Stand der Entwicklung technischer Lösungen für das Textilrecycling

Textile Recycling – an academic perspective

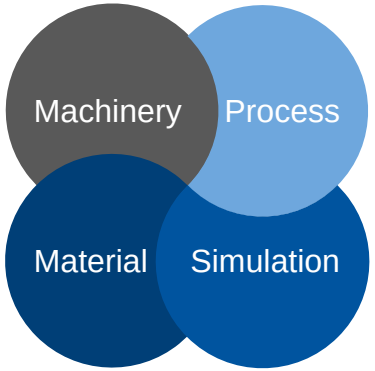
Amrei Becker, Ricarda Wissel, Thomas Gries

ITA | RWTH AACHEN UNIVERSITY

Institut für Textiltechnik at RWTH Aachen University

Human competences

110 Scientists supported by
60 Technical and service employees
190 Undergraduate research assistants

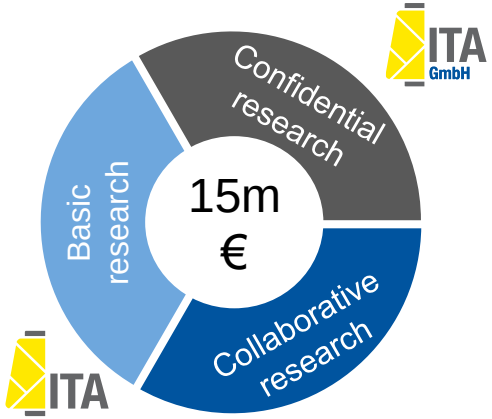


Machinery

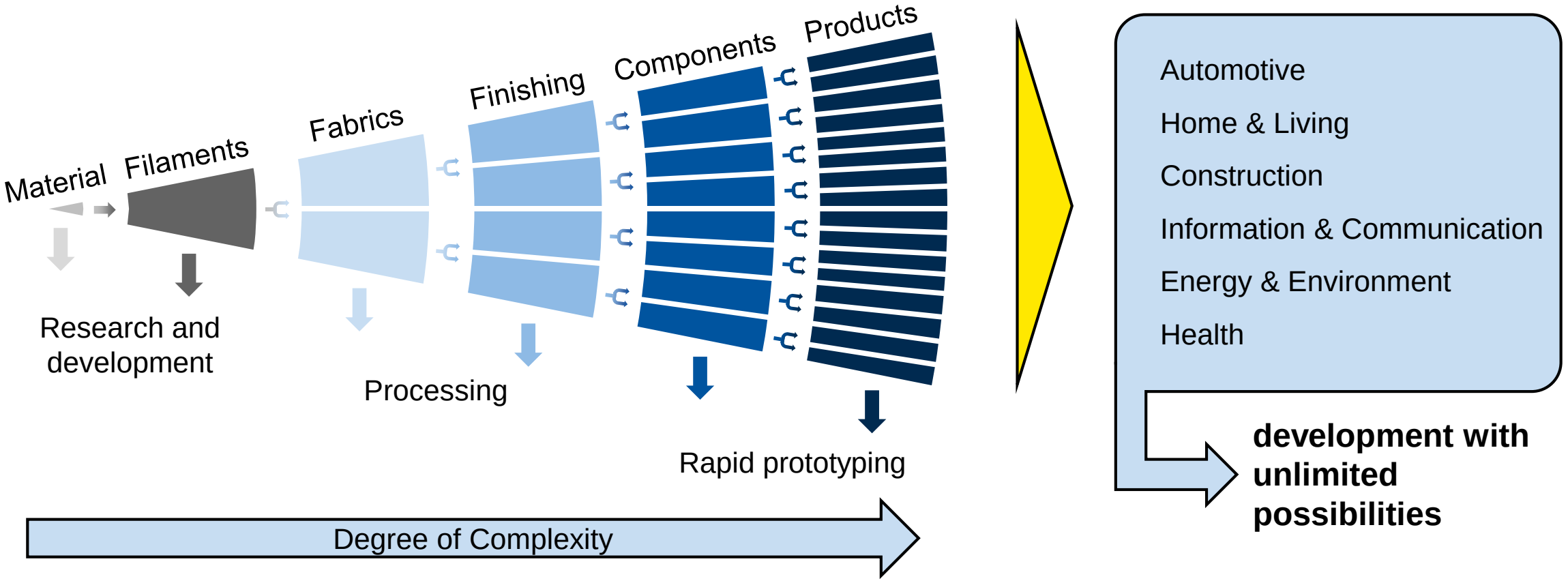
12 Lab devices for polymer analysis
4 Filament melt spinning lines
15 Lab devices for filament analysis
26 Machines for filament processing
243 Machines for textile processing in total

Budget

~ 15m € net income 2019



From Fibre and Fabric to Finished Products



Motivation

Why Recycling?

Textile Recycling – buzzwords, greenwashing or real sustainability?

reuse

biological transformation

textile waste

design for recycling

decentralized

upcycling

intelligent separation

pre-processing

circular economy

fast fashion

traceability

life cycle assessment

material mixes

wishcycling

application oriented

Challenges in textile sustainability

Fast Fashion

- Low material quality
- No reuse
- Rapid growth
- Shorter use-phase

Material Diversity

- Mixed staple fibre yarns
- Multilayer materials
- Highly functional coatings
- Haberdashery
- Prints and dyeings

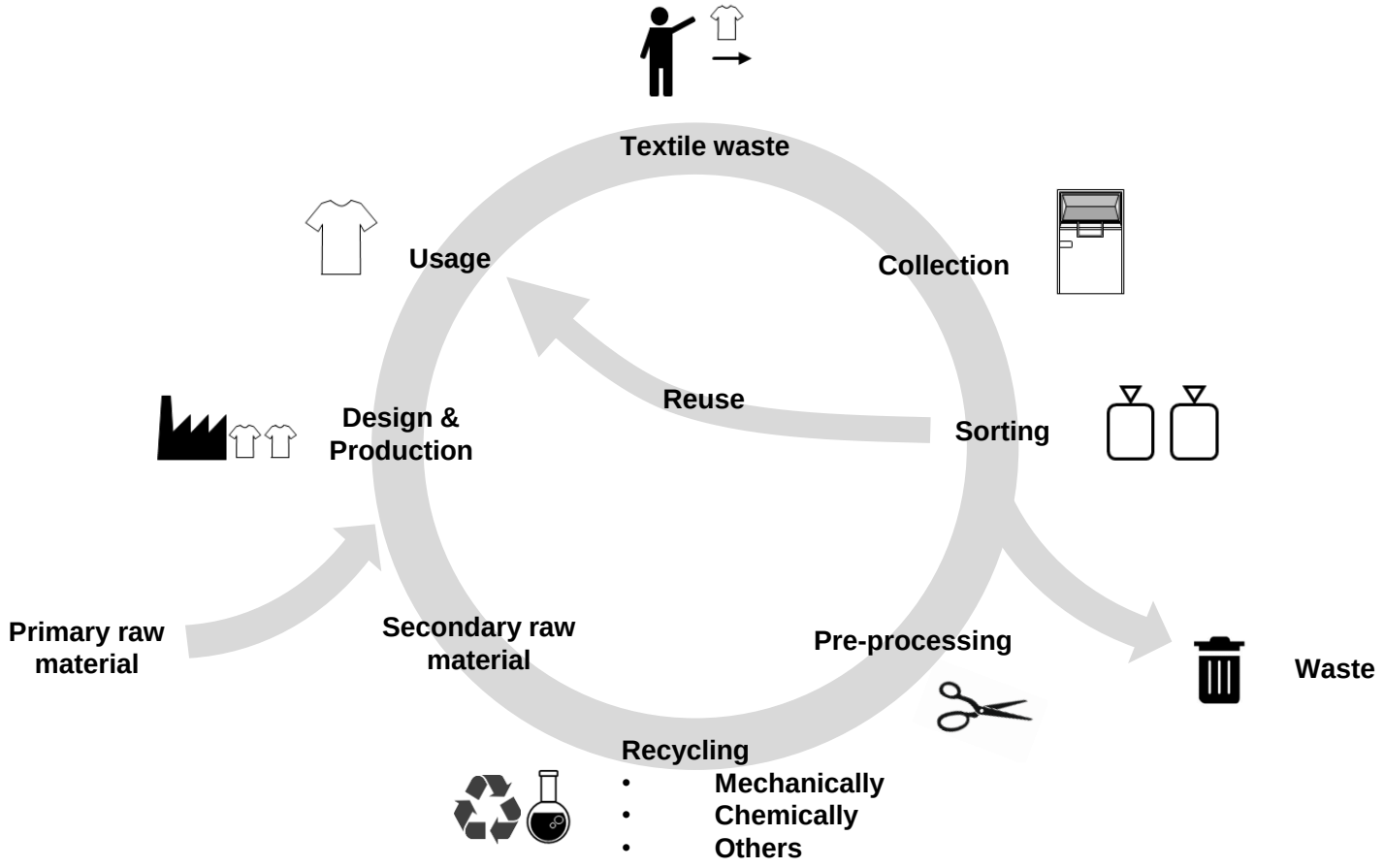
Logistics and Sorting

- Different legal frameworks
- Different collecting systems
- High non resaleable waste fraction
- No tracking or material sorting

State of the Art

Pre-Processing and Recycling Technology

From Textile Waste to New Product



Mechanical Recycling - Tearing

Operating principle	Input material	Desired Output	TRL PET Recycling
Tearing of the textiles, partial dissolution down to the individual fibre	Textilies made of natural or syntetic fibres	Fibres, textile nonwoven down-stream products, e.g. painter's fleece	9


Torn fibres

Thermo-Mechanical Recycling - Regranulation

Operating principle	Input material	Desired Output	TRL PET Recycling
Synthetic fibres/textiles are shredded, melted and regranulated	Synthetic, material-homogeneous textiles, if possible without impurities	Pure polymer with properties of the input material (contaminations possible)	8


Bottle flakes

Physico-chemical Recycling – Solvent Based Separation

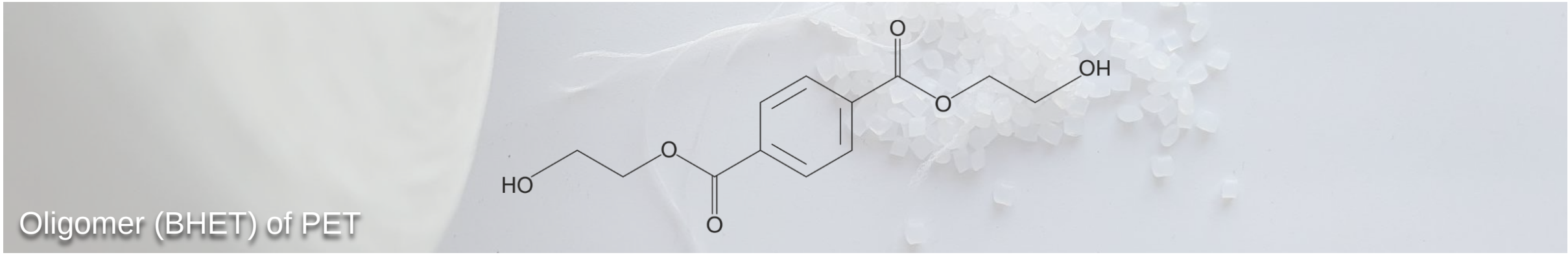
Operating principle	Input material	Desired Output	TRL PET Recycling
Desired material is separated by means of solvent	Mixed material flows of synthetic/ natural fibres, depending on solvent and polymer	Pure polymer with properties of the input material (contaminations possible)	7

Recycling of PAN

Textile waste ⟶ RePAN-pellets ⟶ Spinning solution ⟶ Staple fibres

Chemical Recycling – Back-to-oligomer

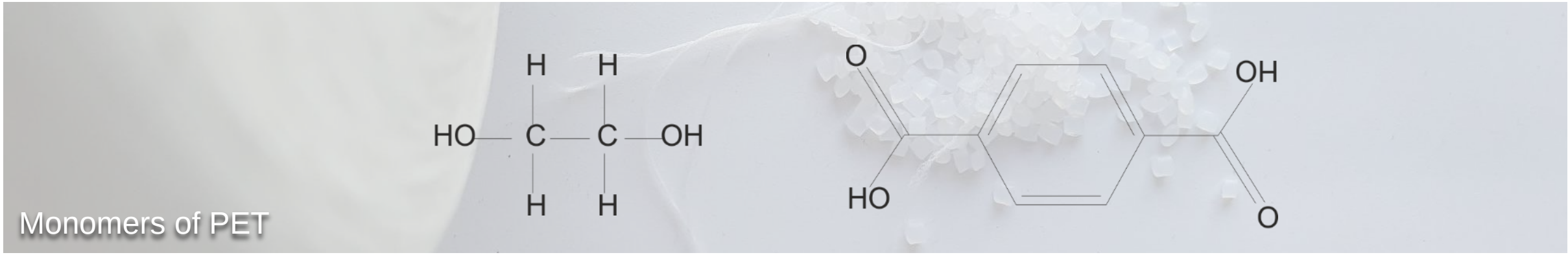
Operating principle	Input material	Desired Output	TRL PET Recycling
Polymers are broken down into very short polymer chains (oligomers), which can be rebuilt into a polymer	Textiles as homogeneous as possible (shredded), maximum impurity content depending on the process/ filtration	Polymer in virgin quality (contaminations possible)	8



Oligomer (BHET) of PET

Chemical Recycling – Back-to-monomer

Operating principle	Input material	Desired Output	TRL PET Recycling
Polymers are broken down into building blocks (monomers); which can be rebuilt into a polymer	Textiles as homogeneous as possible (shredded), maximum impurity content depending on the process/ filtration	Polymer in virgin quality (contaminations possible)	4



Monomers of PET

Thermo-chemical Recycling - Pyrolysis

Operating principle	Input material	Desired Output	TRL PET Recycling
Conversion process, cleavage of organic compounds in the absence of oxygen	Mixed organic material streams	Pyrolysis oils, and -gases	7

Thermal „recycling“ - Incineration

Operating principle	Input material	Desired Output	TRL PET Recycling
Incineration of textiles for energy recovery	Combustible material	Energy	9

Challenges Tackled in Research

Funded projects in Germany, Europe and worldwide

ITA | RWTH AACHEN UNIVERSITY

Provide information about textile products

Project: DiTex - Digital Technologies as Enabler of a Resource-efficient Circular Economy: Pilot Test in the B2B Textile Industry

- Funded by BMBF: ReziProk (Resource Efficient Circular Economy - Innovative Product Cycles)
- Focus on workwear and bed linen
- Development of two product lines equipped with "intelligent labels"
- Label provides knowledge about resource-efficient recycling management
- Information include e.g. fiber material mix, fiber origin, completed washing and recycling cycles
  - Duration: 08/2019 – 07/2022
  - More information: https://www.ditex-kreislaufwirtschaft.de/english/

Challenges Tackled in Research

Enhance and automate textile waste sorting

Project: Smart Garment Sorting for Recycling

- Funded by ITF (Innovation and Technology Fund, HK)
- Development of a robust and reliable method for sorting textile post-consumer waste streams
- Image-based Artificial Intelligence (AI) sorting technology to recognize the garment type
- Material identification system by using Near Infrared (NIR)/ Hyperspectral Spectroscopy
  - Duration: 03/2021 – 03/2023
  - More information: https://hkrita.com/rnd-project-database-detail.php?id=207

Mechanical textile recycling

Project: Raw material classification of recycled fibers - Research into an optimized process chain for sustainable fiber preparation

- Funded by BMWi/IGF
- Methodology for the evaluation of shredding products by means of raw material classification
- Optimizing and adapting the tearing processes regarding the requirements for spinning
- Recycled material with lowest possible loss of properties
  - Duration: 01/2021 – 12/2022
  - More information: https://www.stfi.de/fileadmin/mediamanager/stfi/STFI/Dateien/5_Aktuelles/2_Forschungsberichte/Steckbrief_Rohstoffklassifizierung_AiF.pdf

Chemical textile recycling

Project:
RESYNTEX - A NEW CIRCULAR ECONOMY CONCEPT
From textile waste towards secondary raw materials

- Funded by the European Union's Horizon 2020 program
- Post-consumer textile waste is transformed into secondary raw materials for the textile and chemical industries
- Discoloration and biochemical depolymerization
- Recovery of building blocks for PET polymerization and other chemicals from PA and cellulosic fibres
  - Duration: 06/2015 – 05/2019
  - More information: http://www.resyntex.eu/

Separation and recycling of material blends

Project: Blend Re:wind - a Swedish process for the recycling of polycotton blended textiles

- Funded by MISTRA, The Swedish Foundation for Strategic Environmental Research
- Chemical recycling of polyester/cotton fiber blends through alkaline hydrolysis
- Outputs: Polyester monomers (terephtalic acid and ethylene glycol) and a cotton pulp suitable for regeneration into cellulosic textile fibers
  - Duration: Blend Re:wind - Part of Mistra Future Fashion: 2011 – 2019 (results of Blend Re:wind published in 2017)
  - More information: http://mistrafuturefashion.com/rewind-recycles-cotton-polyester

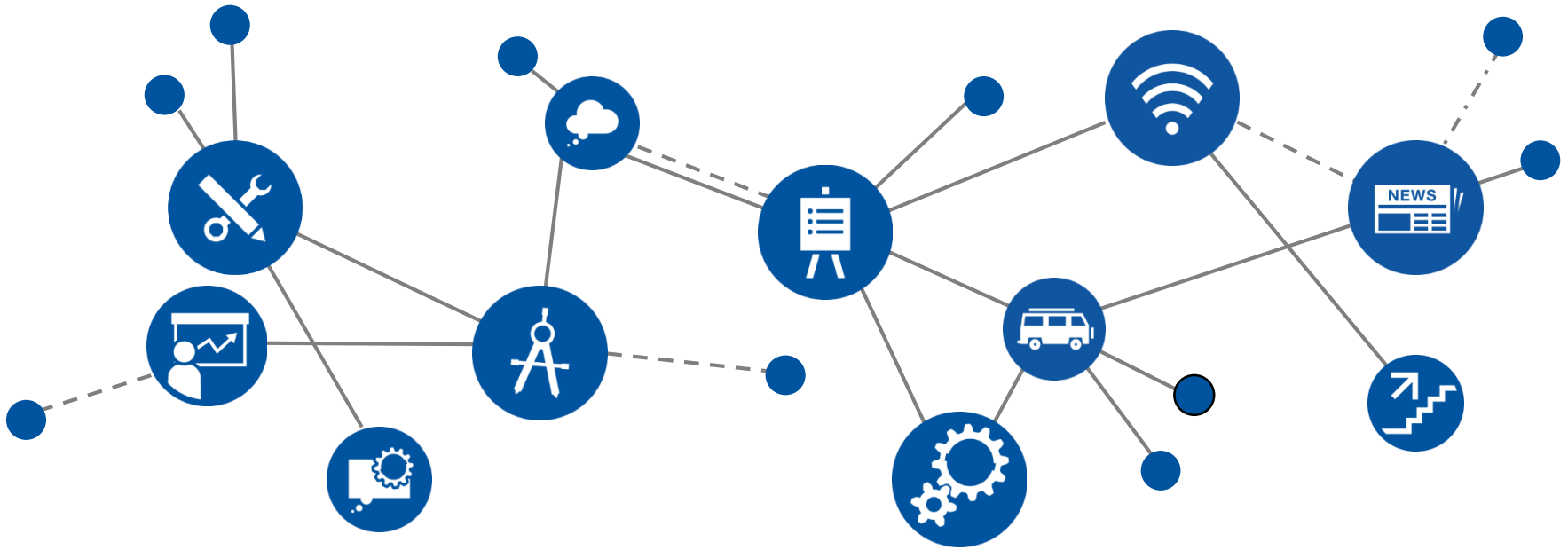
Levers to Enable Textile Recycling

How do we overcome the challenges?

Levers to Enable Textile Recycling

Work interconnected!

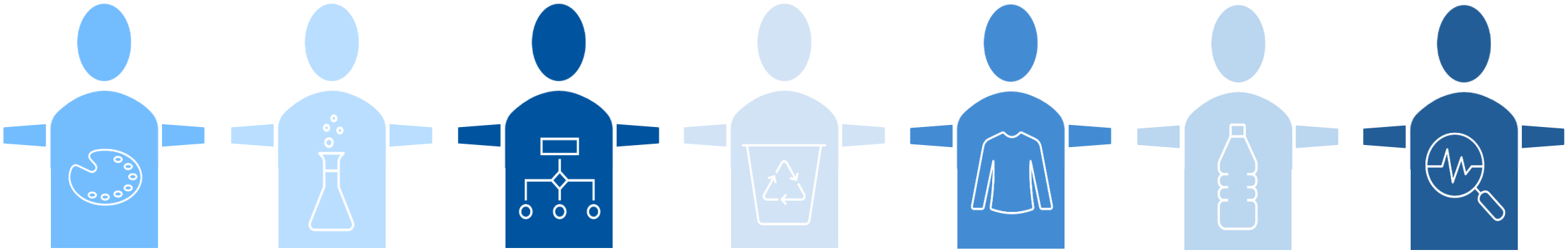
- Companies along the textile recycling chain have to work closer together
- E.g. sorters and recyclers



Levers to Enable Textile Recycling

Interdiciplinary work

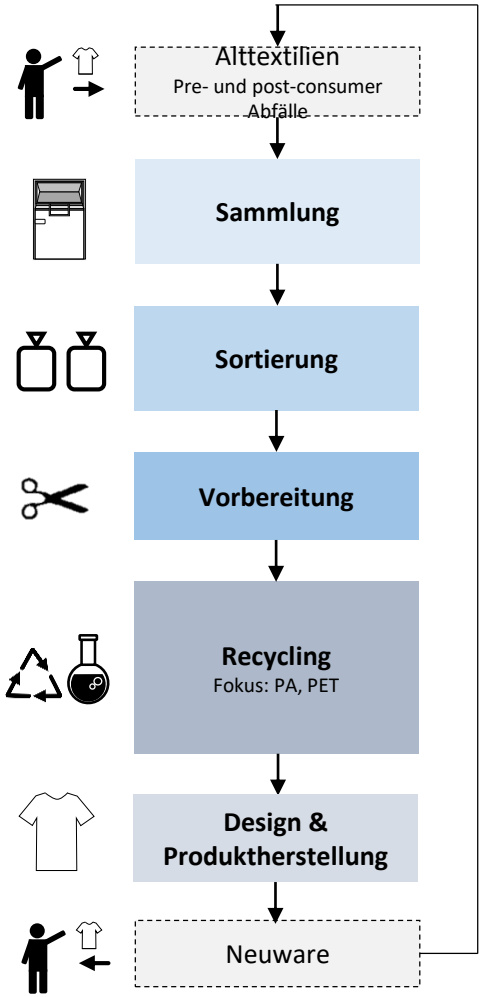
- Especially in all „high quality“ recycling processes
- Textile engineers should partner up



Project Ideas

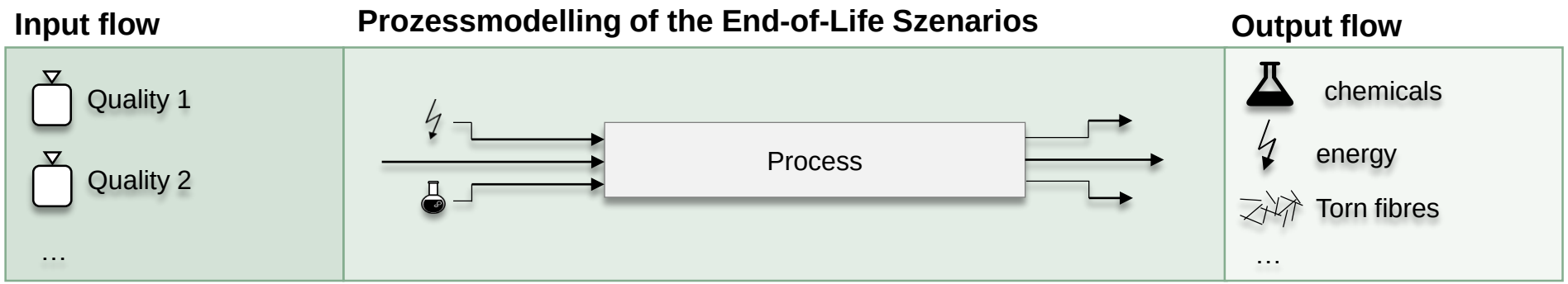
Concideration of the whole recycling chain: NewTex

Call	German funded BMBF, textile recycling - **Submission in spring 2022 – we are still open for partners**
Research partners	Fraunhofer IPMS, Fraunhofer LBF, Institut für Textiltechnik der RWTH Aachen University
Goal	Significant increase in the share of textile waste
Approach	• Materialbased sorting in manual process • Further development for one selected textile waste stream • Life cycle assessment for evaluation of chosen processes



Life Cycle Assessment to compare szenarios: EOL Modell

Call	AiF IGF, **submitted August 2021 – decision pending**
Research partners	Institut für Textiltechnik and Aachener Verfahrenstechnik (Fluidverfahrenstechnik), RWTH Aachen University
Goal	Evaluation of possible End-of-Life szenarios of textile PET waste
Approach	• Modelling of End-of-Life szenarios • Modelling and experimental trials of chemical PET recycling



Industrial Research Group (IRG) Polymer Recycling

The **long-term goal** of the IRG is to analyse and investigate methods and processes to gain **high-purity feedstock of textiles waste made of man-made fibres**. The main focus lies on textiles made of **PET and PA**.

Inform and Analyse

We **inform** about the textile recycling market and current research developments and **analyse** (recycled) methods and processes along the textile recycling value in order to gain high-purity feedstocks of textile waste.

Discuss and connect

We **discuss** findings and results an **connect** companies and experts that have a strong interest and/ or expertise in textile recycling processes.

Outlook

Sustainable. Sustainable?

Thank you
for your attention!

Amrei Becker, M.Sc.

Institut für Textiltechnik (ITA) der RWTH Aachen University
Otto-Blumenthal-Straße 1, 52074 Aachen

Phone (direct): +49 241 80 24708
Phone: +49 241 80-23401
Fax:
E-Mail: amrei.becker@ita.rwth-aachen.de
www: www.ita.rwth-aachen.de

Current events: www.ita.rwth-aachen.de/events
Visit us online: