A holistic view on Composites Sustainability - Current challenges and activities

Conference 'Building the ships of the future: Circular Materials, lightweight design and sustainable shipyard processes'

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an AIRBUS company

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Where do we come from?

Where are we today?

2001

- CTC GmbH founding
- 100% Airbus subsidiary
- Intention R&D projects also outside AIRBUS

Source: Airbus

2026

- International business not only aircraft
- New to the list education & training in the composite environments
- Absolute priority: industrial processes

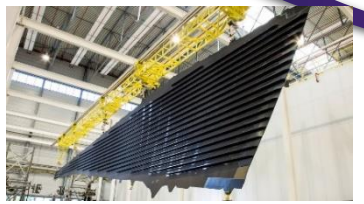
2004

- Technology Center building
- 2500 m² shop floor for carbon activities
- Industrial composite processing for future Airbus aircraft

2012

- Expansion of the fields of activity
- Assembly; cabin processes,…composite recycling
- CTC develop to a service- supplier for carbon production; internal AIRBUS and external

Source: Composites World



Source: Airbus

2006

- A350 development period
- Valuation composite maturity status
- Decision phase for the key technologies composites A350
- Industrial composite production

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CTC – Partners and customers.

Composites Recycling – Status Quo

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Technical Status Quo

- **Repurpose** options (**non-original** re-use) exist and are continuously being expanded, but still very scarce (e.g., furniture from GFRP rotor blade parts)
- **Recycling** of fiber composites: Many options exist

  CFRP: 1) Pyrolysis (fiber recovery, industrialized since 10+ years)
  2) Solvolysis (fiber & matrix recovery, industrialized in Asia, close to industrialization in Europe)

  GFRP: 1) Mechanical Recycling (use of shredded material as filler/compound)
  2) Cement Route (raw material recycling of glass fibers, energy recovery for matrix)

- **Recovery**

  CFRP: 1) Calcium carbide route (TRL 8)
  2) Steel scrap recycling (towards TRL8)

  } Challenge: Limitation of scale

  GFRP: 1) Cement route (TRL 9)

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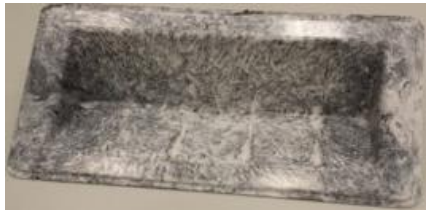
CTC – Extensive past Activities & Projects



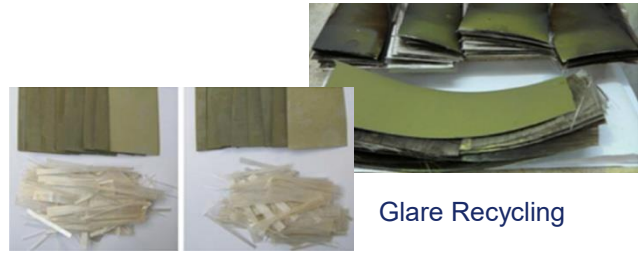
Recycled carbon fiber SMC aircraft cargo step

Uncured prepreg residues processed into chip laminate

Highly aligned tows from short rCF for higher performance

rCF Prepregs for cabin applications

Endless fiber recovery from filament wound parts



Glare Recycling

Reuse of dry fiber waste for childrens orthesis

A350 Gusset filler from reused AFP spools **(in serial application!)**

Recycling of thermoplastic clips (A350 fuselage-frame-clips) into an LFT compression molding compound (+ cargo step demonstrator)

Recycled carbon fiber SMC kitchen tray

Uncured prepreg residues processed into drilling templates

Compression molding material (BMC) from uncured prepreg residues/cut-offs

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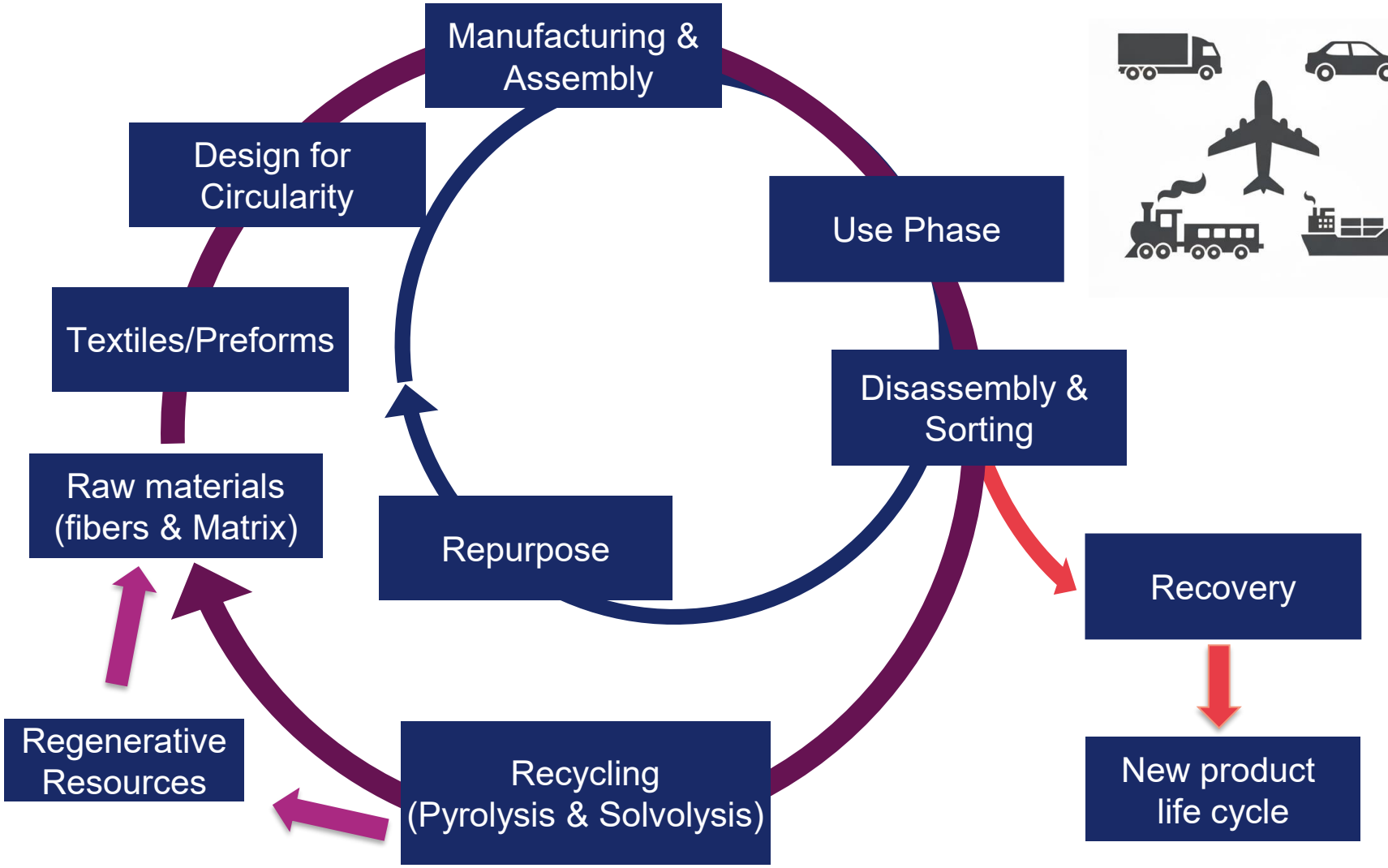
… but the R-option is only one part of the envisioned cycle!



Source:
Google Gemini

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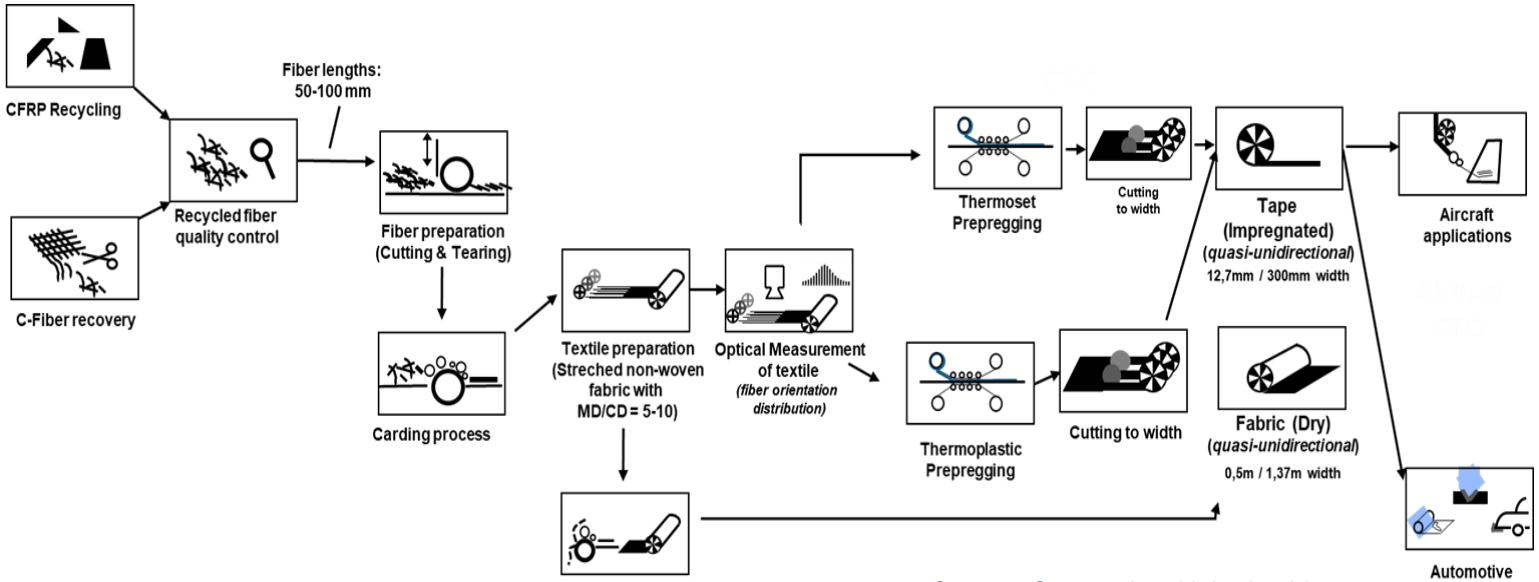
Example: HiPeR-Project

Oriented Recycled carbon fiber prepreg for structure

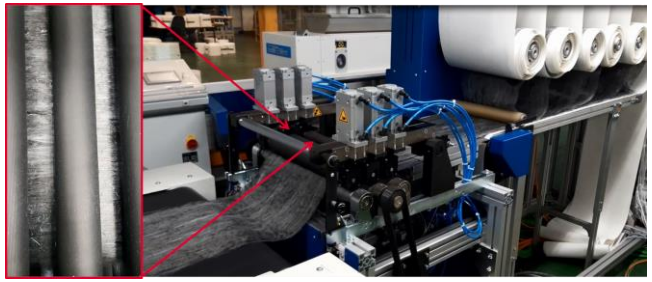
Quasi-UD-Material made from long recycled carbon fibers

- 500 to 600 MPa tensile strength
  (compared to 60-100 MPa for non-wovens)
- Replaces woven fabrics in **SA VTP Rib 10**

Joint research project between Japanese and German partners, funded by BMBF
(Moriroku, CFRI, IHI, ICC, CAR Fibertec, STFI, Fibre, CTC)

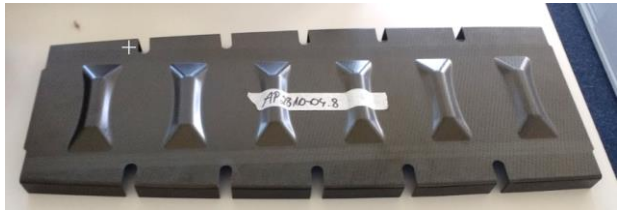


Source: Composites United e. V.

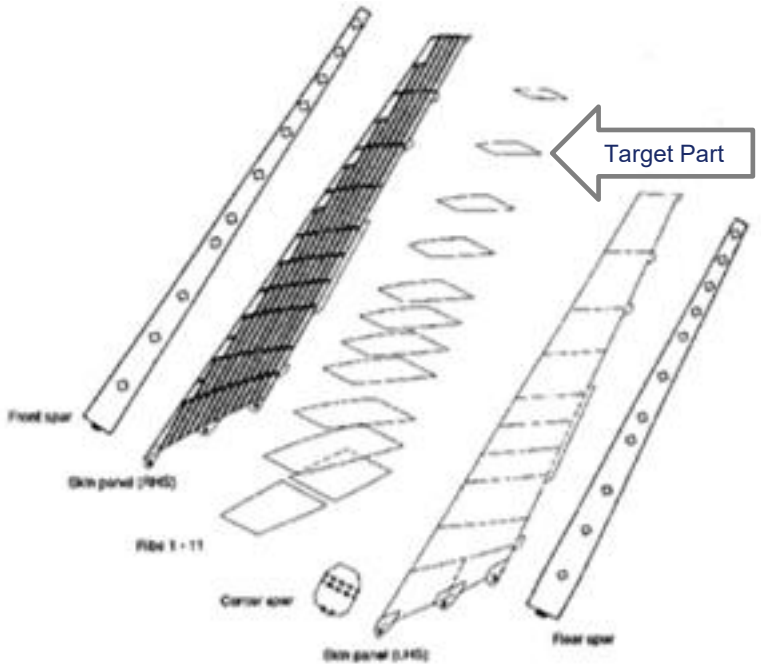


Alignment unit for long fibre oriented textiles at the STFI

Source: cetex/stfi



Integral RTM rib for the vertical tail plane



State-of-the-art VTP Build concept

Source: Airbus

Composites Sustainability: A holistic view

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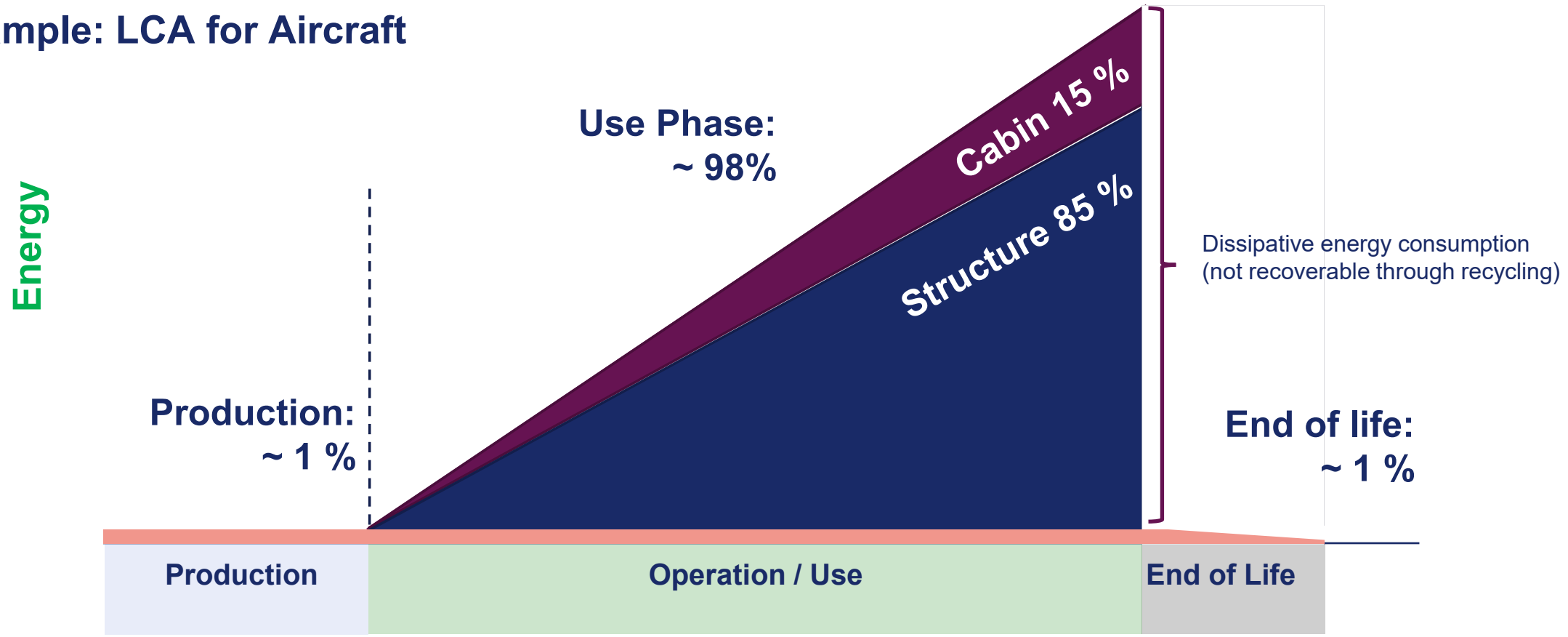
A more holistic view: Energy impact

Example: LCA for Aircraft



About 98 % of the aircrafts resources are consumed in the operation phase (ground and flight ops): 51% kerosine production, 46% fight operation

→ Lightweight Design / Composites is key!

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… but there‘s more – Things to consider

Production

Low waste / no waste

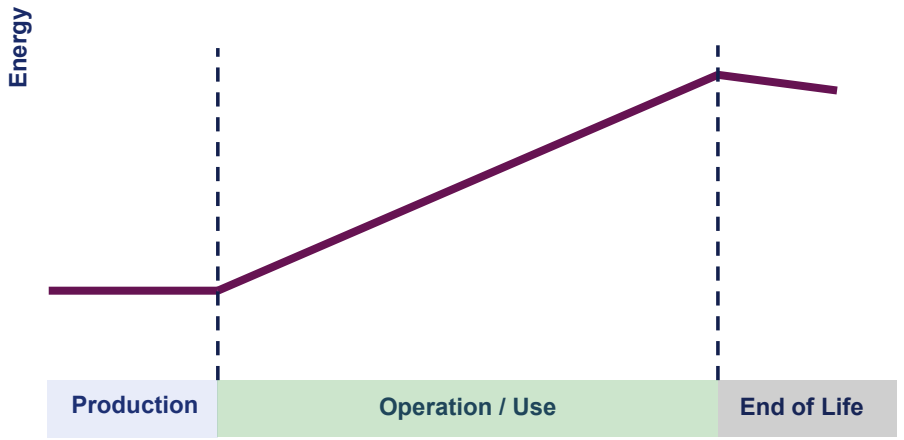
Low (Energy) Consumption Production Environment

Sustainable Materials

Design for Recycling

Don‘t use *bad* materials („Would you like have your kid deal with this?“)

Auxiliary materials waste of a CFRP fuselage section



Operation / Use

Efficiency

Durability

Weight

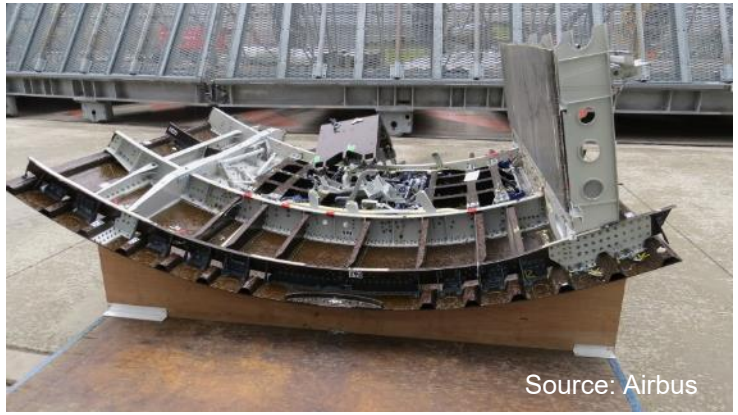
Repair

End of Life

Recyclability / Second life

Material mix / segregability

Disposal routes



Dismantled A350 fuselage section

Significance of Production and End of Life will increase
→ Operation with Sustainable Aviation Fuel (SAF) & H2

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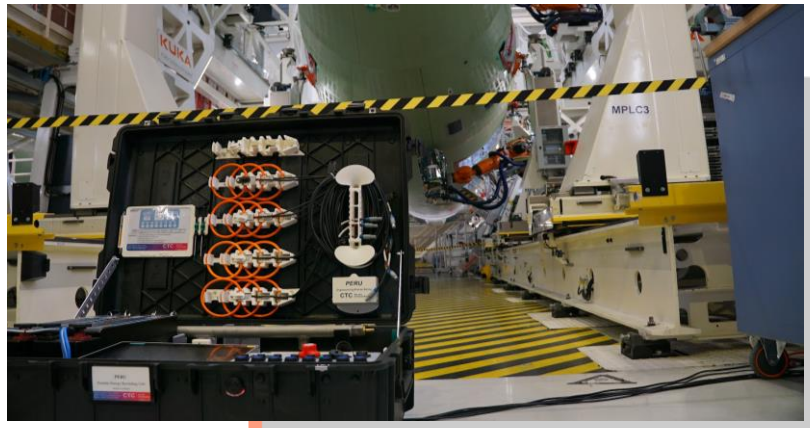
Energy Analysis as key tool for sustainability assessment



Power consumption

- Real data from installed sensor infrastructure
- First approach for transparent ecological part footprint

Stade

First layer CFRP

pre-assembled fuselage shell

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Composites Sustainability Research: The focus is shifting

Focus: Recycling Technology

Focus: rCF-Material Development

The holistic view on the entire circle is the key to sustainability

Focus: Information Systems (Circularity)

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„Holistic“ includes non-technical topics

Current Challenges in Composites Sustainability

Technical

- Sorting & Separation of the waste fractions
- (Automated) Disassembly
- (High quality fiber recovery)
- Matrix recovery
- Fiber length degradation
- (Production of high quality secondary materials)
- (Price/Performance ratios for recycled materials)
- Material specification / standards for secondary use

Non-technical

- Missing material information transport along value chain (Digital Product Passport)
- Missing waste codes on EU level (allocation of waste)
- Missing logistics system for waste collection
- Missing customs framework for composite waste

→ **Overall: Missing waste volumes**

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ESPR & Digital Product Passport

Source: European Commission

- Ecodesign: Integration of environmental sustainability considerations into the characteristics of a product
- **Aim of ESPR: Improve circularity, energy performance and other sustainability aspects of products**

ESPR-Document is available at:

Ecodesign for Sustainable Products Regulation - European Commission

The European Commission (EC) defines a '**product passport**' as:

"a product-specific data set, which can be electronically accessed through a data carrier to "electronically register, process and share product-related information amongst supply chain businesses, authorities and consumers".

The DPP
- is an integral part of the ESPR
- shares the same adoption timeline and future work program for priority products

Goal:
Simplified access to product specific information related to sustainability, circularity, and legal compliance along the entire value chain

Slide Source: https://commission.europa.eu/document/download/c5db3b9e-23ae-42c8-a50a-b549f20a377d_en?filename=2024_05_22_EC%20Presentation%20ESPR%20Webinar_final.pdf

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Digital Product Passport – Main Design Features

DPP-system

*(the "**HOW**". To be developed horizontally for all product groups and legislations)*

- **The DPP registry**
- **A searchable Web Portal**
- **All standards and protocols related to IT architecture:**
  1. Unique identifiers
  2. Data carriers and links between physical product and digital representation
  3. Access rights management, information security, and business confidentiality
  4. Interoperability (technical, semantic, organisation)
  5. Data processing , data exchange protocols, and data formats
  6. Data storage, archiving, and data persistence
  7. Data authentication, reliability, integrity
  8. APIs for the DPP lifecycle management and searchability

DPP-data

*(the "**WHAT**". To be developed through **product-group specific** dedicated legislation)*

Information to be included in the DPP will be **product-group specific** and identified in delegated act process.

It may include information/data on one or more of the following areas:

- Technical performance
- Environmental sustainability performance
- Circularity aspects (durability, repairability, etc)
- Legal compliance
- Product-related information (e.g., manuals, other labels)

Source: European Commission

European Commission

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GE-EC-Not-Technical

Slide Source: https://commission.europa.eu/document/download/c5db3b9e-23ae-42c8-a50a-b549f20a377d_en?filename=2024_05_22_EC%20Presentation%20ESPR%20Webinar_final.pdf

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Example: EU-Project DigiPass

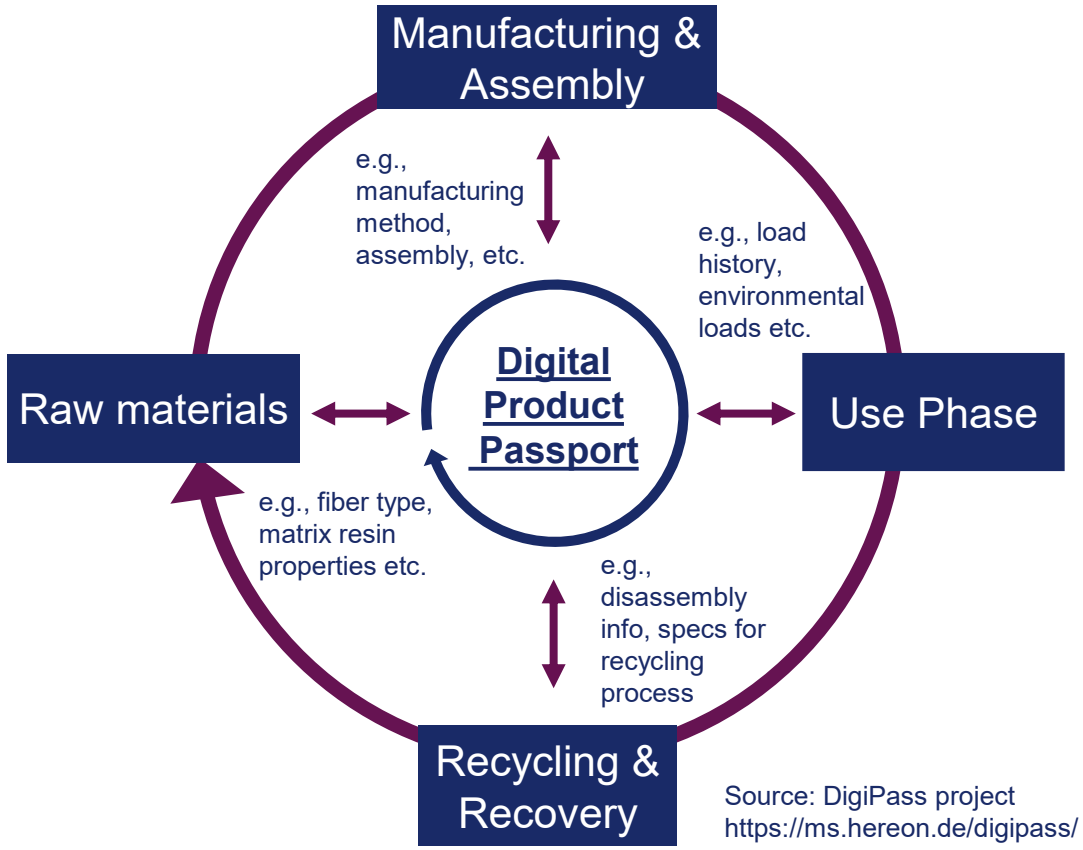
- Focus: Development of a concept for a digital passport for composite materials

- Composites United as project partner, responsible for use case “Advaned Composite Materials”:

Work plan:
- Analysis of existing tools & status quo
- Analysis of the requirements of all players involved along the value chain
- Gap analysis
- Development of a suitable **concept**
- Use of the demo case “wind turbine rotor blade” to verify and optimize the concept

- Project attracts great interest from the EU Commission

DigiPass
Know Your Products!



Source: DigiPass project
https://ms.hereon.de/digipass/

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European Circular Composites Alliance (ECCA)

- ECCA is a sectorial alliance of the European Composites Industry Association
- Goal: Establish a circular economy for composites in Europe
- 193 organizations have joined ECCA (status 13. Jan. 2026)
- 5 working groups to define and reach specific targets in different areas:
  - Aerospace & Defense
  - Road Vehicles & Public Transportation
  - Industrial & Recreational
  - Construction
  - Crossover
- **Key Task: Identify and resolve legal, economic, and technical barriers to composites circularity**
  → waste codes, design guidelines for circularity, European standards etc.

Source: European Composites Industry Association

More info and participation: https://eucia.eu/ecca/

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Breakdown: What does this all mean for composites use in ship building?

- The holistic potential value of a use of composite materials in ship building should be the deciding factor **for go/no go**
  - Technical solutions for CFRP/GFRP recycling exist

- Opportunity “First time right”: Learn from other industries
  - Design for circularity
  - Material/Information tracking
  - No harmful materials
  - Develop common guidelines/standards

- Addressing the cost challenge: Learn from other industries
  - Modularization
  - Standard parts/designs
  - Automation

Source: Google Gemini

AI-Result for „Sustainable Use of Composites in Ship Building“

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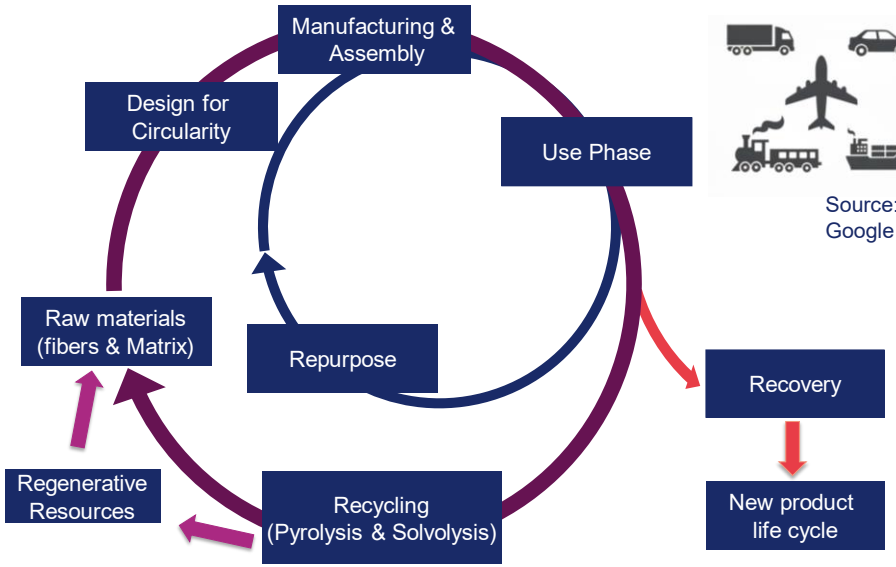
Conclusion & Take Away's

- Recycling is only one aspect – holistic sustainability evaluation is necessary
- Perfect circles don't exist → pragmatic improvements
- Key Challenges in Composites Sustainability today are non-technical → Missing waste volumes
- The challenges (technical & non-technical) are being addressed (e.g., ESPR, ECCA etc.)
- Opportunity for ship building industry: Learn from others



Source: Google Gemini

ECCA European Circular Composites Alliance by EuCIA

Source: European Composites Industry Association

DigiPass Know Your Products!

Source: DigiPass project: https://ms.hereon.de/digipass/

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Thank you.

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