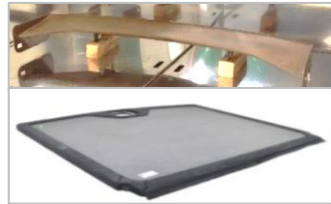
Manufacturing via Pultrusion Process

Validation via Use Cases

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- Application: Leading Edge (movable surface)



Hybrid fabric from r-CF + PA6 + p-CF filament

+

Bio-benzoxazine



Manufacturing via RTM or infusion

Summary

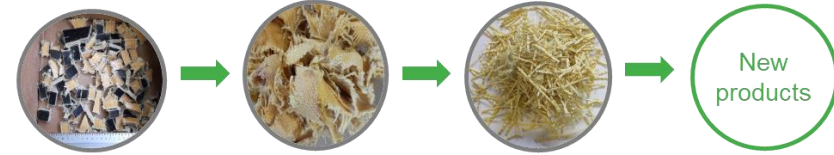
Sustainability results

- New bio-based resins and sustainable fabrics
- Sustainable manufacturing and recycling technologies
- Holistic optimisation tools for sustainable composite structures
- Tools for composite material modelling and validation

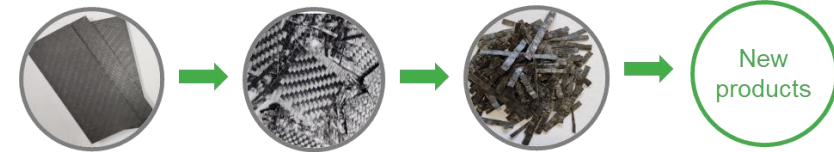
Further results

- Life Cycle Assessment (LCA) study
- Guidelines for standardised production processes & sharing best practices
- New business models

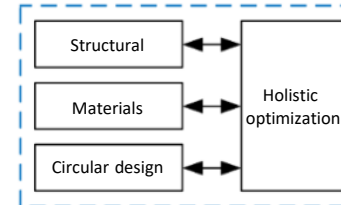
Aramid fibres



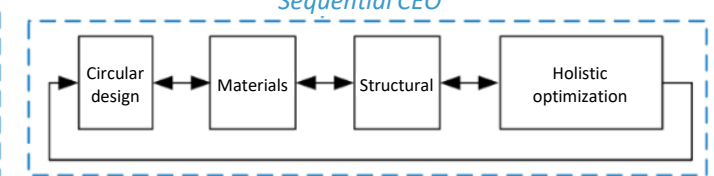
Carbon fibres



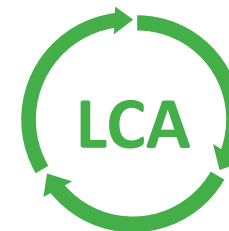
Parallel CEO



Sequential CEO



Coupled Ecological Optimization (CEO) Flowchart



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High-Performance Composites / Low Environmental Impact



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