

INTERNATIONAL
COTTON
CONFERENCE
BREMEN

2024



20 – 22 MARCH 2024 | BREMEN PARLIAMENT HOUSE

PRESENTATION

Session:

A Wider View

Title:

Textiles on the way to circularity

Speaker:

Prof. Dr. Stefan Schlichter, Faculty of Mechanical and Process Engineering –
Makers Labs Recycling & AI, Technical University of Applied Sciences Augsburg (Germany)

Conference Organization

Faserinstitut Bremen e.V., Bremen, Germany. E-Mail: conference@faserinstitut.de

Bremer Baumwollboerse, Bremen, Germany. E-Mail: info@baumwollboerse.de

TEXTILES ON THE WAY TO CIRCULARITY

Prof. Dr.-Ing. Stefan Schlichter, Technical University of Applied Sciences Augsburg
Makers Labs Recycling & AI

37th International Cotton Conference Bremen

20.03.2024, Bremen

Textiles on the way to circularity

Agenda

- Motivation for textile circularity
- Facts around circularity
- Overview on circular technologies
- Concepts for realization
- Best practise: Recycling Atelier Augsburg
- Summary



Motivation for textile circularity



IT IS UTMOST URGENT!

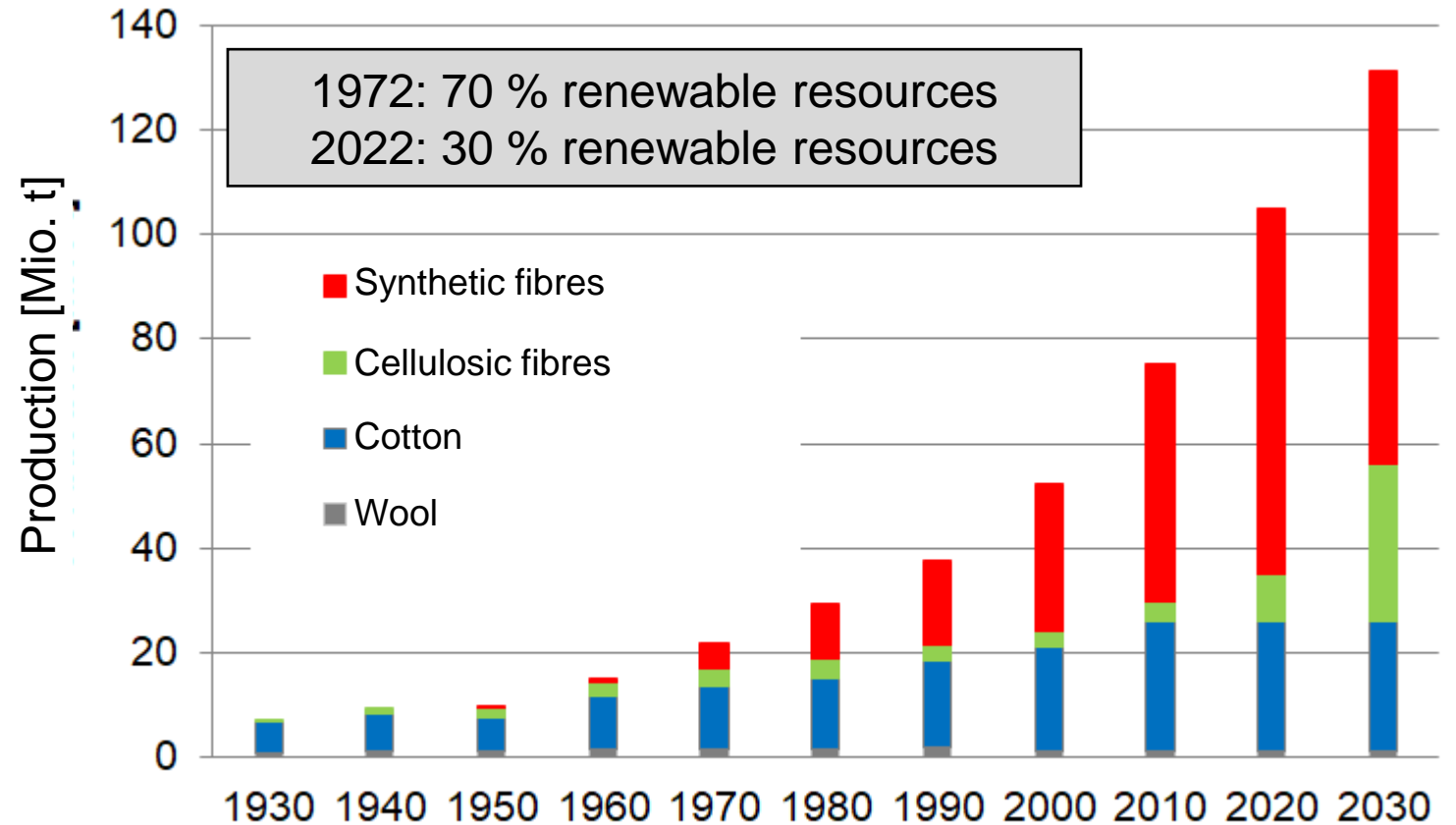
„We must act now to mitigate the impact of rising energy prices, diversify our gas supply for next winter and accelerate the clean energy transition. The sooner we switch to renewable energy and hydrogen, combined with greater energy efficiency, the sooner we will be truly self-sufficient and in control of our energy system.”

Ursula von der Leyen

Commission President on REPowerEU: Joint European action for more affordable, secure and sustainable energy - March 2022

Sustainability and defossilisation are targets of highest urgency

- 65% of world fibre market is petro-based
- Environmental foot print of cotton is severe
- Increase of demand on cellulosic fibres
- High demand and urgent need → „Drop-in-Solutions“



Transformation is an inherent part of the textile industries and is today overdue

Endemic



<1800

THA

Textiles on the way to circularity – Prof. Dr. Stefan Schlichter

Colonial



1800

Wood



1897

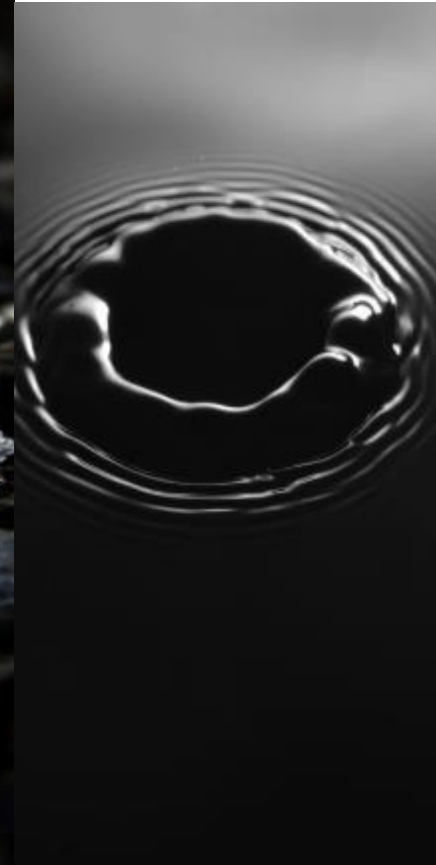
Coal



1935

RECYCLING
ATELIER

Petro



1950

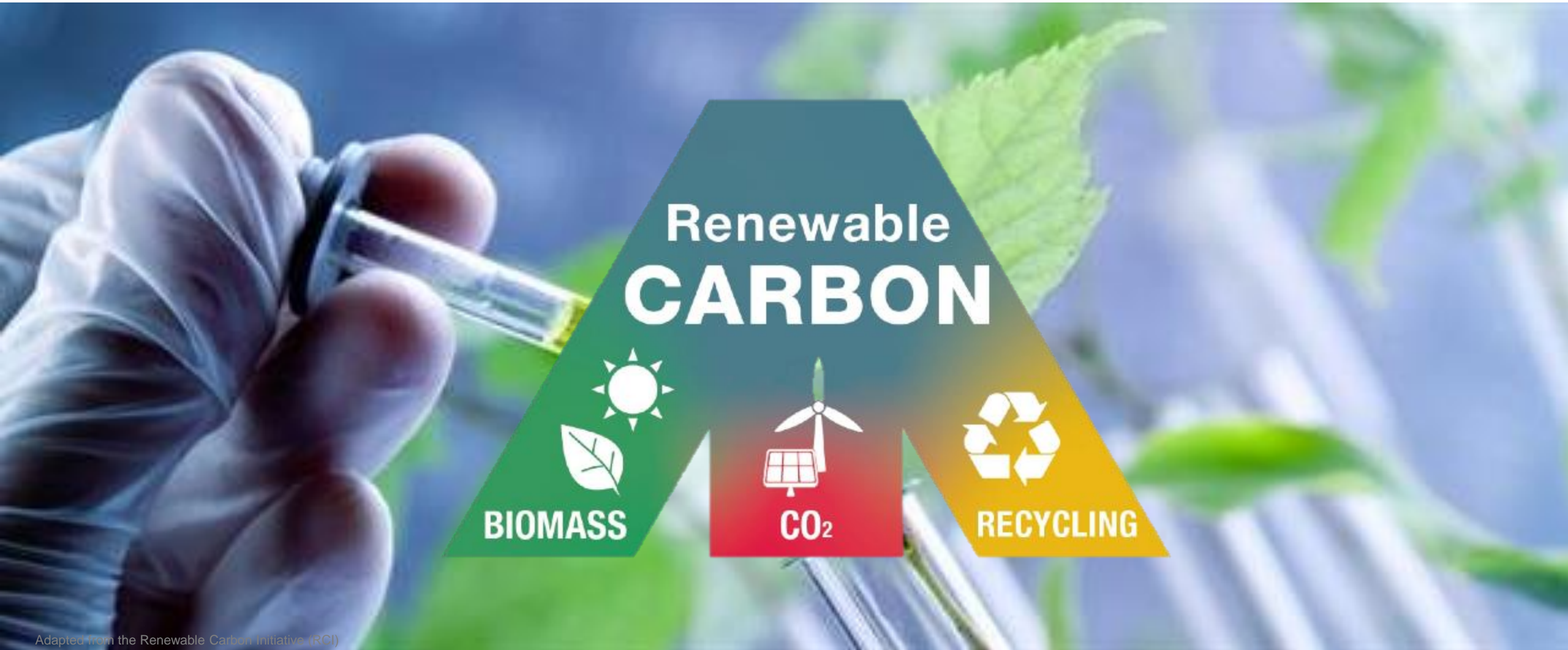
Bioeconomy



>2020?

ITA
Augsburg

Three pathways towards defossilisation



Adapted from the Renewable Carbon Initiative (RCI)



Textiles on the way to circularity – Prof. Dr. Stefan Schlichter

RECYCLING
ATELIER



Current situation of the textile cycle: only linear economy landfilling and energy recovery

Only 1% of used textiles are recycled in a closed cycle₁

High material diversity of used textiles leads to problem in recycling

Textile waste more than just old clothes, large quantities of technical textiles and hygiene textiles₃

Linear economy:



production

use

disposal

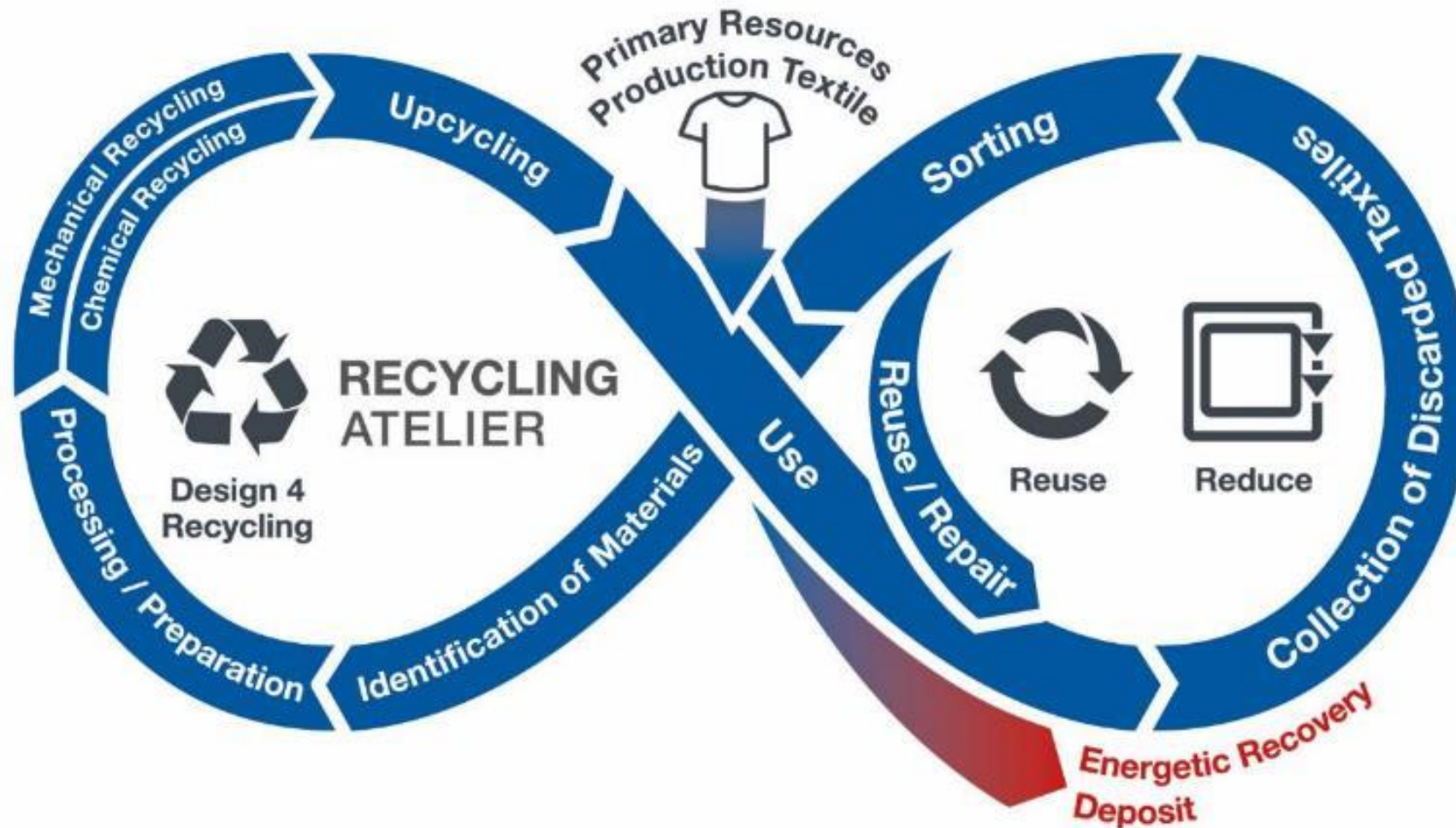
Fast fashion as a driver of larger quantities of lower quality used textiles

large quantities of used clothing are collected (1.6 million tons in Germany)₂

Mainly downcycling to low quality products (rags etc.)₃

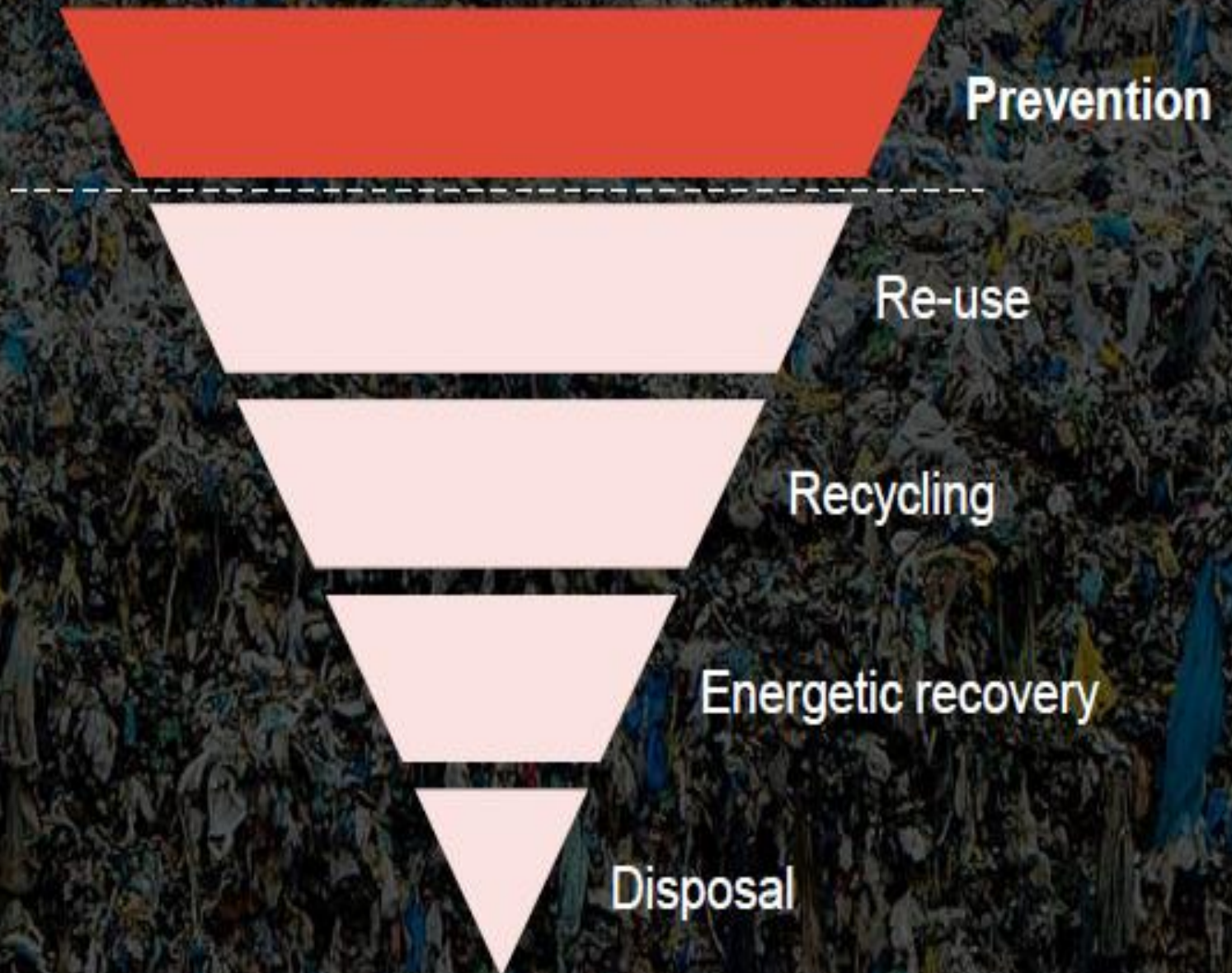
Today, 73% of used textiles are recycled for energy or landfilled. Only 1% is recycled in the closed loop.

Vision of modern textile cycle: high-quality recycling instead of landfill and energy recovery



Facts around circularity

The **top**
priority of the
waste
hierarchy is
waste
prevention.



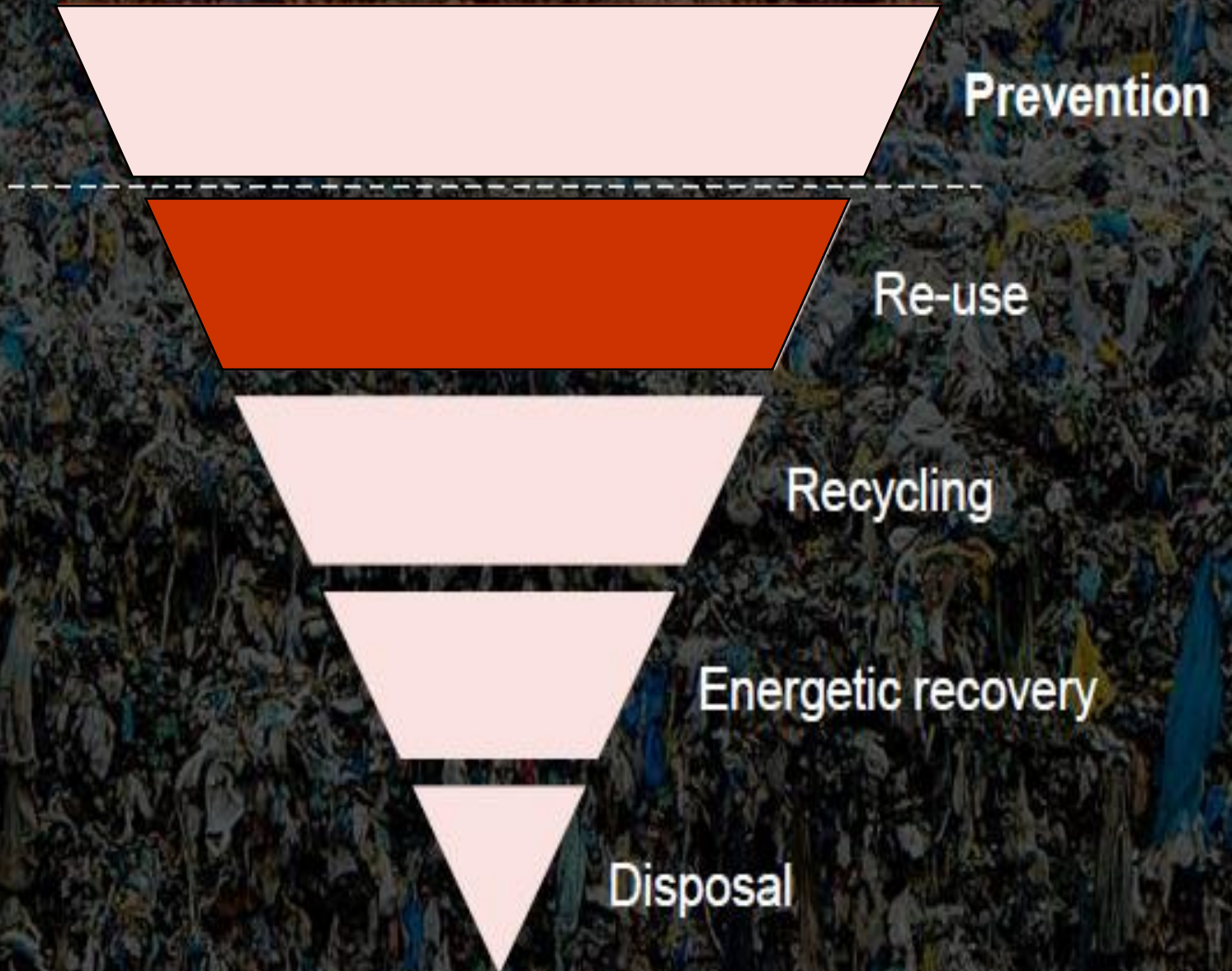


Wardrobe Study: ... what we may need ...



Wardrobe Study: ... versus reality (on average only 3 - 4 use cycles)

The **top**
priority of the
waste
hierarchy is
waste
prevention.





Quelle:
Lanade

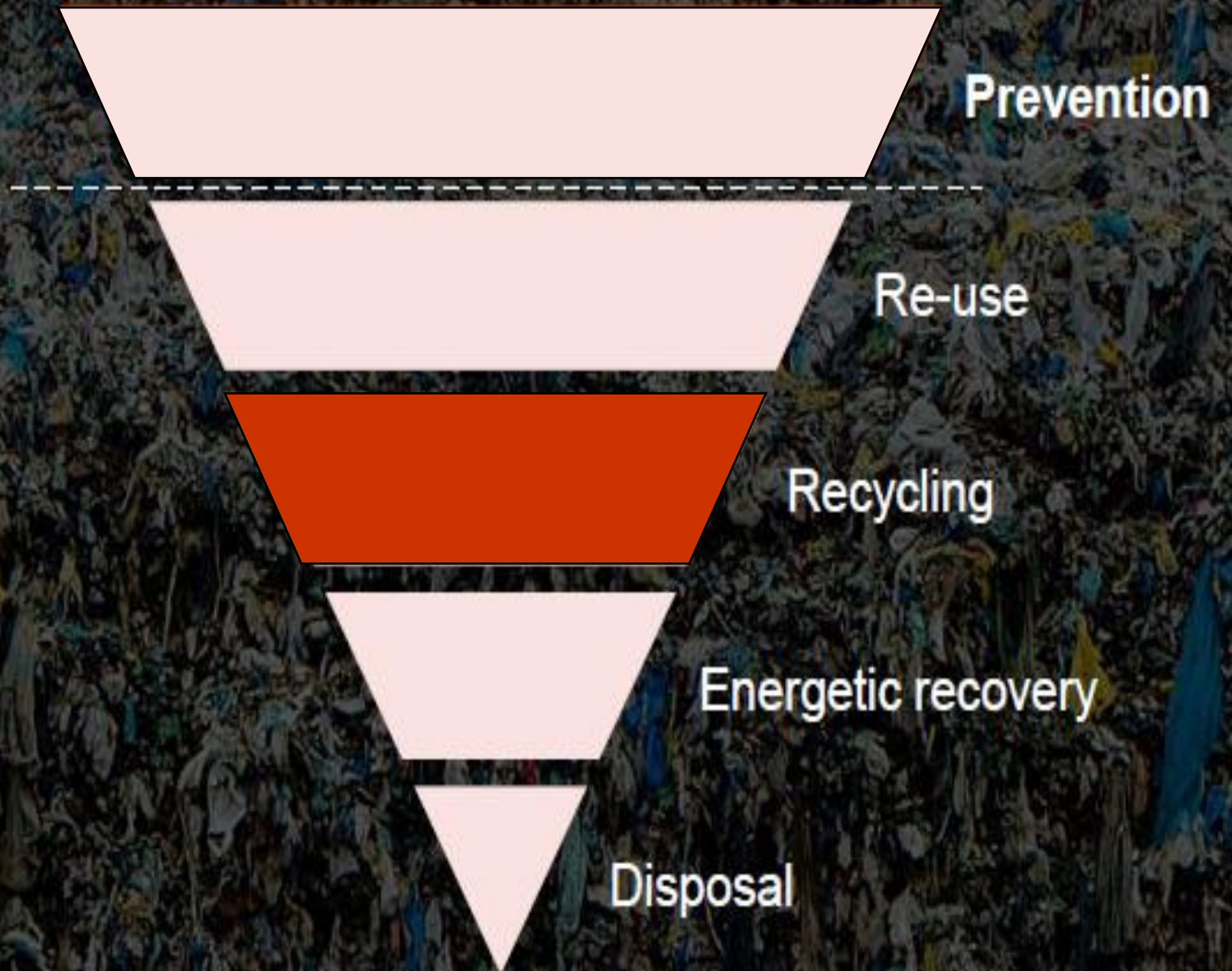


Reuse and Upcycling



THA

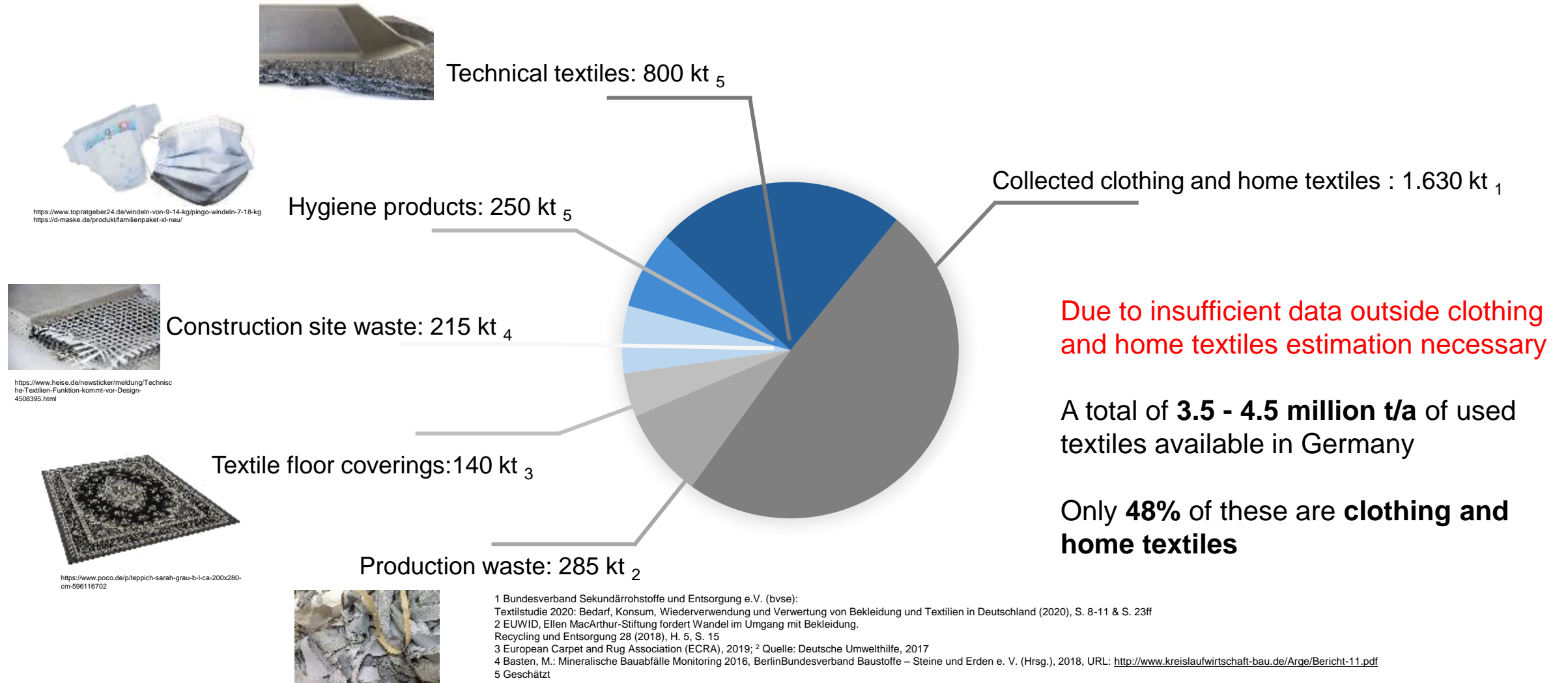
The **top**
priority of the
waste
hierarchy is
waste
prevention.





The Business Model of municipal Textile Collection has collapsed!

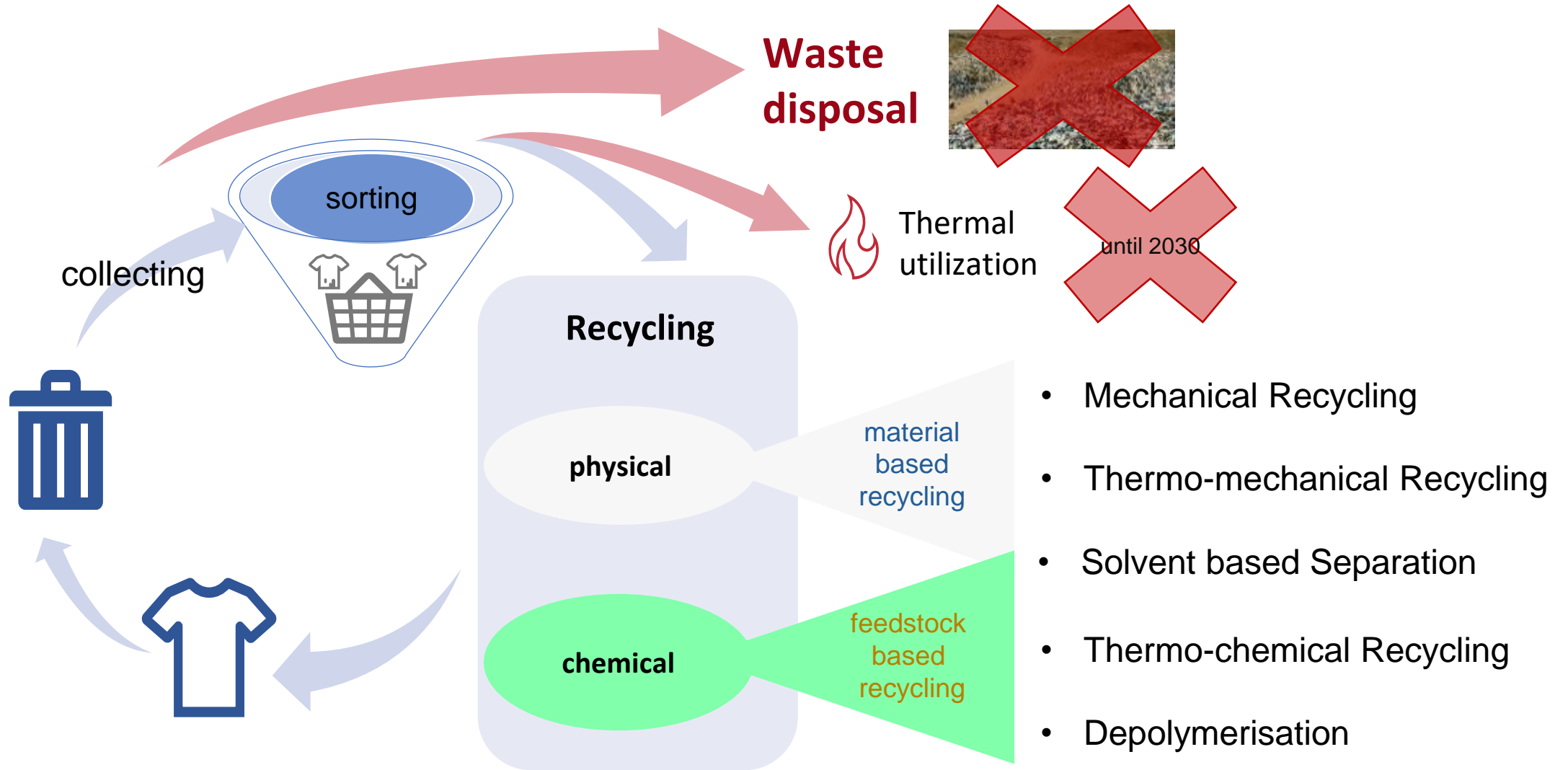
Used textiles are more than just clothing and home textiles (not only in Germany)



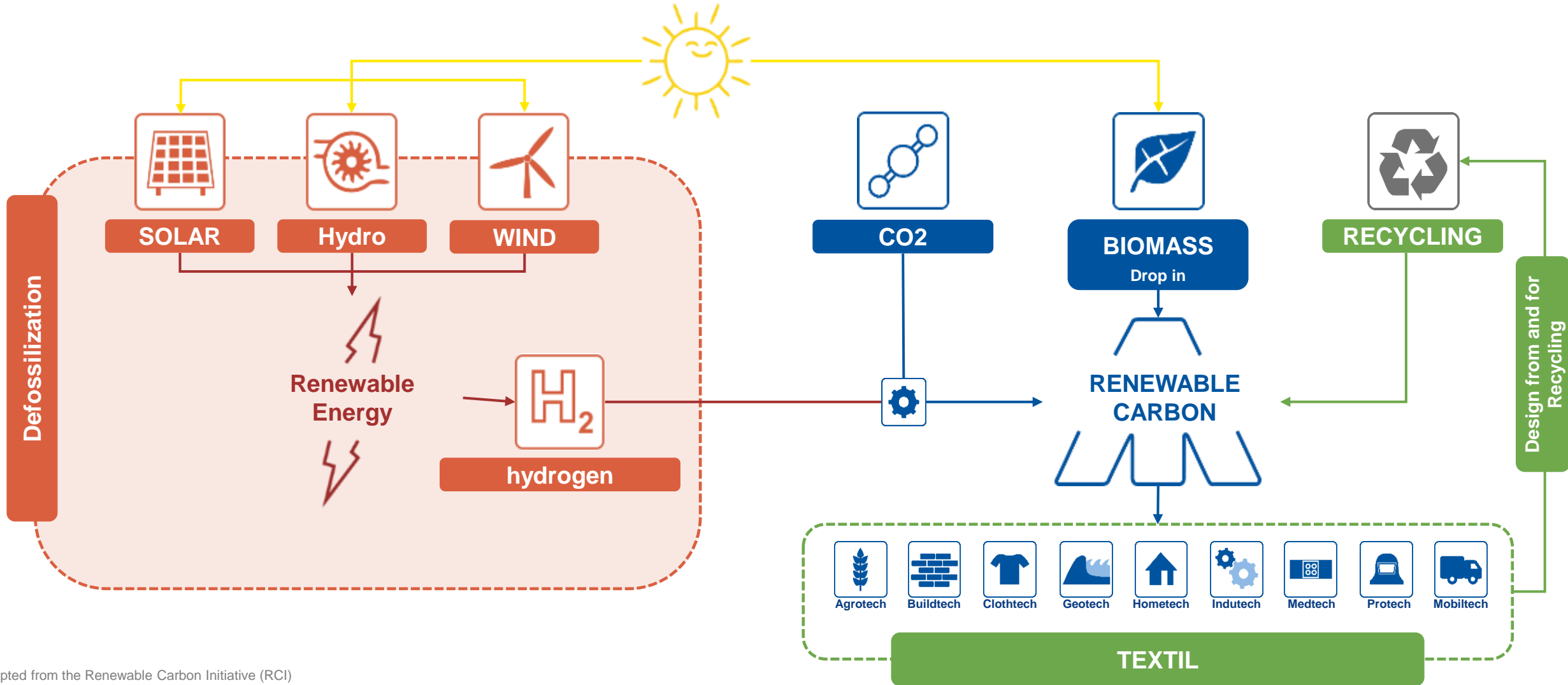


Overview on circular technologies

Different ways of reutilization



Sectoral Coupling of Renewable Energies and Renewable “Carbon”



Adapted from the Renewable Carbon Initiative (RCI)



Textiles on the way to circularity - Prof. Dr. Stefan Schürner

Recycling processes also consume energy and generate entropy. Textile recycling only becomes sustainable by coupling it with renewable energy

Concepts for realization



Limitation: mechanical
2. Fundamental Law of Textile Recycling
„With every Cycle the Fibres get shorter“ [Th.Gries]

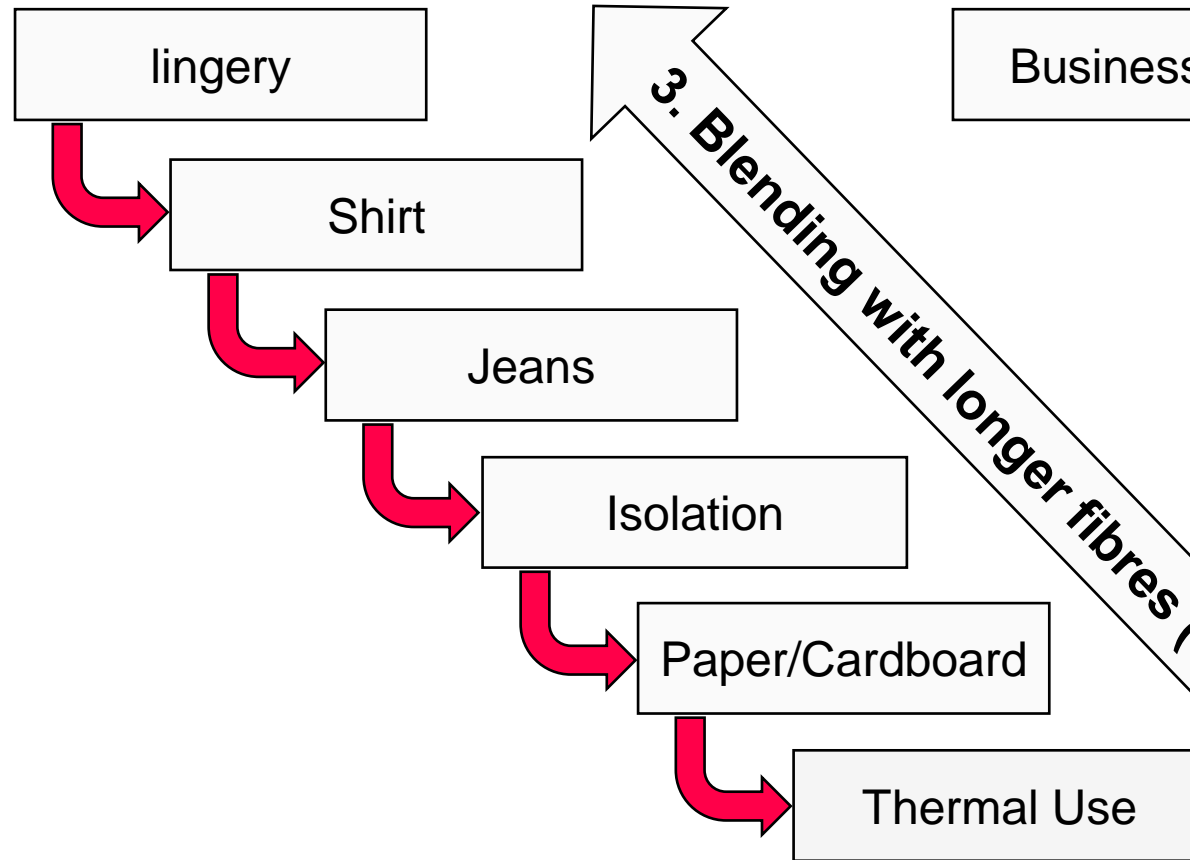
a

b

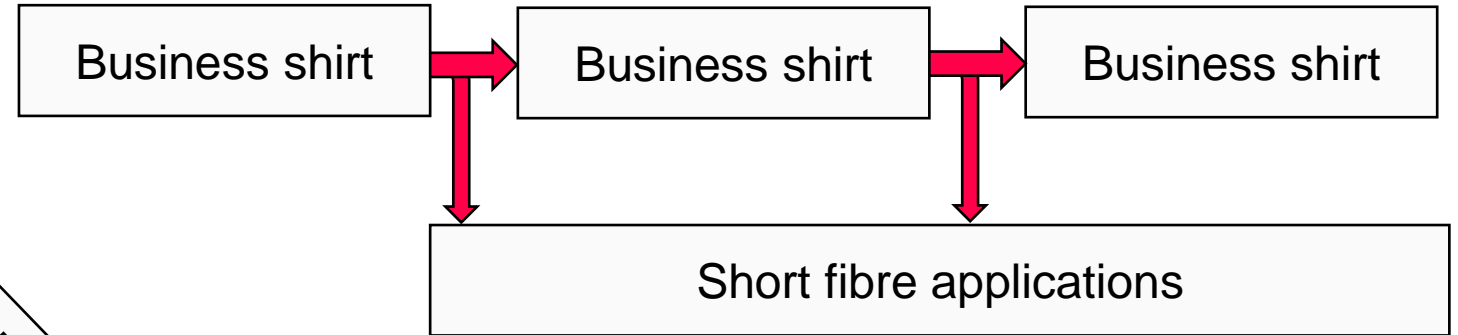
c

SOLUTION FOR THE 2. FUNDAMENTAL LAW OF FIBRE RECYCLING

1. Cascade applications

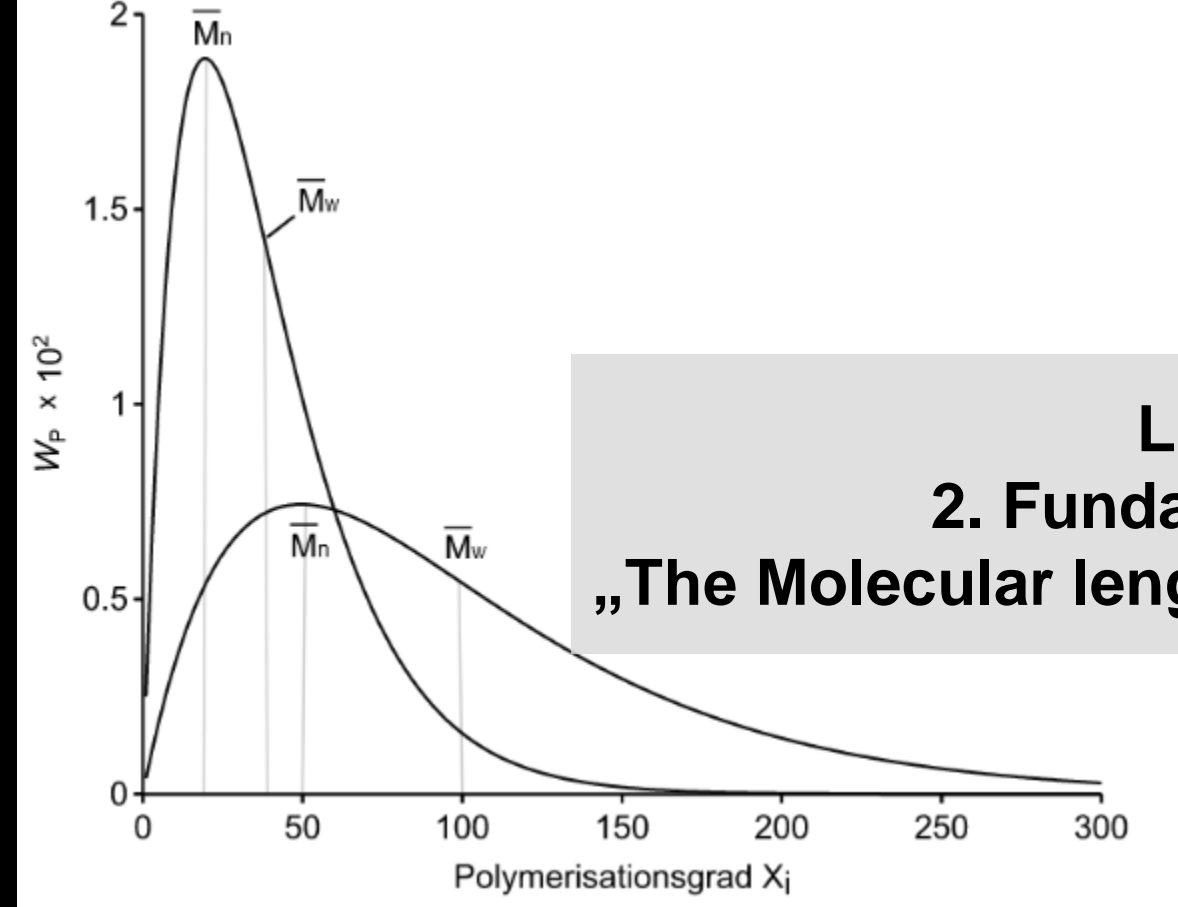


2. Short fibre Separation

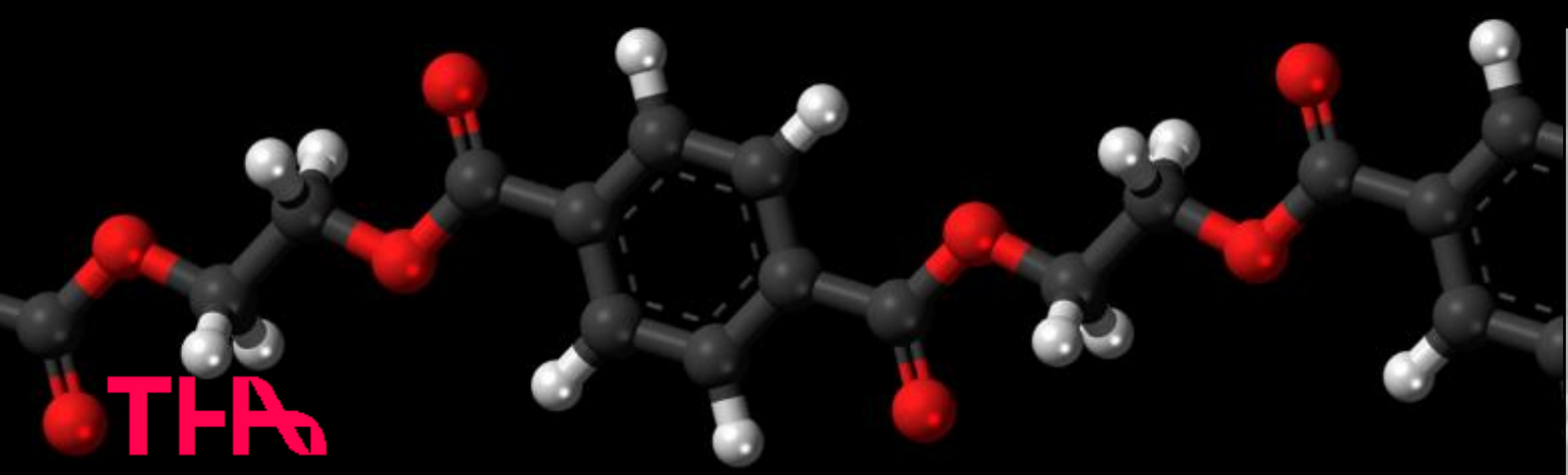


3. Blending with longer fibres (e.g. virgin)

3 Strategies exist to maintain the staple length.



Limitation: polymer physical
2. Fundamental Law of Polymer Recycling
„The Molecular length gets shorter with every cycle “ [Th. Gries]



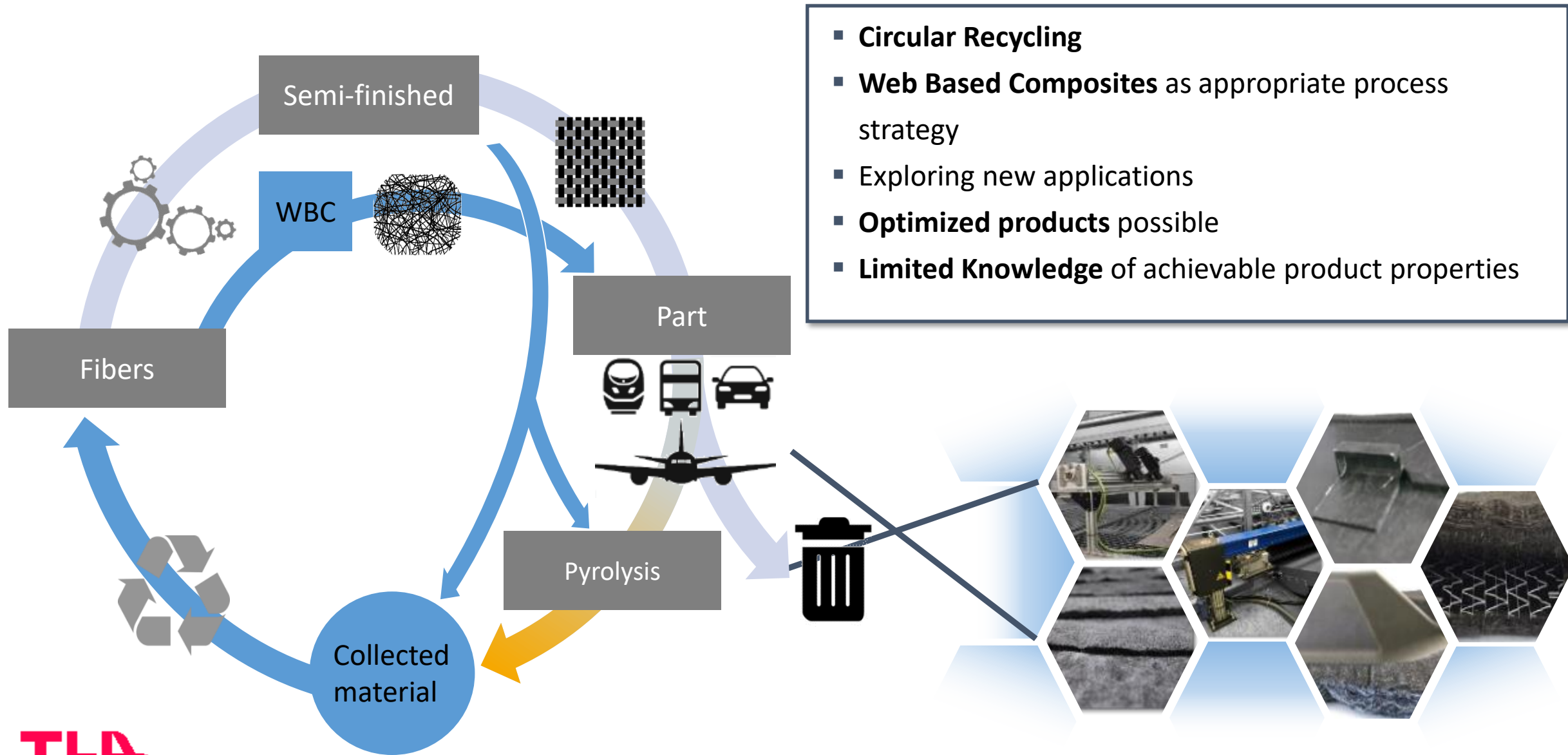
1. Solid-State-Postcondensation
2. Partial Depolymerisation and new Polymerisation (finisher)
3. Depolymerisation and new Polymerisation



Circular Economy needs a new balance of ...



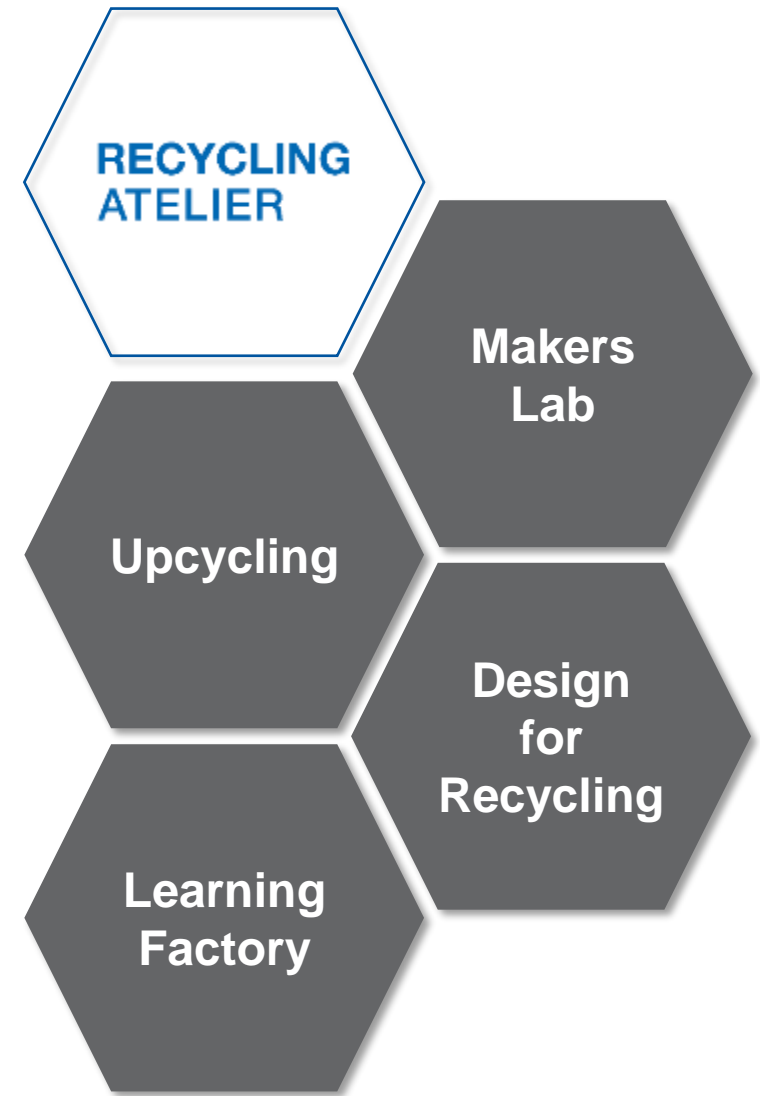
Cradle to cradle material flow with Web Based Composites (WBC)



Best practise: Recycling Atelier Augsburg

Recycling Atelier a new approach of open innovation for textile secondary raw materials

- **Development of new products and processes** in the makers lab
- **Development of concepts** for the complete recycling of used textiles:
 - Integrated and high-quality recycling (**upcycling**)
 - recycle-oriented product design (**design 4 recycling**)
 - **Longer lasting products** and **repair strategies**
- **Industrial implementation** of recycling concepts and business models
- **Learning factory** for training, and capability build up



Recycling Atelier Augsburg a new concept to meet the requirements of circular economy

Makers
Lab

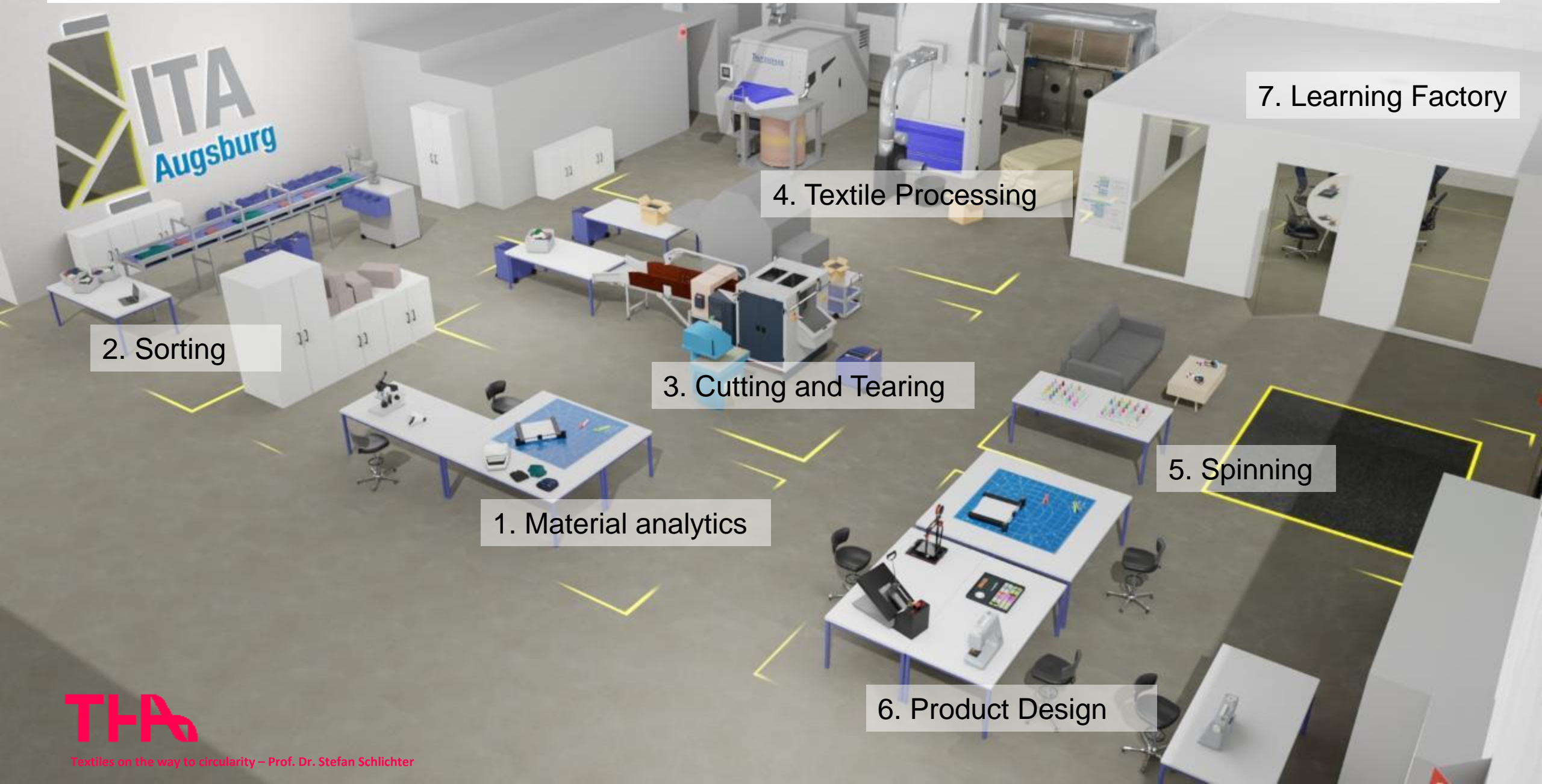


Textiles on the way to circularity – Prof. Dr. Stefan Schlichter

RECYCLING
ATELIER



THE CONFIGURATION OF THE RECYCLING ATELIER FOLLOWS THE MATERIAL FLOW



2. Sorting

1. Material analytics

3. Cutting and Tearing

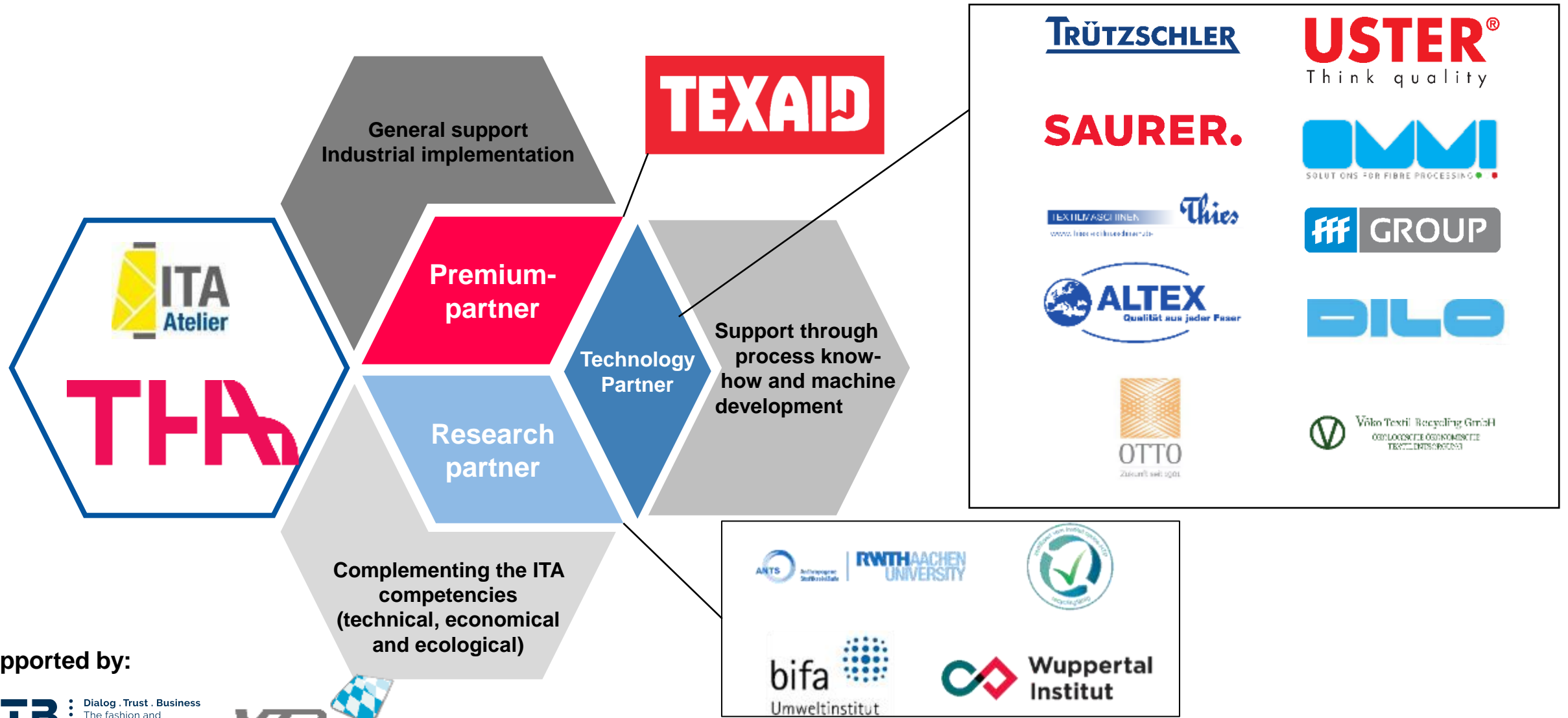
4. Textile Processing

5. Spinning

6. Product Design

7. Learning Factory

Bundled competence leads to new recycling products through innovative technologies along the entire process chain!



supported by:



RECYCLING ATELIER

Recycling Atelier – Sorting

Artificial
Intelligence



Source: TexAid

from manual



to automatic, high quality
material selection



Textiles on the way to circularity – Prof. Dr. Stefan Schlichter

RECYCLING
ATELIER




AI based image analysis project

Artificial
Intelligence



Detection-Results:

 Category: **Shirt**

 Textile structure: **Woven**

Buttons: **Yes**



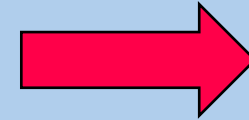
continous **THA** project



Select the right process for different applications

Carding - Spinning

- Cotton, manmade fibres
- Blends
- Recycling material



yarn

Nonwoven compact line

- Industrial setup
- Processing of technical fibres (carbon, glass, secondary waste)



nonwoven



INTELLIGENT PRODUCT DESIGN CREATES SUPERIOR PROPERTIES

Advantages of locally adapted consolidation

- Manufacturing of parts with adapted properties from single semi-finished material
- High bending and buckling stiffness in plane areas
 - **Longer span length possible**
 - Better thermic and acoustic isolation
- Good **point load integration in connecting points**



WBC-parts with locally adapted consolidation

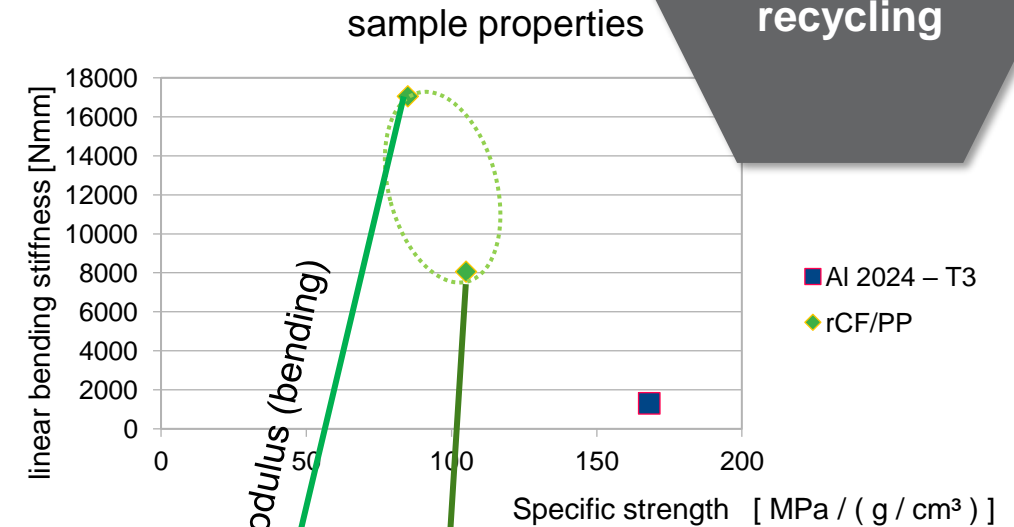


Textiles on the way to circularity – Prof. Dr. Stefan Schlichter

RECYCLING
ATELIER

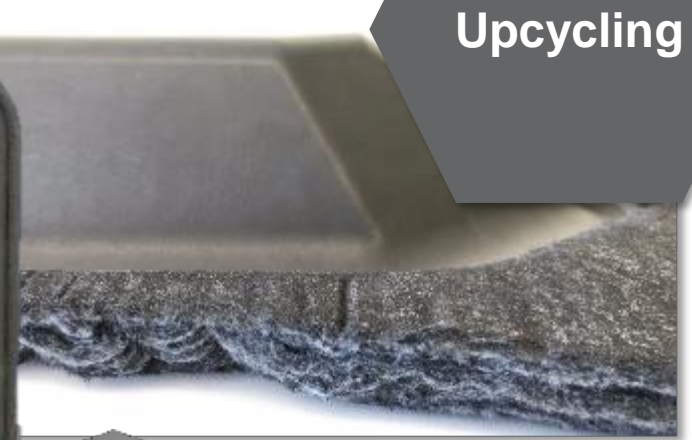
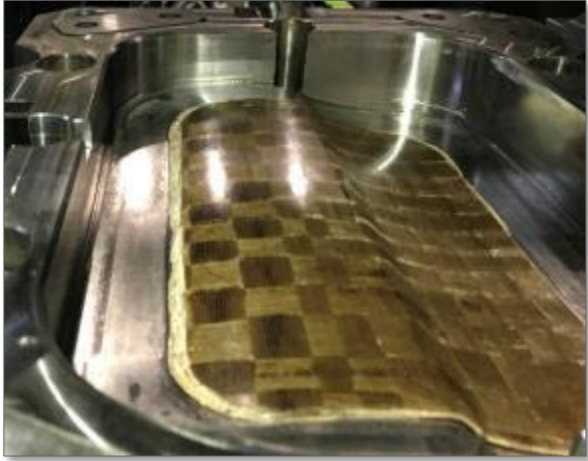
Material data and calculation: Institut für Strukturmechanik und Leichtbau (SLA) der RWTH Aachen, Miguel Nuño Spiewak, M. Krause

Design 4
recycling

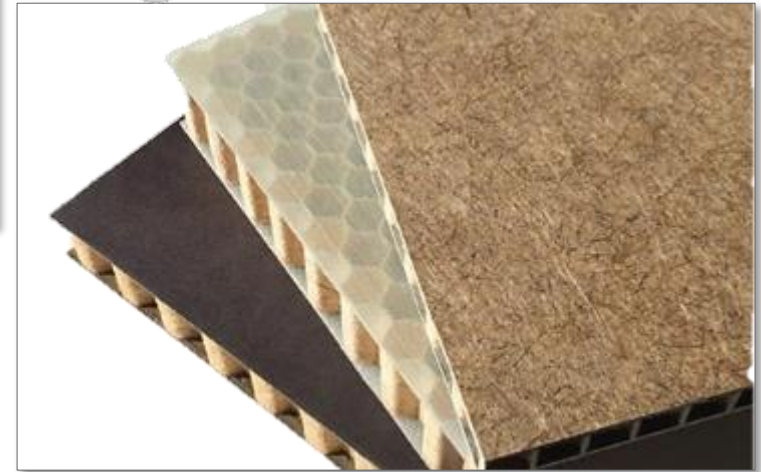


Web Based Composites | Specific properties allow superior products and processes

Upcycling



WBC can substitute metal (> 20% FVC)



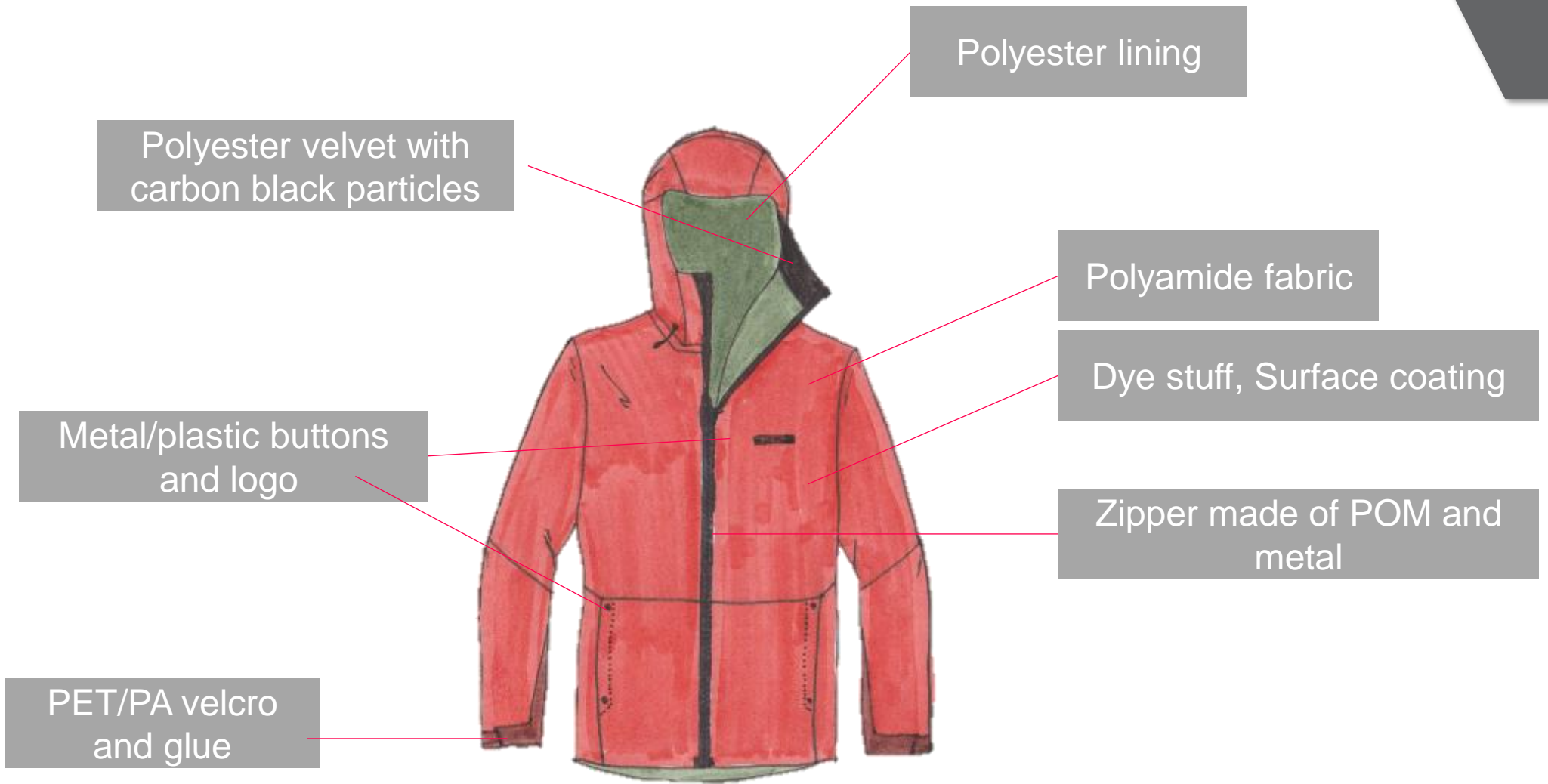
Textiles on the way to circularity – Prof. Dr. Stefan Schlichter

RECYCLING ATELIER



Challenges in Recycling

Design 4 recycling





Functional Limitation: Material-Efficiency via Material Mix versus Recyclability [Th. Gries]

1. Design for Recycling
2. Largely Mono-Material-Mix
3. Comprehensive Life-Cycle-Assessment

- McKinsey Study postulates recycling solutions with a maximum of 10% higher consumer prices
- Marketing experts know the power of (price) segments

- On-Shoring and Urban-Production result in higher wages
- Decentralized production at 5-10 times smaller units lead to „negative“ Economics-of-Scale

- New Business Models
- Digitale Business Models and Producer Networks
- Direct B2C or C2M Business Models

Station 7 – Learning Factory

Learning
Factory



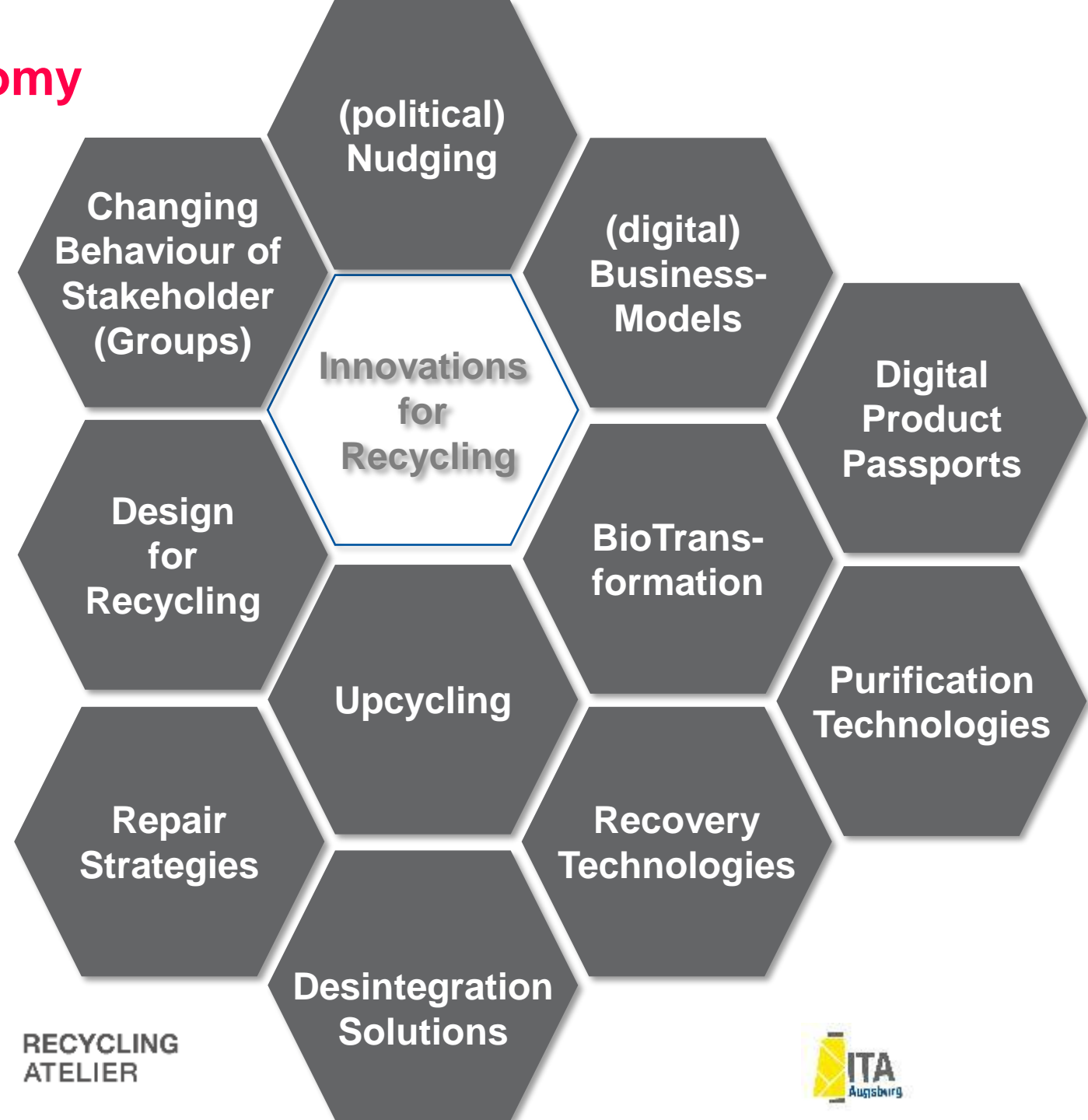
Training

- all industrial stakeholders
- students, trainees
- using modern learning methods and equipment
- integrated in the makers factory lab

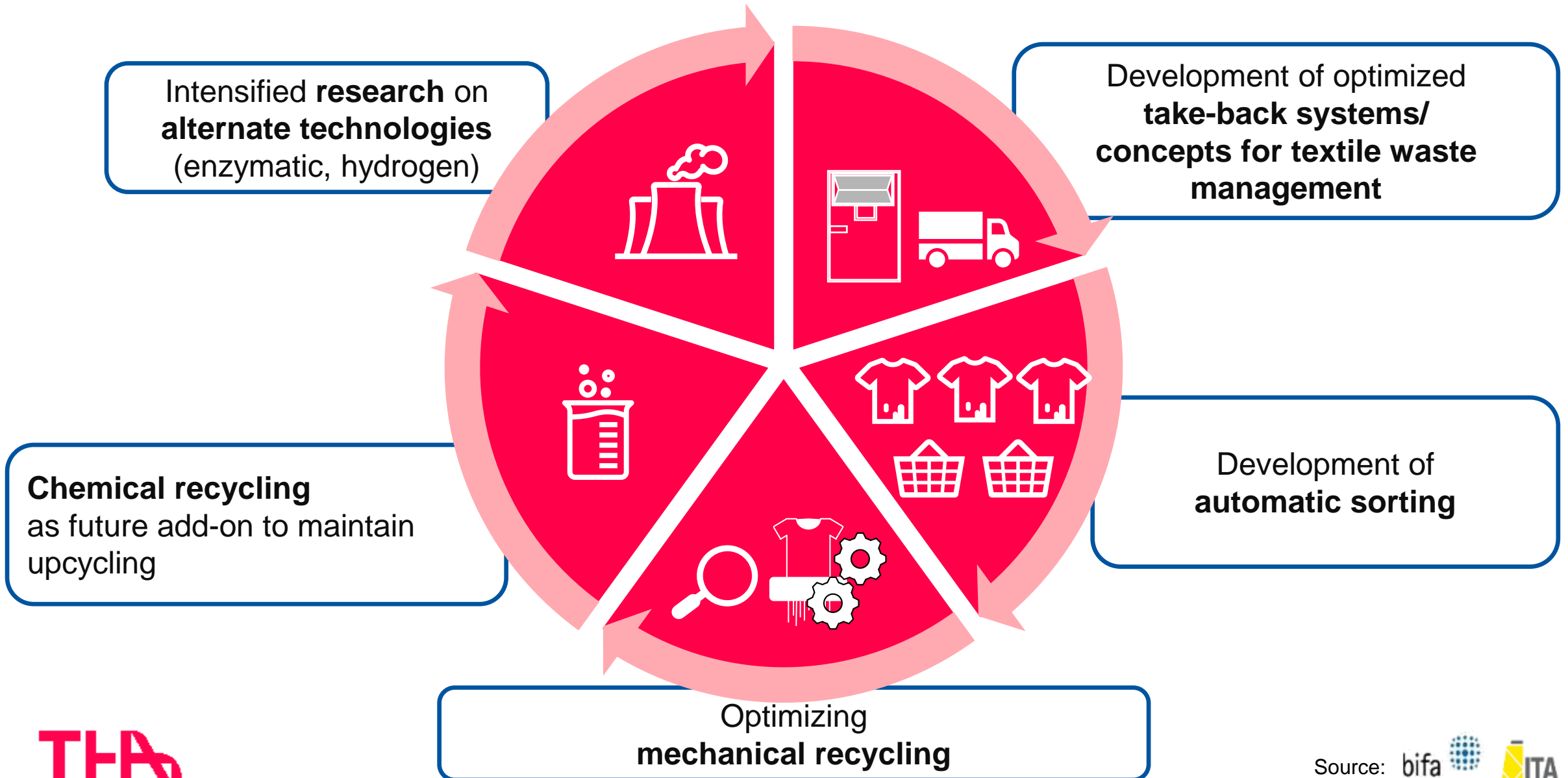
Summary

Innovation for a new Circular Economy

- Fewer, **longer-lasting** and more durable **products**
- Avoid **overproduction**
- **Reuse and repair** before recycling
- **Textile recycling** is an approach to becoming a more sustainable
- **Design for recycling**
- Sustainable distribution of waste and recycled materials



WHAT IS NEEDED TO MASTER THE CHALLENGES OF RECYCLING IN R&D ?





Makers Labs Recycling & Artificial Intelligence

Technical University of Applied Sciences
An der Hochschule 1, 86161 Augsburg

Tel (direct): +49 821 5586 3678

mobile: +49 174 1724167

E-Mail: stefan.schlichter@tha.de

www: www.tha.de

Thank you for your attention!

THA Technische
Hochschule
Augsburg



RECYCLING
ATELIER

