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INSTITUT e.V.



Sächsisches Textilforschungsinstitut e.V. (STFI)

Affiliated institute of the University of Technology Chemnitz



ZUSE-GEMEINSCHAFT
FORSCHUNG, DIE ANKOMMT.



Faszination **TEXTIL**

www.stfi.de



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Zirkuläre Zukunft – Themen, Trends und die Rolle des mechanischen Textilrecyclings

21. Kreislaufwirtschafts- und Deponieworkshop Zittau-Liberec 2025– 27./28.11.2025

Johannes Leis, Sächsisches Textilforschungsinstitut e.V. Chemnitz (STFI)



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- Brief introduction to STFI
- Introduction to textile circular economy
- Legislative dynamics in the context of circular economy in the EU
- Outlook and summary



Who we are



- Founded in 1992 out of the Forschungsinstitut für Textiltechnologie GmbH (FIFT) and Institut für Technische Textilien GmbH (ITT)
- Testing and certification orders from customers in more than 60 countries worldwide
- Free, industrial research institute, one of the co-founders of the Zuse-Gemeinschaft

- 100 national / European research projects
- 154 employees
- Annual turnover: 15 Mio.€



Photo: Ernesto Uhlmann / CWF

Research and development



Testing and certification



Akademie



Transfer



Grafics: Adobe Stock

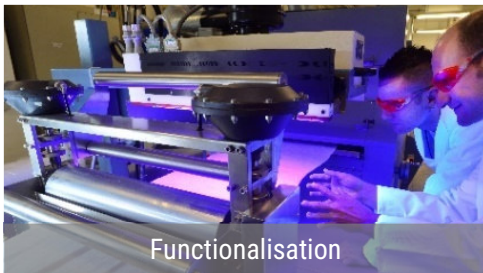
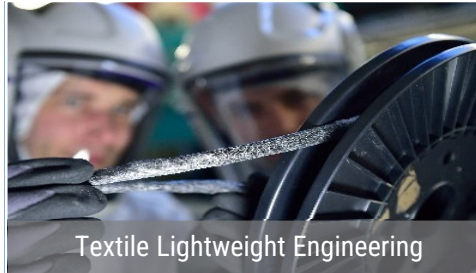


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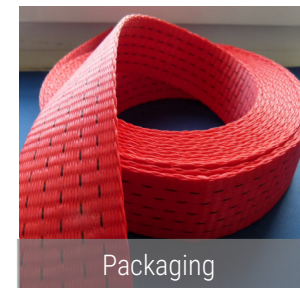
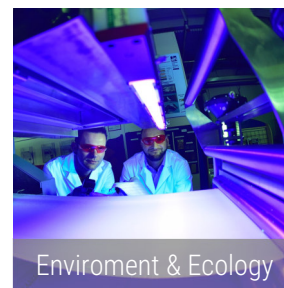
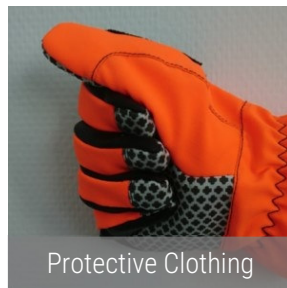
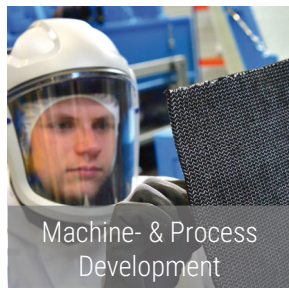
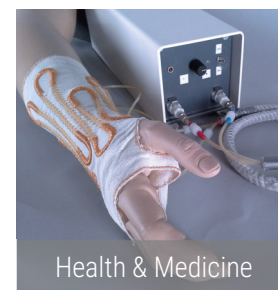
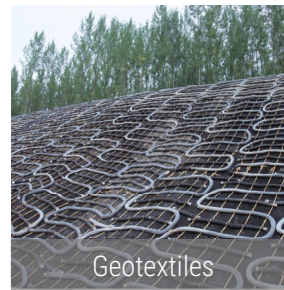
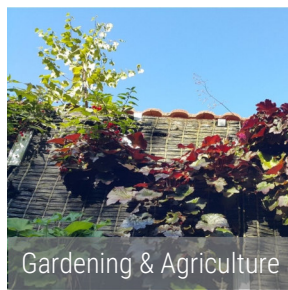
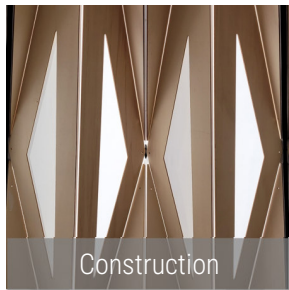


Our competences

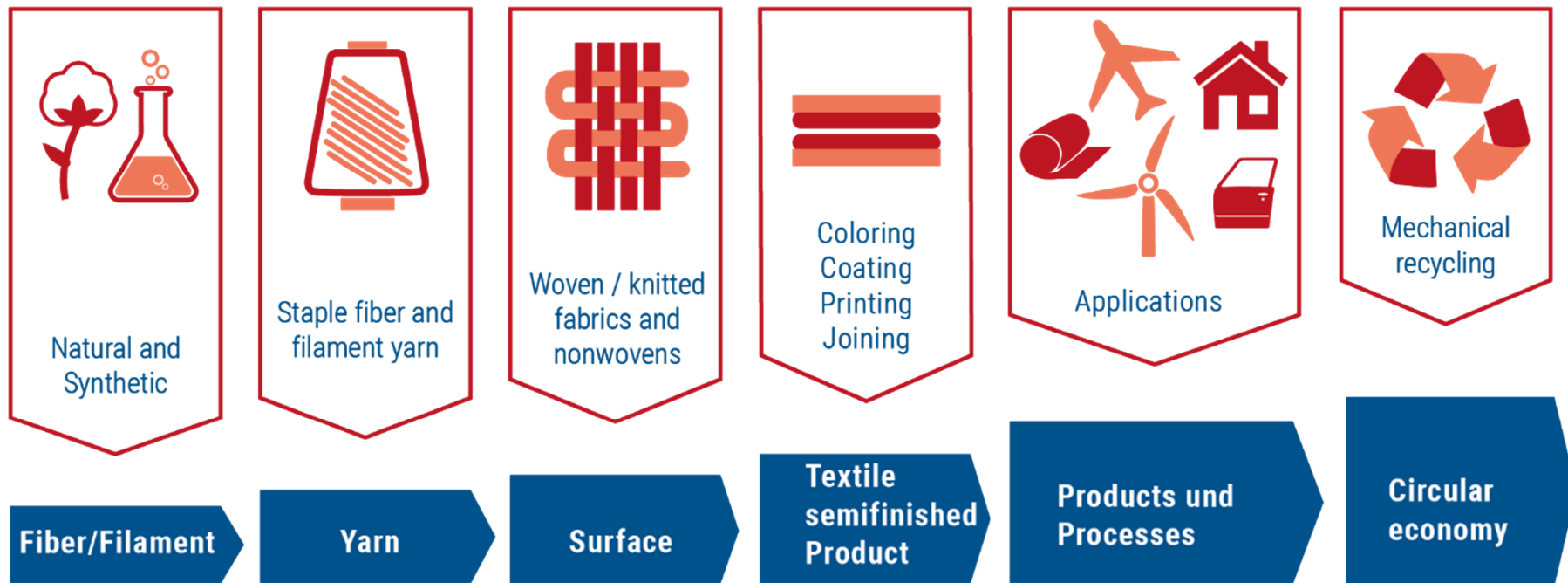




We address numerous applications



We cover the entire textile chain

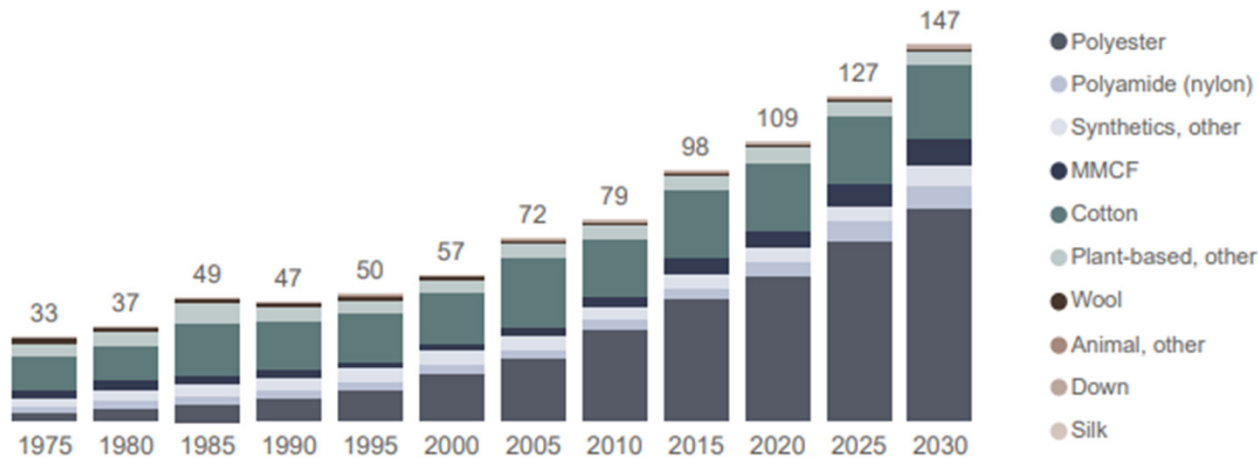




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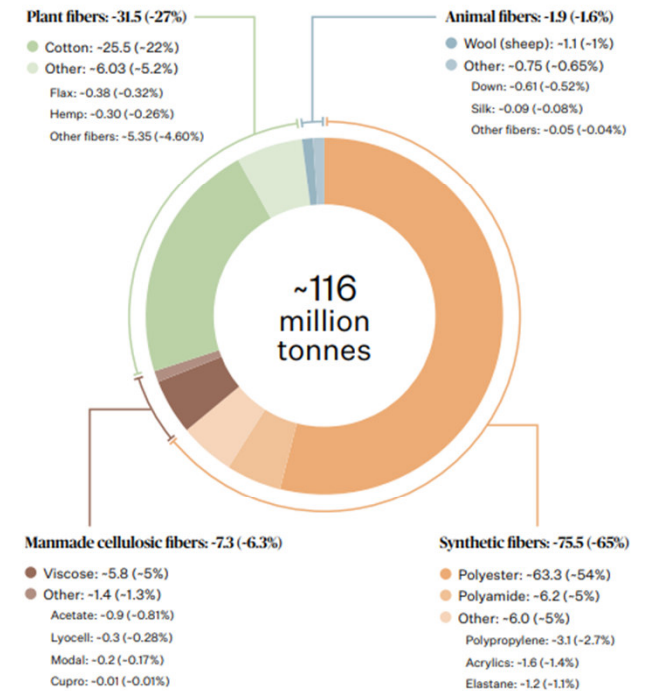
Development of global fiber production

Global fiber production (million tonnes)¹

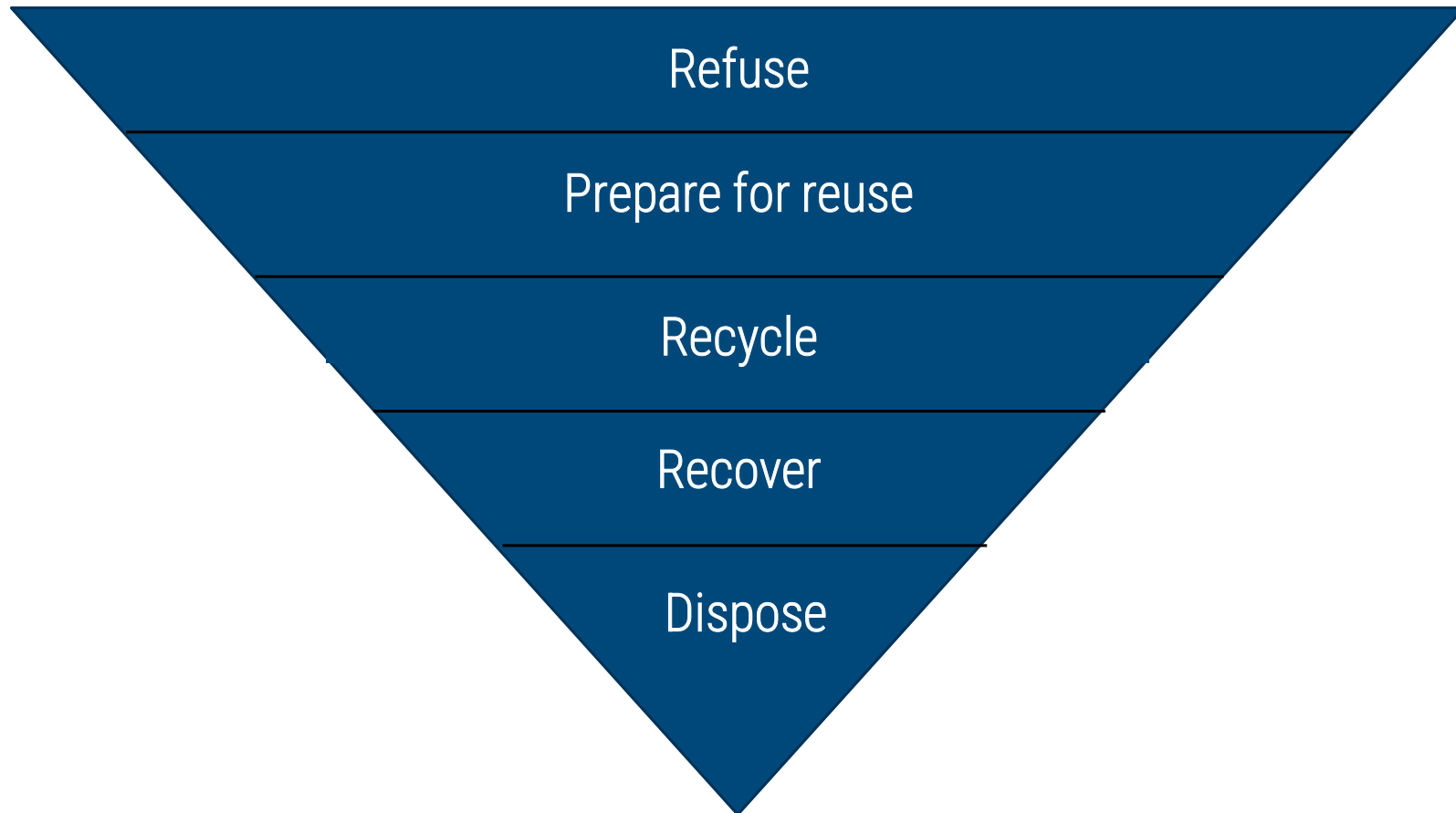


Source: Textile Exchange based on data from CIRFS, FAO, ICAC, IVC, IWTO, Maia Research, and its own modelling

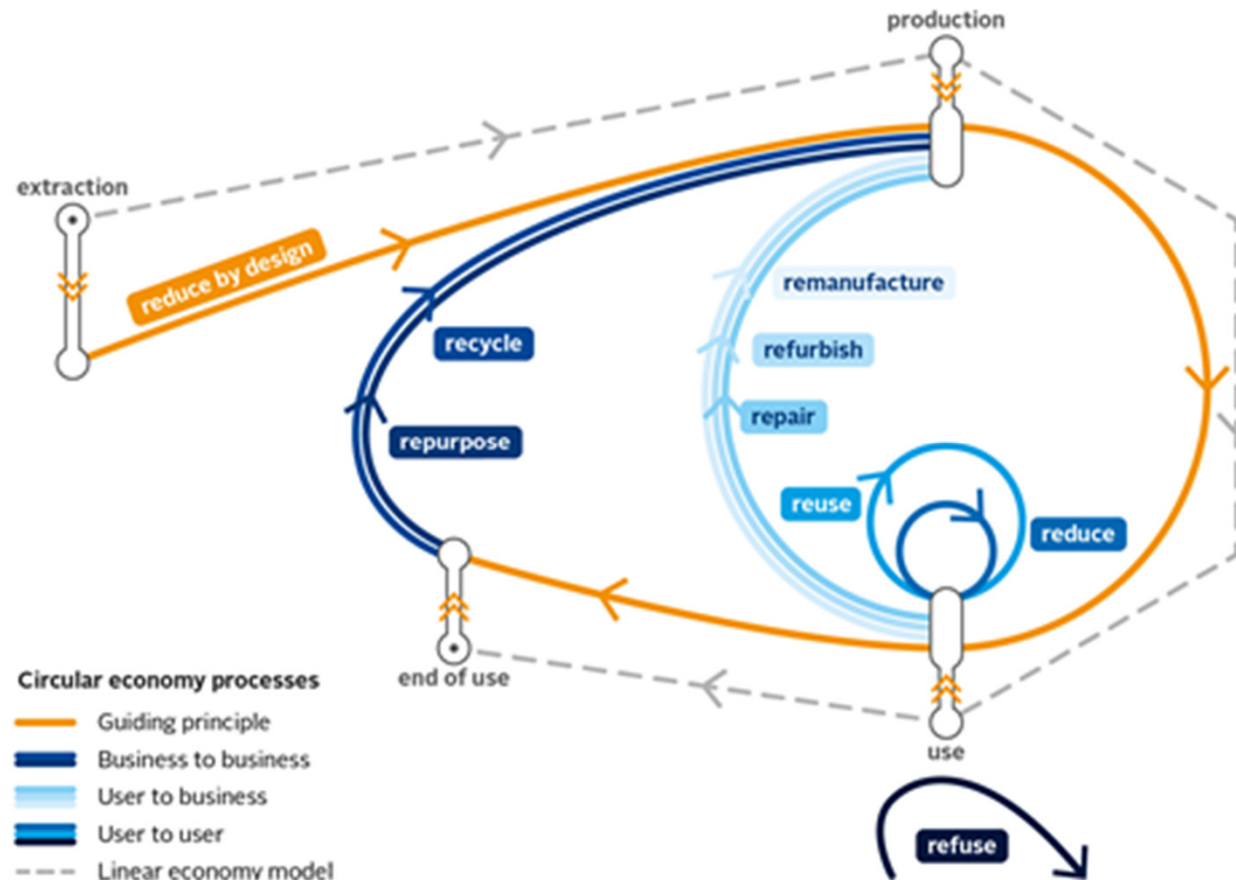
Global fiber production in 2022
(in million tonnes and % of global fiber production)



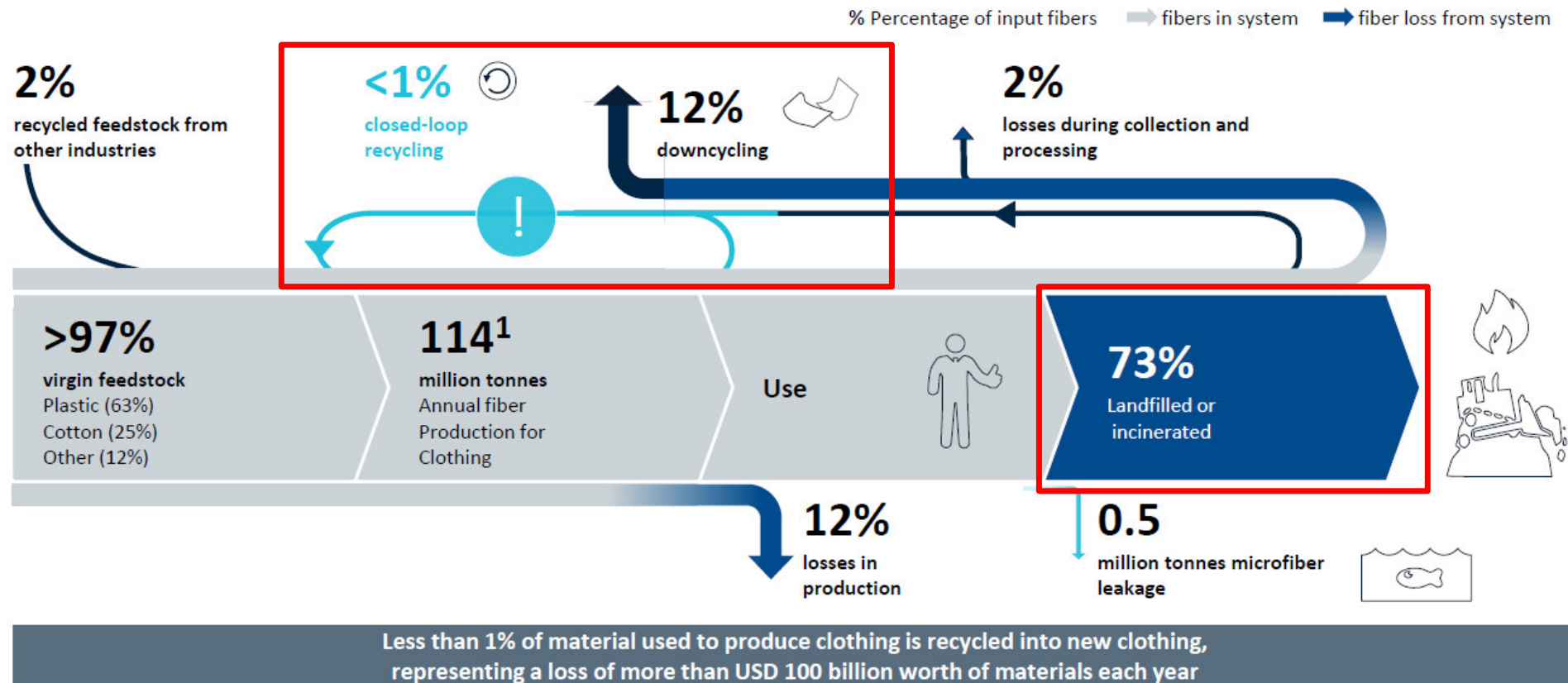
Source: Textile Exchange based on data from CIRFS, FAO, ICAC, IVC, IWTO, Maia Research, and its own modelling.
Note: This chart includes recycled fibers. Other animal fibers included here are alpaca, angora, camel, cashmere, guanaco, llama, mohair, vicuna, and yak. Other plant fibers included here are jute, coir, sisal, abaca, ramie, kenaf, kapok, and agave.



R strategies of a circular economy

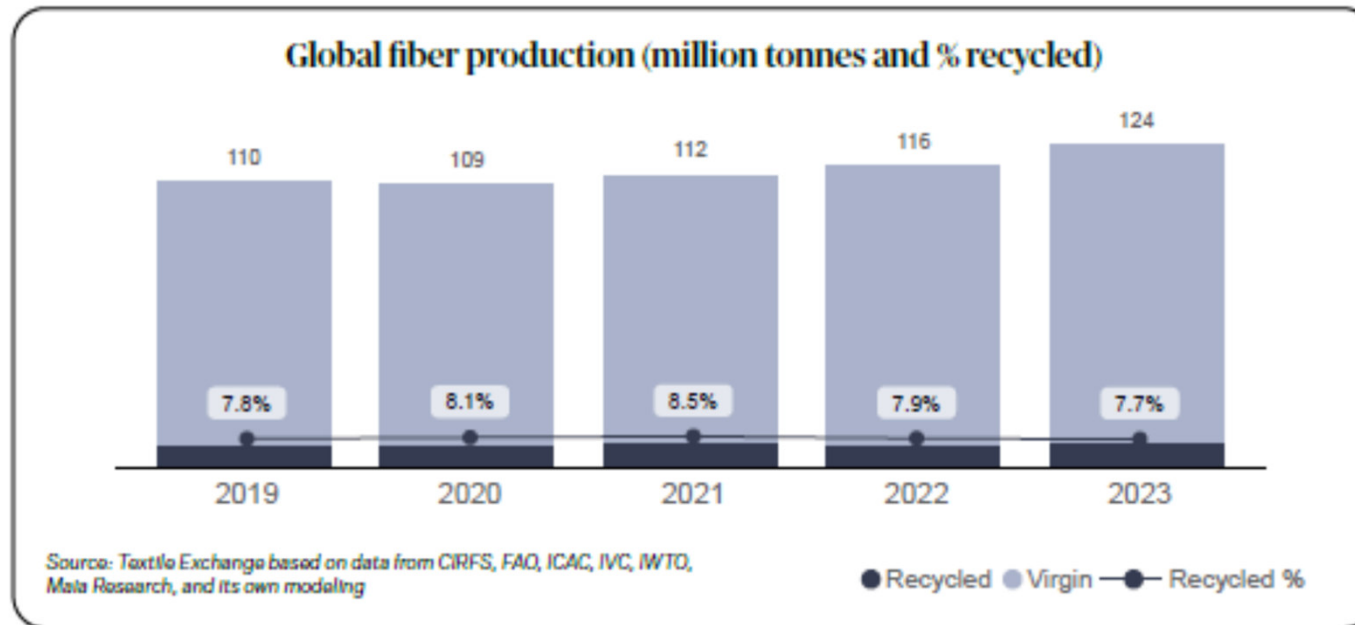


Source: The UNEP Circularity Approach using the 9-R concept



Source: Sorting for circularity, how automatised sorting is closing the gap between wasted textiles and recycling, Louisa Hoyes, Tomra, ETP Masterclass

Share of recycled fibres globally



Source: Materials Market Report; Textile Exchange, 09/2024

Approximately 7 % of global fibre production from PES bottle flakes

Fiber parameters as a result of the recycling technology

- Expectations of recycled material: “exactly like virgin fiber”
- Differences in processing properties (depending on the process, especially mechanical recycling)
 - Fiber length distribution
 - Strength & elongation
 - Fiber-fiber and fiber-metal-friction
 - Opening behavior / resistance
 - Fiber breakage
- Dependency on the feedstock (quality, impurities,...)
- Standards are missing
- Price?

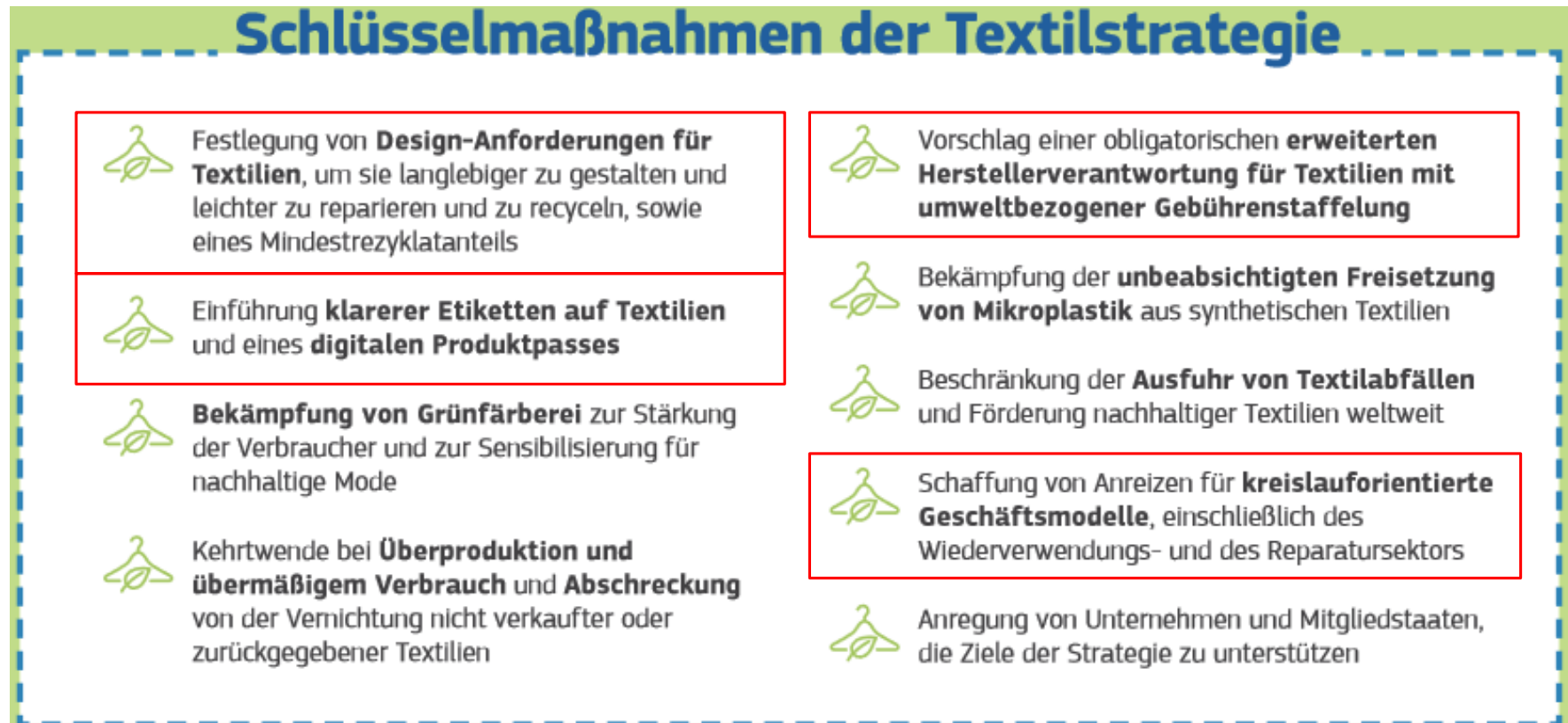
Incentives for circularity?!

- Increased circularity in the textile industry is going to need incentives
 - Why repairability?
 - Why alternative fiber types?
 - Why longevity/durability?
- How many of us actively promote circularity?
 - Conscious consumption
 - Proper care, correct disposal
 - Repair

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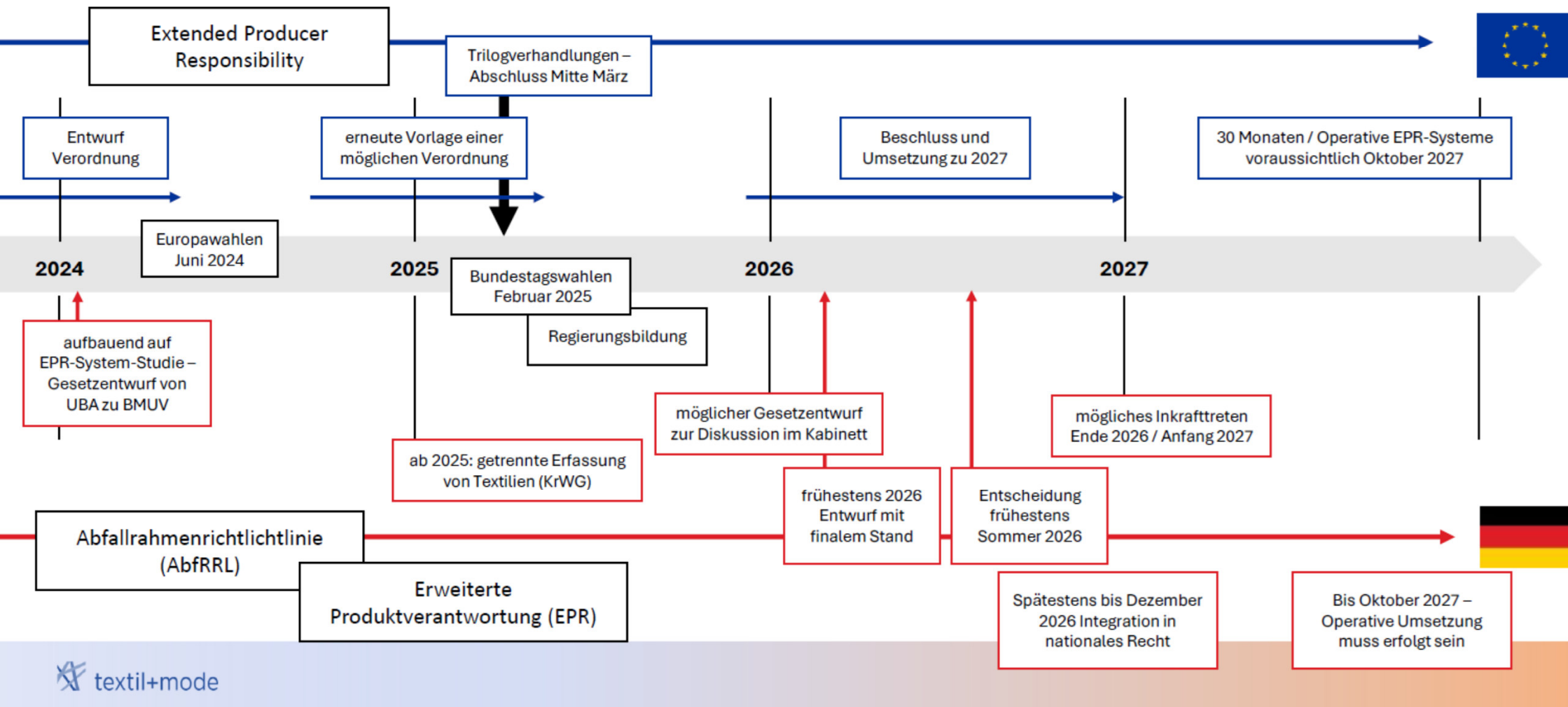




Amendment of the waste framework directive

- The EU has amended the Waste Framework Directive to reduce food and textile waste. The new Directive (EU) 2025/1892 came into force on October 16, 2025, and sets binding targets for waste prevention by 2030
- The measures in the directive stipulate, among other things, that
 - all member states establish their own extended producer responsibility system for textiles and footwear, which includes the collection of fees to finance the recycling and disposal of textiles,
 - all separately collected textiles are now considered waste,

Politische Einordnung – Abfallrahmenrichtlinie/EPR



§23 Produktverantwortung

- (1) „Wer Erzeugnisse entwickelt, herstellt, be- oder verarbeitet oder vertreibt, trägt zur Erfüllung der Ziele der Kreislaufwirtschaft die Produktverantwortung. [..]“
- (2) Die Produktverantwortung umfasst:
 - Ressourceneffizienz & Langlebigkeit
 - Vorrangiger Einsatz von Rezyklaten
 - Sparsamer Einsatz kritischer Rohstoffe
 - Hinweispflichten (Rückgabemöglichkeiten/-pflichten, Pfandregelungen)

§23 Produktverantwortung

(1) Die Produktverantwortung umfasst:

- Rücknahme und nachfolgend umweltverträgliche Verwertung oder Beseitigung der Erzeugnisse
- Übernahme der finanziellen oder der finanziellen und organisatorischen Verantwortung [..]
- Information und Beratung der Öffentlichkeit [..]
- Beteiligung an Kosten für die Reinigung der Umwelt durch öffentlich-rechtliche Entsorger
- Obhutspflicht bei Vertrieb und Rücknahme der Erzeugnisse, dass Gebrauchstauglichkeit erhalten bleibt

Textile EPR-Systeme in anderen Ländern

Frankreich

- Textiles EPR-System seit 2008
→ betrifft Bekleidung, Schuhe und Heimtextilien
- Große Firmen haben ihr eigenes Takeback-System, 95% der Marktteilnehmer sind bei der PRO Refashion registriert
- Gebühren von 0,01€-0,06€ pro Artikel
→ Ökomodulation in drei Stufen
- Hersteller melden jährlich ihre POM-Mengen

→ 300% Anstieg der Sammelmenge seit 2006
→ 25,5 mio € EPR-Gebühren (2019)
→ 5,6 mio € für Förderung von gezielter Forschung und Entwicklung im textilen Recyclingbereich

Niederlande

- Textiles EPR-System seit 2023
→ betrifft Bekleidung und Heimtextilien
→ betrifft Produzenten und Importeure („first to put on market“)
- Gebühren von 0,10€ - 0,20€ pro KG

Schweden

- Vollständige Umsetzung ab 2025
→ betrifft Bekleidung, Schuhe, Heimtextilien und Accessoires
- Bis 2028 soll textiler Abfall um 70% reduziert werden und 90% wiederverwertet oder recycelt werden

EPR Systeme für Textilien sind bisher kaum in Umsetzung. In der EU sind sie nur in Frankreich, den Niederlanden und Ungarn vollständig umgesetzt.

Quellen und weitere Informationen:

- [Textiles EPR Status Report](#)
– WRAP
- [Abschlussbericht](#)
„Erarbeitung möglicher Modelle der erweiterten Herstellerverantwortung für Textilien“ (UBA)

Ecodesign for sustainable products regulation ESPR

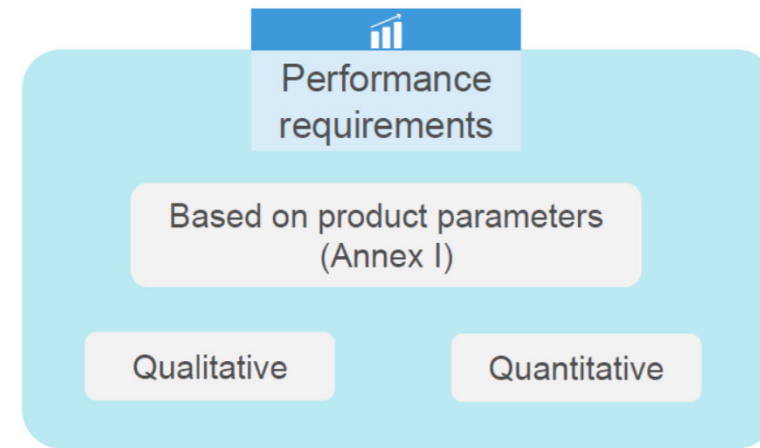
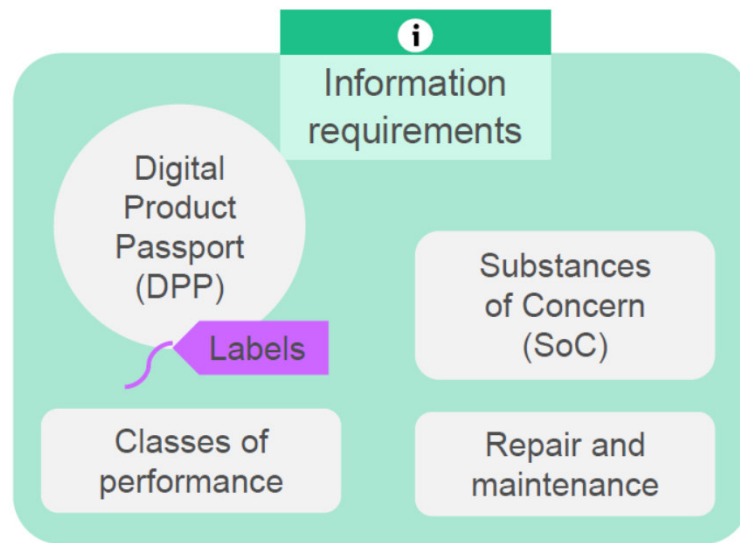
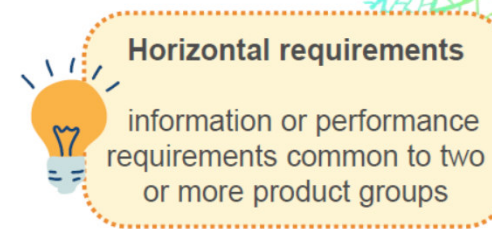
- The new EU Ecodesign for sustainable products regulation (ESPR) was published in the EU Official Journal on June 28, 2024 (Regulation (EU) 2024/1781) and entered into force on July 18, 2024.
 - Significant expansion of the scope to include almost all product groups
 - Life cycle assessment of products
 - Expansion of requirements for quality, efficiency, and resource conservation
 - Specification of requirements for the environmentally friendly design of products
 - Specification for product groups in delegated acts
 - Digital product passport, Art. 9 ff. ESPR
 - Prohibition on the destruction of goods (initially for textiles from 2026)

ESPR – developing ecodesign requirements



Ecodesign requirements

Product specific or horizontal



Key product aspects under ESPR

Article 5 – Ecodesign requirements





Digital product passport DPP

A digital product passport (DPP) is a structured collection of product-related data with a predefined scope and agreed data ownership and access rights, which is transmitted via a unique identifier and accessible electronically via a data carrier.

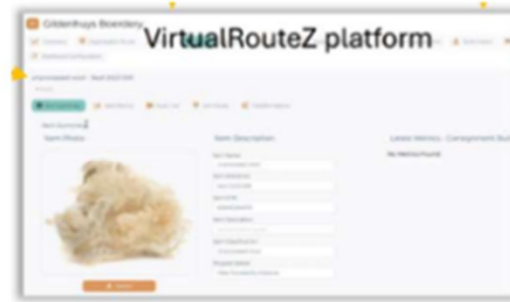
The intended scope of application of the DPP is information relating to sustainability, circular economy, value retention for reuse, reprocessing, and recycling."



EU-Projekt Cirpass & Cirpass2: <https://cirpassproject.eu/>

The Fiber Traceability Initiative – “Technical illustration”

1. Data is collected through the supply chain using digital product identifiers such as RFID tags, 2D barcodes, and OR Codes, to automate the recording of the production.



2. When the QR code on the garment is scanned, a request is sent to a resolver that identifies the data source where the product's specific data can be retrieved. In this test pilot, the data is stored on the VirtualRouteZ platform.

- 2.1 Scan QR - URL and a product ID in a GS1 Digital Link send a call To the resolver
- 2.2 Resolver to request link to data sources
- 2.3 Data source



3. The data is displayed on the mobile screen, providing the customer with a comprehensive view of the product's journey, including RWS certification.

Through the QR code, the brand can add recommendations on care, repair and resell.



THE STORY
BEHIND THIS PIECE



FILIPPA
K



- The new Right to Repair Directive (R2R-RL) was published in the EU Official Journal on July 10, 2024 (Directive (EU) 2024/1799) and must be transposed into German law by July 31, 2026.
 - Strengthening consumers' rights to have products repaired
 - Obligation for manufacturers to repair products that are technically repairable under EU law
 - Voluntary repair form with information about the repair (e.g., prices)
 - EU online platform for repair services
 - Extension of the legal warranty by 12 months if consumers opt for a repair

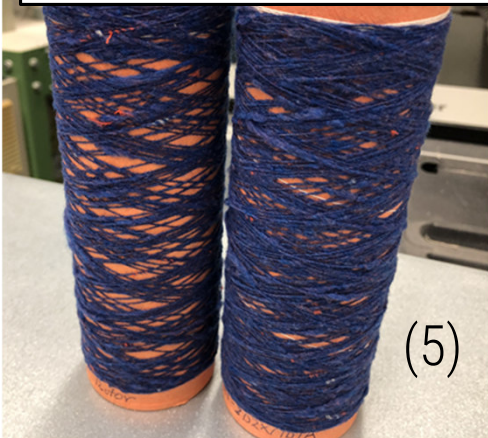
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Approach 1: recycling to save costs

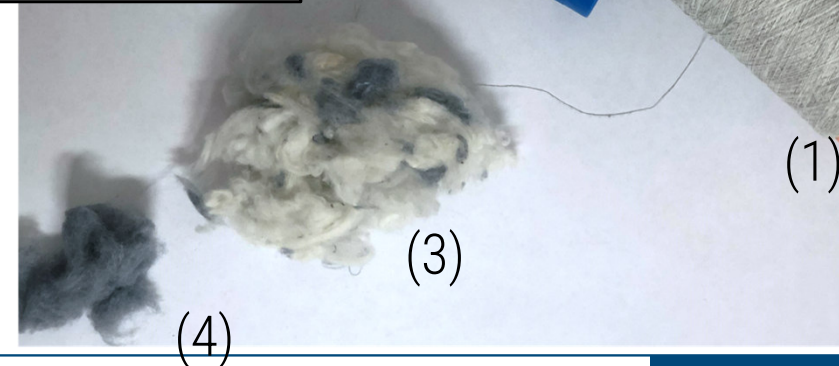
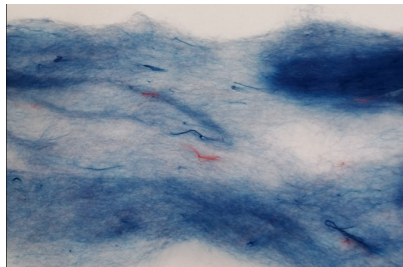
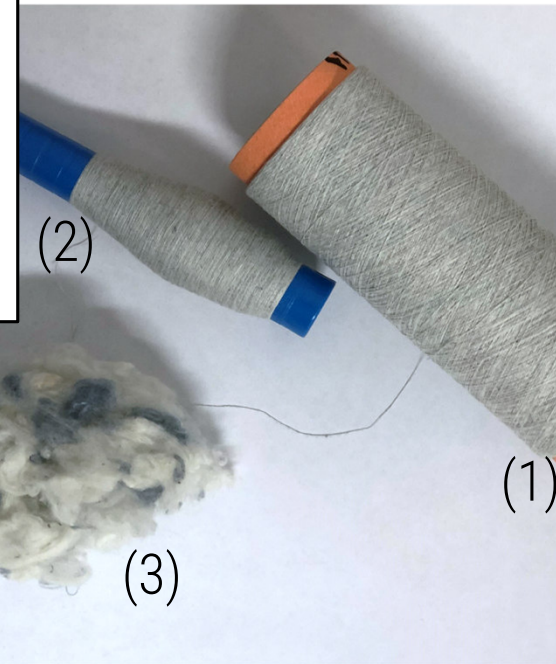


- Need to find commercial applications for recycled materials
- Without real demand, technological feasibility is irrelevant in the market
- Nonwovens as economically viable concept
 - Insulation, upholstery, "Malervlies"
 - Throuput (price) > max. quality of fibers
- Traditionally low demand for spinning staple fibers in Europe, higher in Southeast Asia, but no application in clothing

Meta-Aramid:
100% recycled aramid (5)

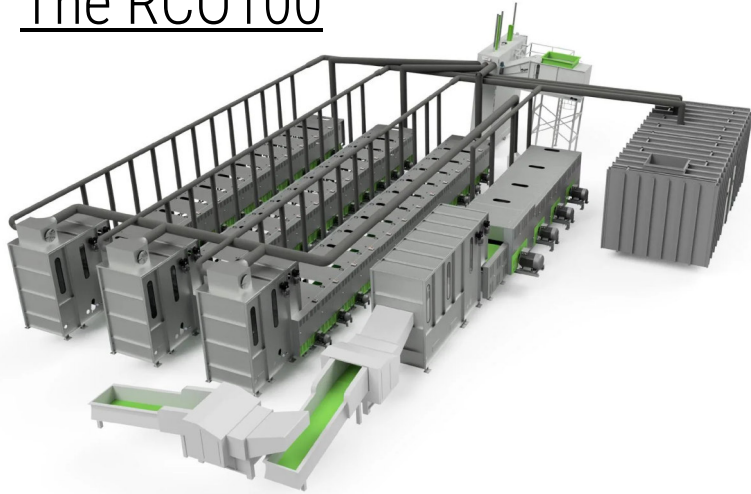


OE (1) and ring yarn (2)
Yarn count: Nm 40
Cotton blend (3):
70% recycled cotton (4)
30% virgin cotton.



Trend: fiber quality > throughput (?)

Säntis Textiles PTE LTD, Singapur The RCO100



- 4 pre-openers + 12 fine openers (per line)
- Throughput: 300 kg/h/line

Dell'Orco & Villani S.R.L., Capalle The twin-carding-opener TCO



- 2 cylinders with total of 8 opening positions
- Throughput: 500 kg/h

Conventional tearing lines with throughputs of 1.000 kg/h (for spinnable fibres) to 3.000 kg/h

Does the fiber quality justify the lower throughput?



TRIGEMA T-Shirt made of 100 % mechanically recycled fibers

Herren / Neu & Beliebt



Art. Nr.: 46202



Heavy T-Shirt aus 100% recycelter Baumwolle Schwarz

★★★★★ 5 130 Bewertungen

Farbe schwarz - 008



Größe

[Größentabelle](#)



38,10 €

inkl. MwSt.



IN DEN WARENKORB

sofort verfügbar

- ✓ 14 Tage Rückgaberecht
- ✓ Hergestellt in Deutschland
- ✓ Klimaneutraler Versand
- ✓ Versandkostenfrei ab 100€

Source: <https://www.trigema.de/magazin/recycltes-t-shirt/>

To summarize: how can we shift towards a circular economy?

- Technological solutions for the automated sorting, recycling and the processing of recycled fibres are available, but gaps/bottlenecks remain:
 - Sorting: Certain dyestuffs, multi-layers, hidden components
 - Mech. recycling: Consistent properties, short fibre content, Neps,
 - Chem. recycling: Feedstock, Cost structure, LCA data
 - Processing: Standardisation, Adaption to processing of rec. fibres
- Mechanisms of global fibre market (increasing supply – same demand(?!))

To summarize: how can we shift towards a circular economy?

- Technologically there isn't really an incentive for recycled fibres
 - Best case scenario: comparable processability and price (not anytime soon)
 - For some applications price motive → exclusively downcycling
- Which other advantages can be delivered by recycled fibres?
- Where do incentives (or courage?) for transformation come from?
- Pushing towards increased circularity in the textile industry requires regulations
 - Compromises
 - Level playing field



Impressum

17. Kolloquium

3.-4. Dezember 2025
Chemnitz



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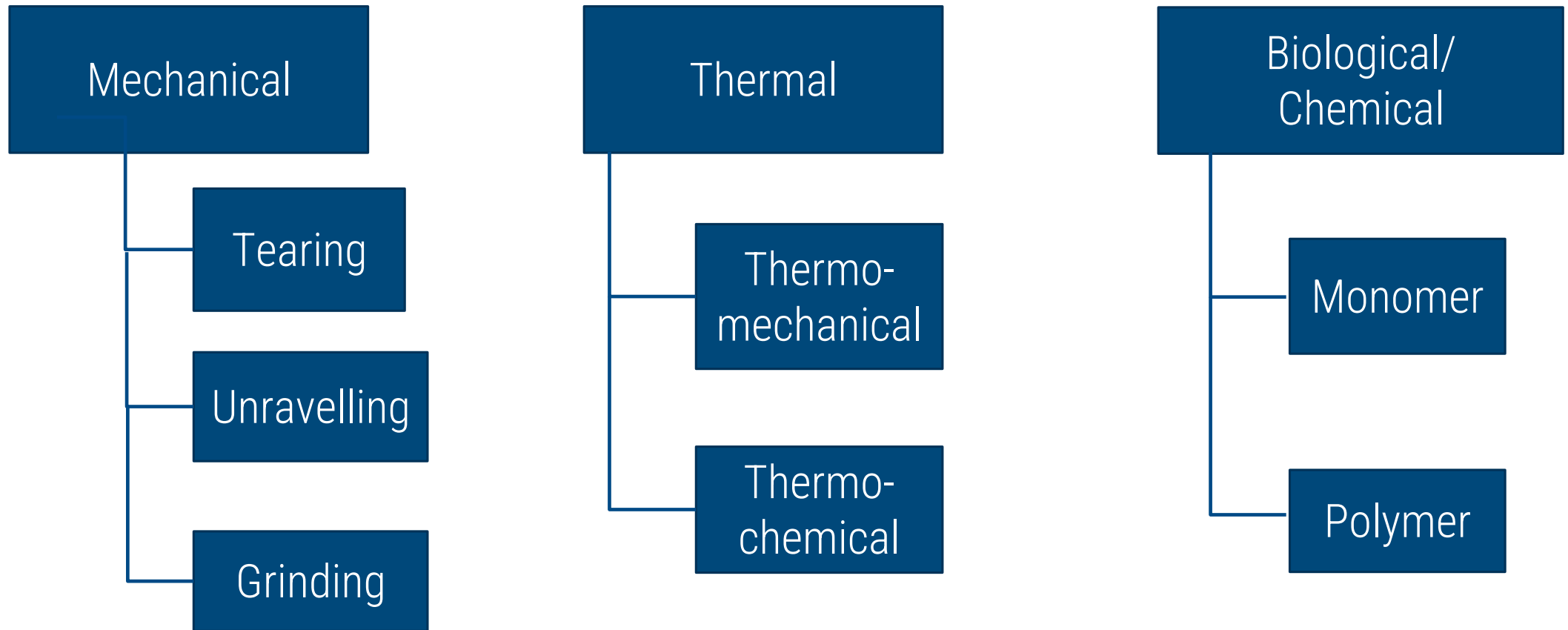
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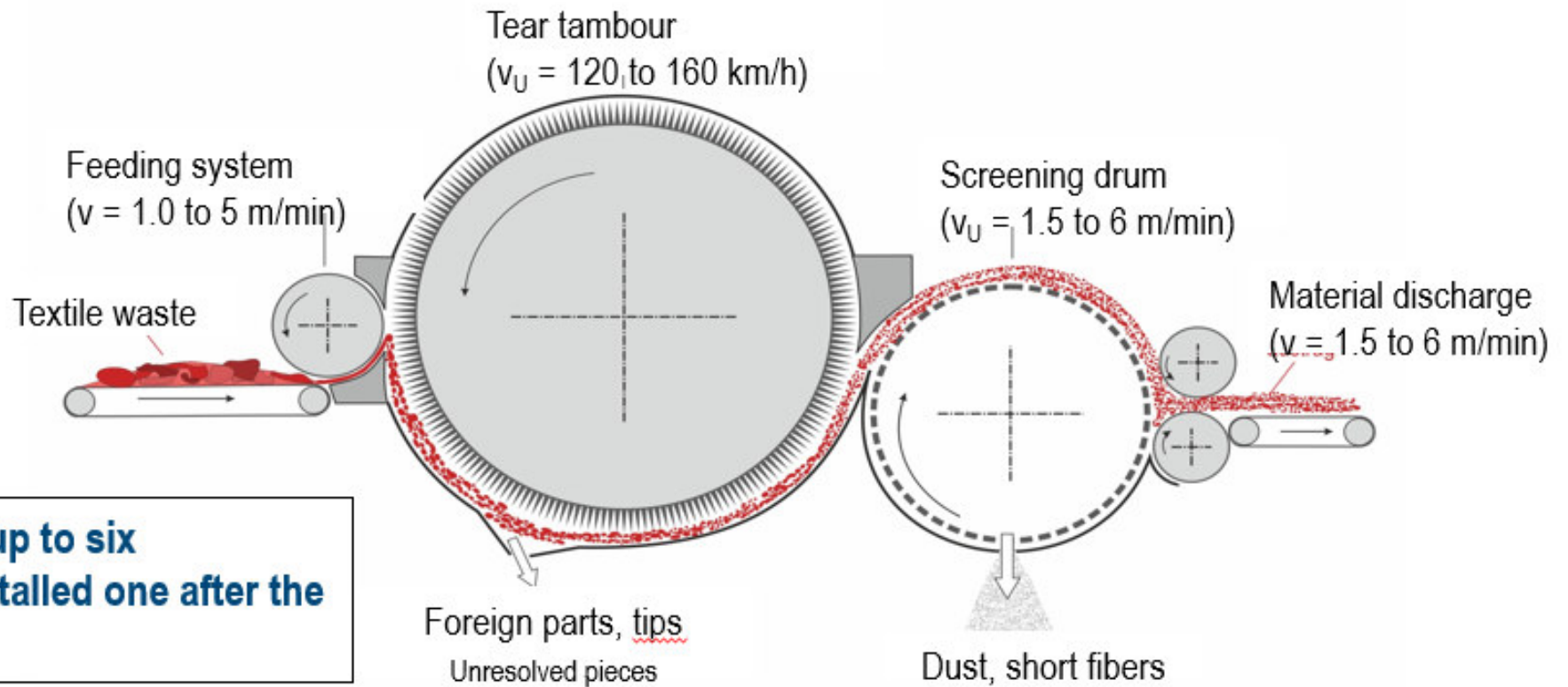


Follow us

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Mechanical recycling of textile waste

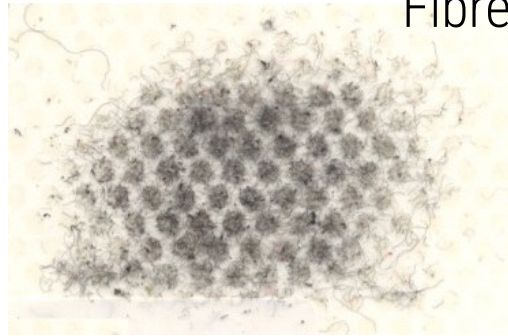


In practice, up to six units are installed one after the other!

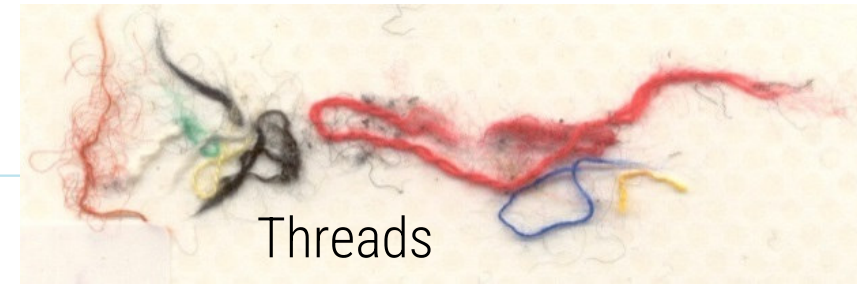
Mechanical recycling of textile waste



Neps



Fibre dust, short fibres

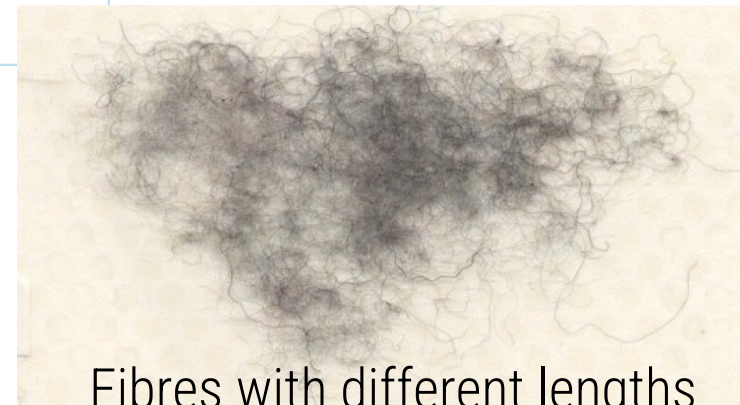


Threads

Reclaimed fibres
as a blend of:



Unopened pieces



Fibres with different lengths

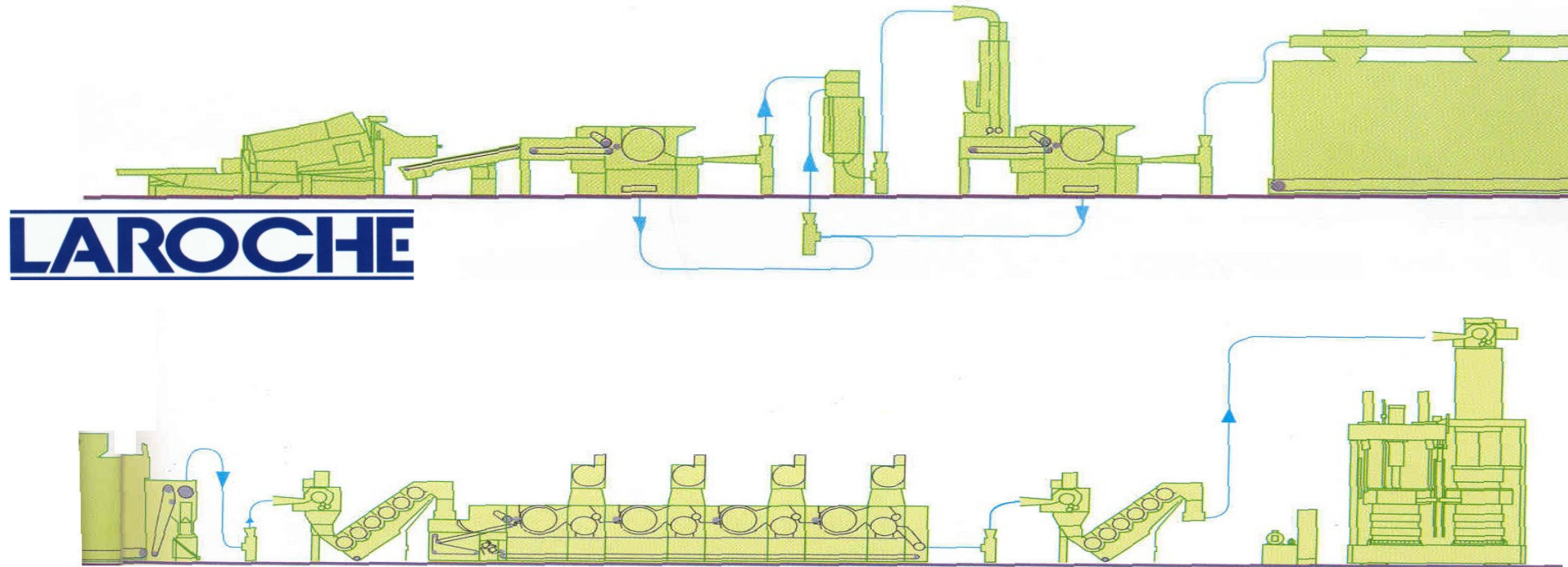
Trial set-up – Raw materials

Raw material properties

Raw material		Cotton	Recycling
Origin		Chad	Recover
Commercial staple; UQL(w)	mm	29.7	19.4
5% - fiber length (n)	mm	36.5	23.3
Mean fiber length L (n)	mm	18.9	10.3
Short fiber content < 12.7 mm (n)	%	29.5	69.1
Fiber Neps	1/g	197.0	1120.0
Seed Coat Neps	1/g	12.0	38.0



Quelle: Will, M.; Rieter: Unlocking the Potential of Recycled Ring Yarn with the Combed Process; ITMA revisited; 14.03.2024



Tearing line „JUMBO“
- Working width 2000 mm
- 2500 kg/h

LAROCHE S.A., Cours La Ville/France

- Pre-treatment, melting, cleansing and filtration of the material
- Any thermoplastic material, but huge differences in achievable properties and share of virgin material needed
- With production waste often close to virgin quality, for Post-Consumer-Textiles so far not an option
 - Avoid material mixtures
 - Avoid added chemicals
- EREMA, GNEUSS, Starlinger,...



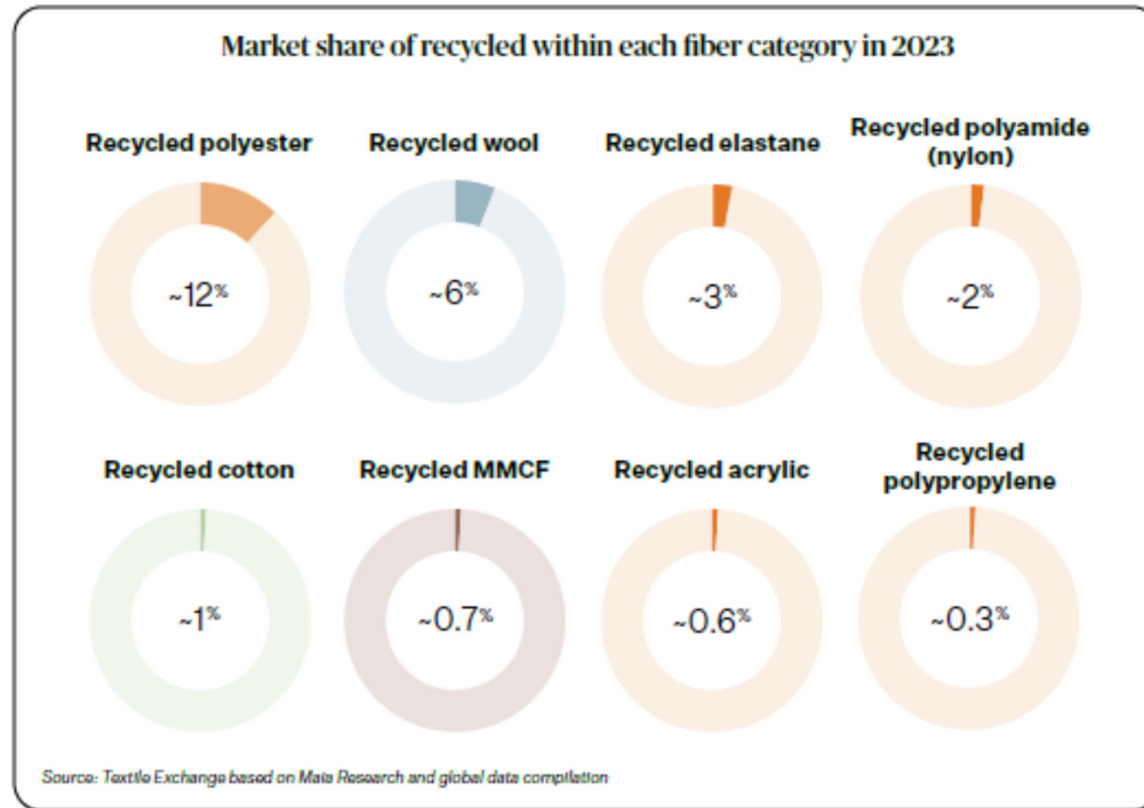
Source: EREMA presents INTAREMA® FibrePro:IV

- Recycling of polymers or monomers using chemistry
- Not yet very established, but a few commercialised processes exist
- Input does not control output as much. However, color, material, auxiliaries, fiber length (and others) might be important. Proper collection and precise sorting are key.
- Output is of higher restored quality → resource consumption is very often higher, depends a lot on exact process

Evru	Infinite Fiber	Circulose	Loncel	Syre	Rittec	Mistra	DEMETO	Asahi Kasei	Fraunhofer
CO	CO	CO	CO	PES	PES	PET	PET/PA6	PA66	PA6

- Erwartungshaltung an Rezyklat: „Genau wie Primärfaser“
- Unterschiede in Verarbeitungseigenschaften (je nach Verfahren, v.a. mech. Recycling)
 - Faserlängenverteilung
 - Festigkeit & Dehnung
 - Faser-Faser- und Faser-Metall-Reibung
 - Auflöseverhalten
 - Faserbruchneigung
- Abhängigkeit vom Feedstock (Qualität, Störstoffe,...)
- Ressourcenverbrauch der Recyclingtechnologien
- Standardisierung fehlt oft noch
- Preisstruktur?

Share of recycled fibres within different fibre types



Source: Materials Market Report; Textile Exchange, 09/2024

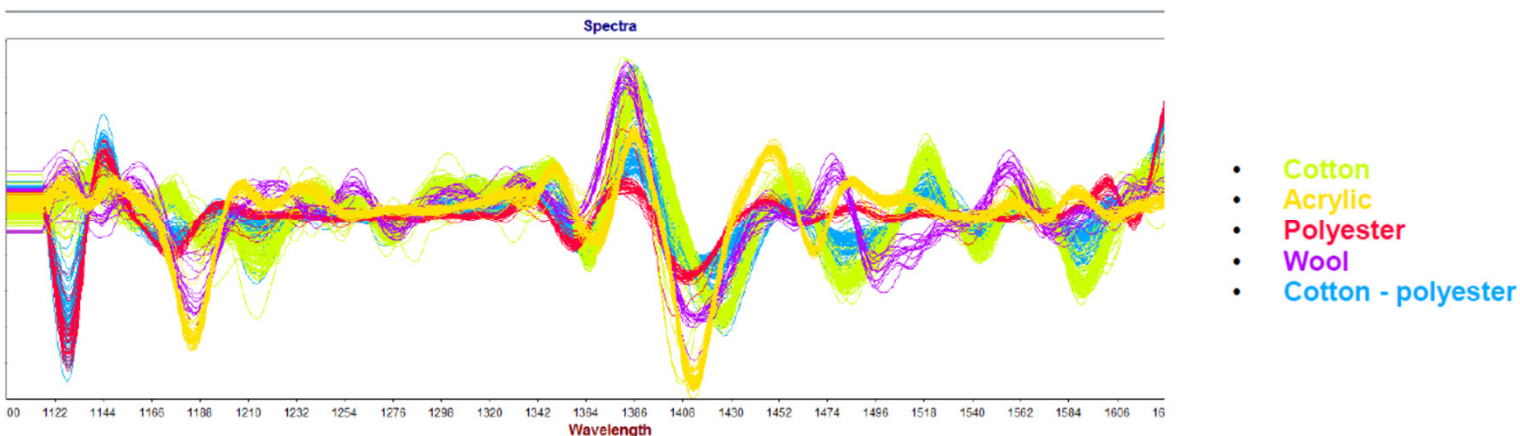
Collection and sorting of textile waste



Goal is a high share of reusable products

Sorting for reuse vs. sorting for recycling

Source: Dr. E. Perzon, IVL, Siptex – the first automated, industry scale sorting plant for textile waste, ETP Strategic Program Circular Economy, 2020



Examples: Sysav, Valvan, TOMRA, Wastex, ...

- Technology: NIR, Combination with colour detection, cameras, AI possible
- Difficulties for multilayers, reflected or absorbed radiation → but it works for a high number of products!

Developments towards automated sorting for purification

- TRIMCLEAN from Valvan as an example
- Also NIR sorting of cut textile pieces as an option
- Sorting makes sense when there is a demand!

THE NEXT STEP: TRIMCLEAN

PREPARE TEXTILE STREAM FOR RECYCLING PROCESSES

Latest development for automatic removal of trims:

- Labels
- Zippers
- Buttons

First test results are very promising, industrial tests are planned in Q1 2023.

MORE INFO BY Q2 2023



 **VALVAN**

Source: Valvan, Gaetane Decloedt, The future of textile sorting, ETP Masterclass, Module 3