

## Tekstiilit ja purkumateriaalit kiertoon

Tekstiilikuitujen kierrätys - tekniikat, hyödyt ja haasteet:

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31/08/2023 VTT – beyond the obvious

# Global trends

## Personalized experience

- Individual fashion
- Personalized e-commerce – prediction
- Personalized experience through the value chain

## Sustainability and responsibility

- Values are transforming into behaviour
  - Consumers, manufacturers and brand owners
- Bio-based materials in textiles
- Recycled and recyclable textiles

## Knowledge-based

- Relevant information content: essential information needed for the sustainability and acceptability of production, traceability of the origin of products, suitability for customer use, maintenance, repair and recycling

# VTT focuses in textiles in nutcel

Circularity of  
textiles and  
nonwovens

Value chains  
and scaling up

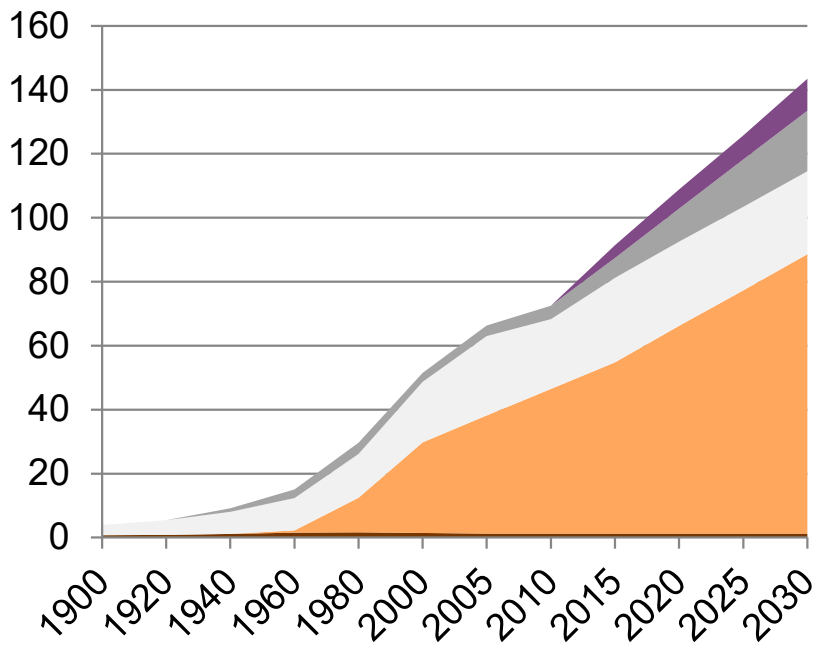
Coatings and  
functionalization

**Advanced textile  
recognition**  
**Textile id technologies**  
**Mechanical and chemical  
textile separation**  
**LCA and product  
handprint (PEFCRS)**

**Business ecosystem and  
logistics**  
**Recycled fiber converting,  
incl. nonwovens and  
composites**  
**Recycled polymer  
materials rehabilitation**  
**Cellulose as rawmaterial**

**Chemical enhancing of  
polymer materials for  
coloring and finishing**  
**Advanced functionalities  
for fibers**  
**Applied coating methods  
e.g. foam and e-spin.**

Sustainability: renewable, recyclable, water scarce, low LCA, microplastic safe

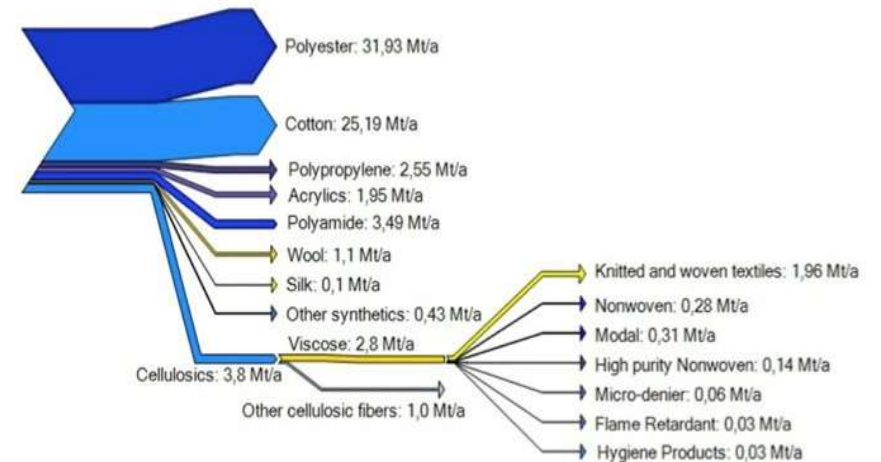


=> Raaka-aineen riittävyys ja toiminnan kestävyys

Source: The fiber year 2018

## Hyvinvointi ja väestöpohja kasvavat

- Cellulose gap
- MMCF
- Cotton
- Synthetic fibres
- Wool



Source: Oerlikon, PCI Fibres, Pöyry analysis

# Eroon tekstiilien kestävyysvajeesta

KESTÄVYYS

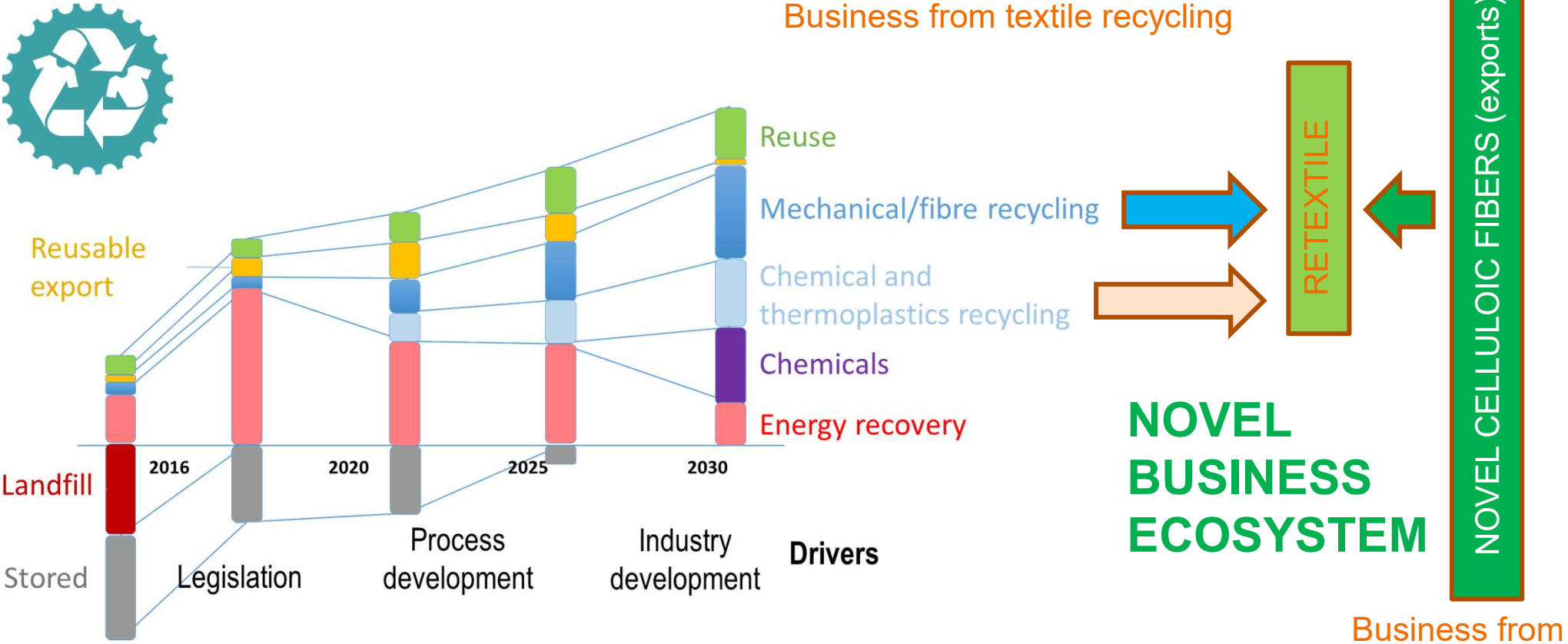
- Raaka-aine
  - Öljypohjainen raaka-aine lähes 70%
  - Puuvillan viljely
- Työolot
  - Palkat, työajat, turvallisuus
  - Pakkotyö, lapsityövoima...
- Teollisuuden ympäristökuorma
  - Kemikaalit vesistöön
  - Hiilidioksidipäästö
- Kauppatapa
  - Pikamuoti (laadun vaje)
  - Verkkokauppa (palautusten määrä)
- Tekstiilijäte
  - Kierrätyksen puuttuminen
  - Mikromuovi
- .....

LÄPINÄKYVYYS

Producer responsibility  
The European Union regulated EPRs in the 2018 Waste Directive introduces minimum requirements

Julkinen mielipide ja raaka-aine on pakottamassa muotibrändejä muutokseen

# Some Future Prospects

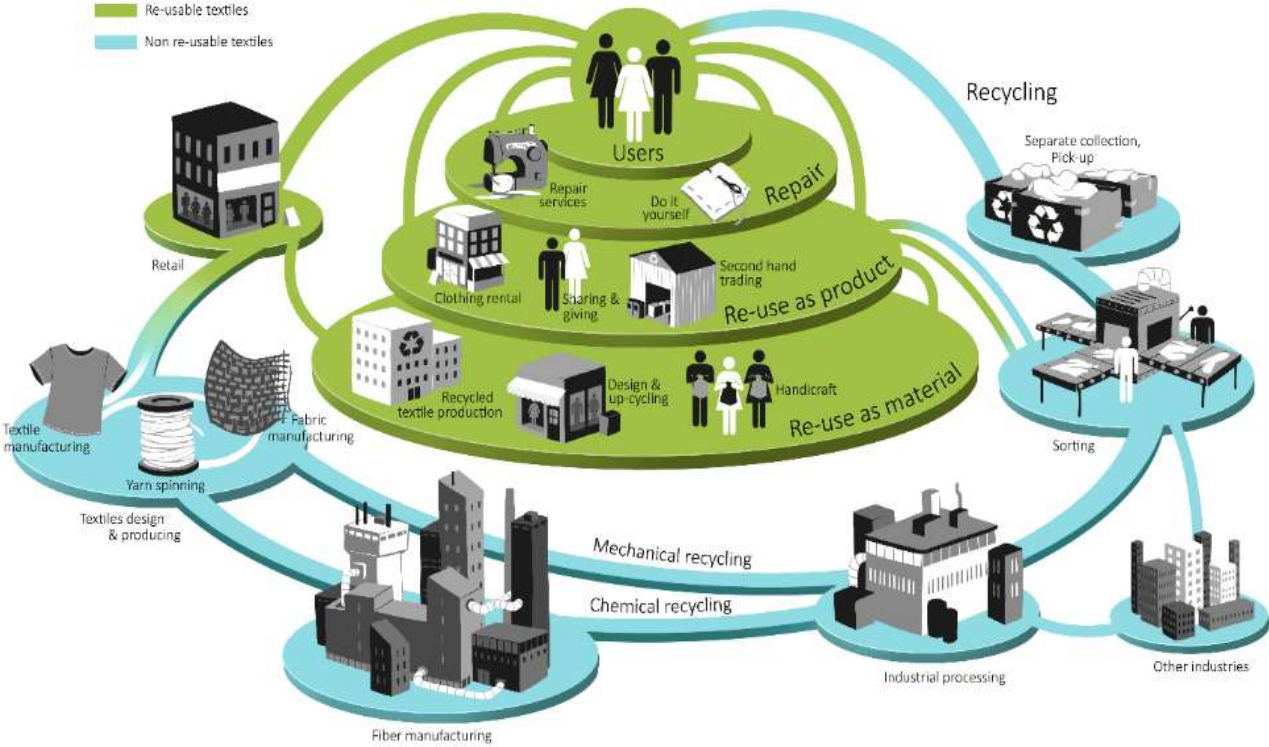


Adopted and re-drawn from Harlin, Roadmap for recycled textiles in Finland in 2020's, Telaketju-seminar, Hanasaari Espoo, 18.9.2018 Heikkilä P. et al., Telaketju - Towards Circularity of Textiles, VTT Research Report, VTT-R-00062-19,



# Textile recycling platform

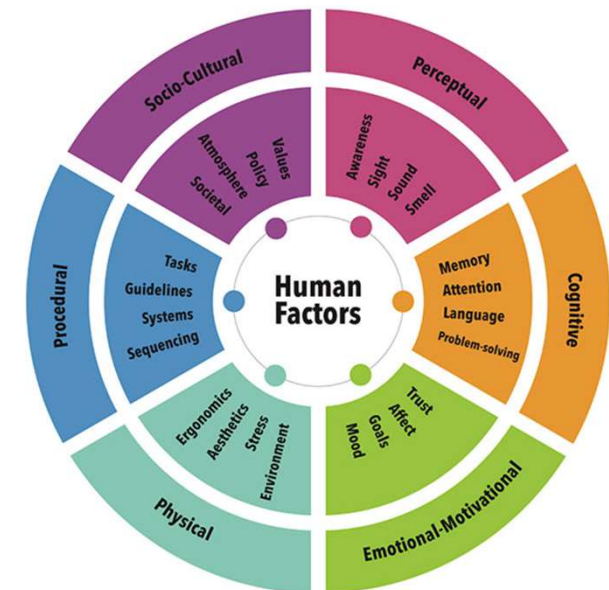
- REQUIREMENTS:
  - Added value
  - Existing platform
  
- To run an ecosystems
  - Trust
  - Knowhow
  - Mutual interest
  - Ground rules
  - Standards
  - Companies
  - People



The Relooping Fashion Initiative  
[www.reloopingfashion.org](http://www.reloopingfashion.org)

# Design for recyclability

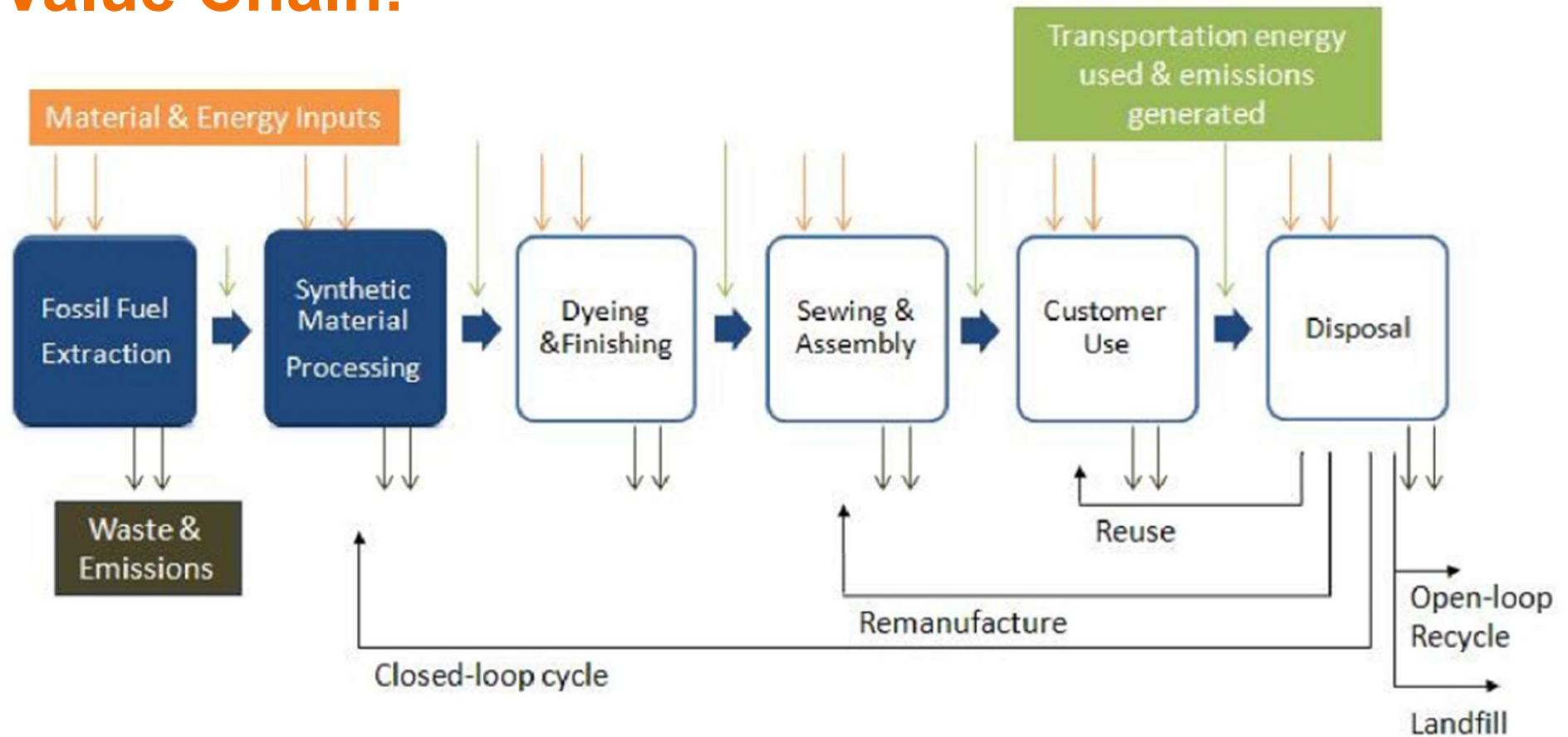
- Human factor
  - Motivation
  - Knowhow
  - Capability
- Safety
  - Pronounced in personal applications
  - Microbial and chemical issues
- Performance
  - Mechanical has more challenges but lower LCA
  - Mixing with virging materials
- Repeatability
  - Standardation is needed



Design for repair and disassembly has to be considered in product design

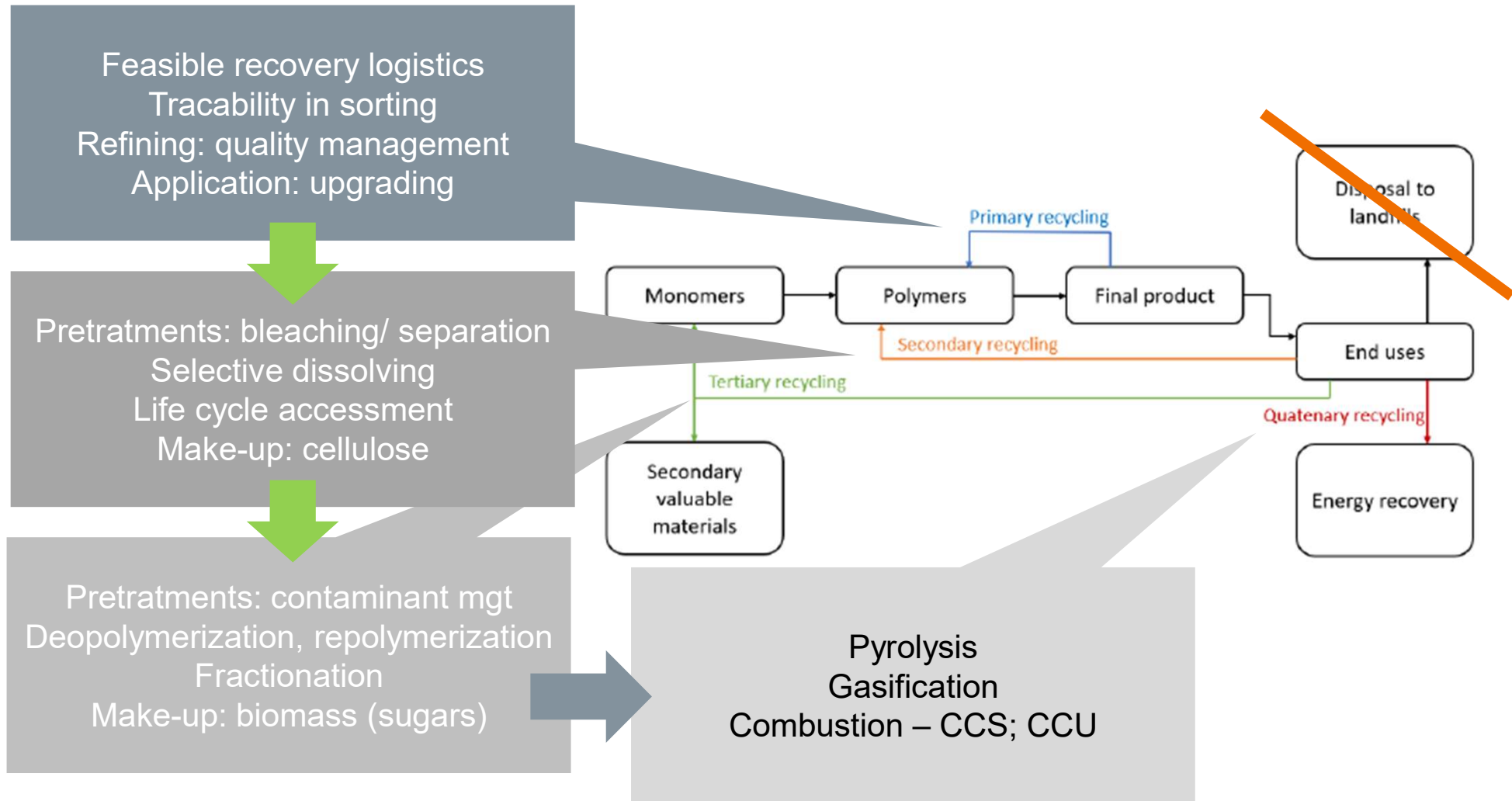


# Value Chain!



<https://textilevaluechain.in/2019/05/29/%C2%AClife-cycle-analysis-of-textiles/>

# Shortest cycle is more sustainable



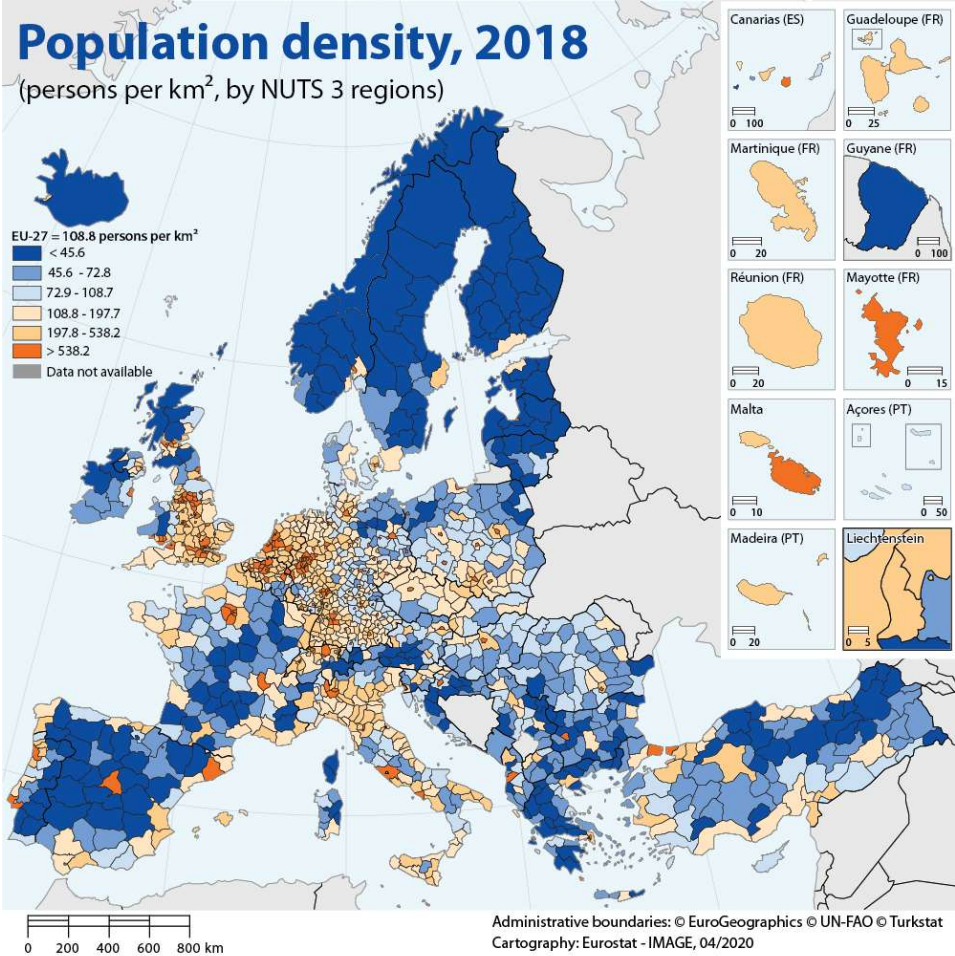
# Infrastructure

- Density of the population
  - Presorting preferred in less populated areas
- Peoples communication routes
  - Maching with transportation and hubs



<https://vayla.fi/en/transport-network/data/maps-charts>

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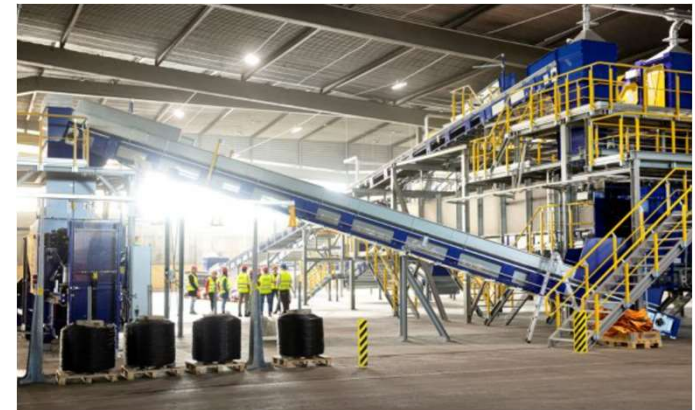
<https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200430-1>

[ec.europa.eu/eurostat](https://ec.europa.eu/eurostat)

# Sorting and fractionation

- Recognition
  - Currently only material types
  - Towards single object id
- Multicomponent separation
  - Sorting criteria
  - Existing
    - Polyester mechanical recyclen
    - Cotton chemical recycling
  - Rapid development on mixed materials
- Automation
  - Increased use of robotics
  - Artificial intelligence benefits

Sysav Industri AB in  
Malmö, Sweden.  
Autoshort unit by Tomra  
4,5 t/h





# Hyperspectral NIR imaging

Combines chemistry with the spatial information of an image

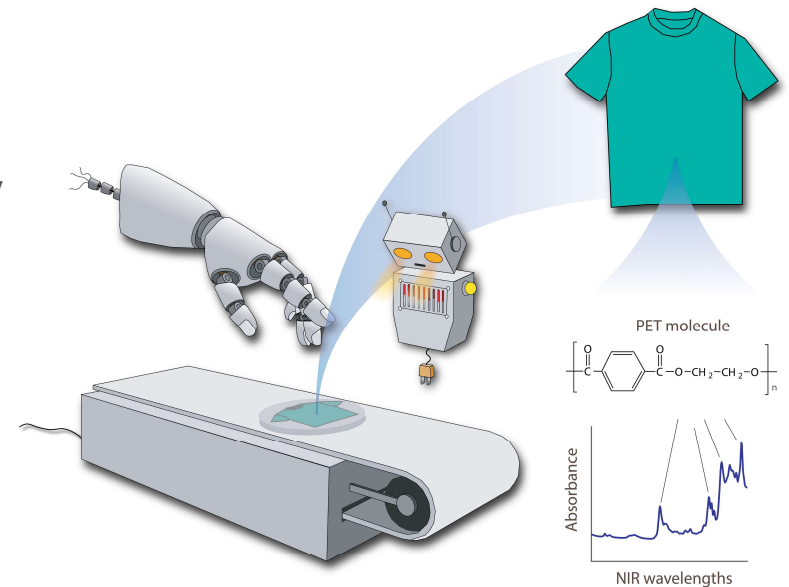
- Data intensive as every pixel contains a continuous spectrum
  - Anharmonic vibrations of fundamental IR modes
- Light penetrates deeper into a material due to lower molar absorptivity

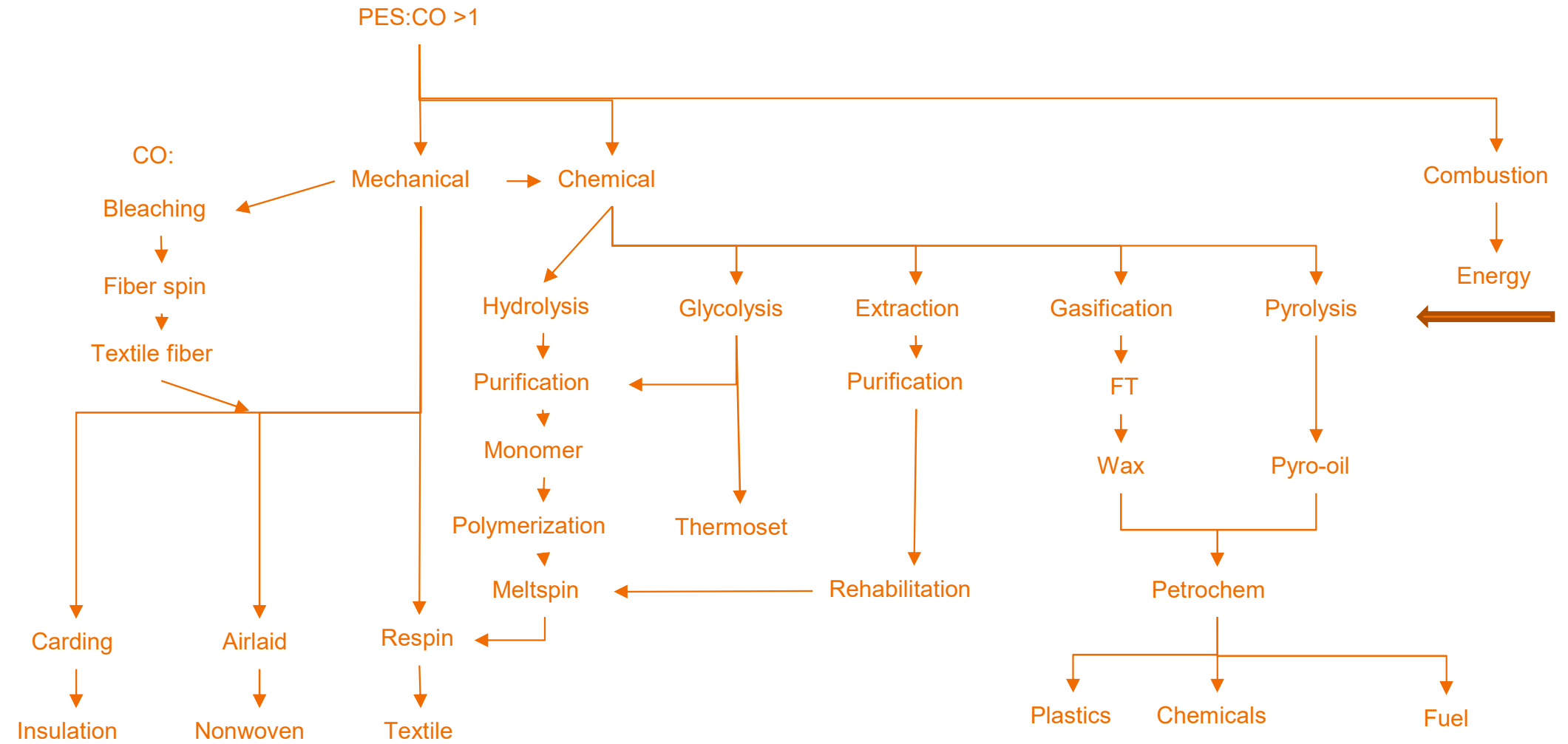
Enables automated textile fiber identification and sorting

- Synthetic and renewable fibers
- Different cellulose fibers and their properties

VTT has a long background in imaging spectroscopy

- From line-scanning sensors to satellites and space exploration



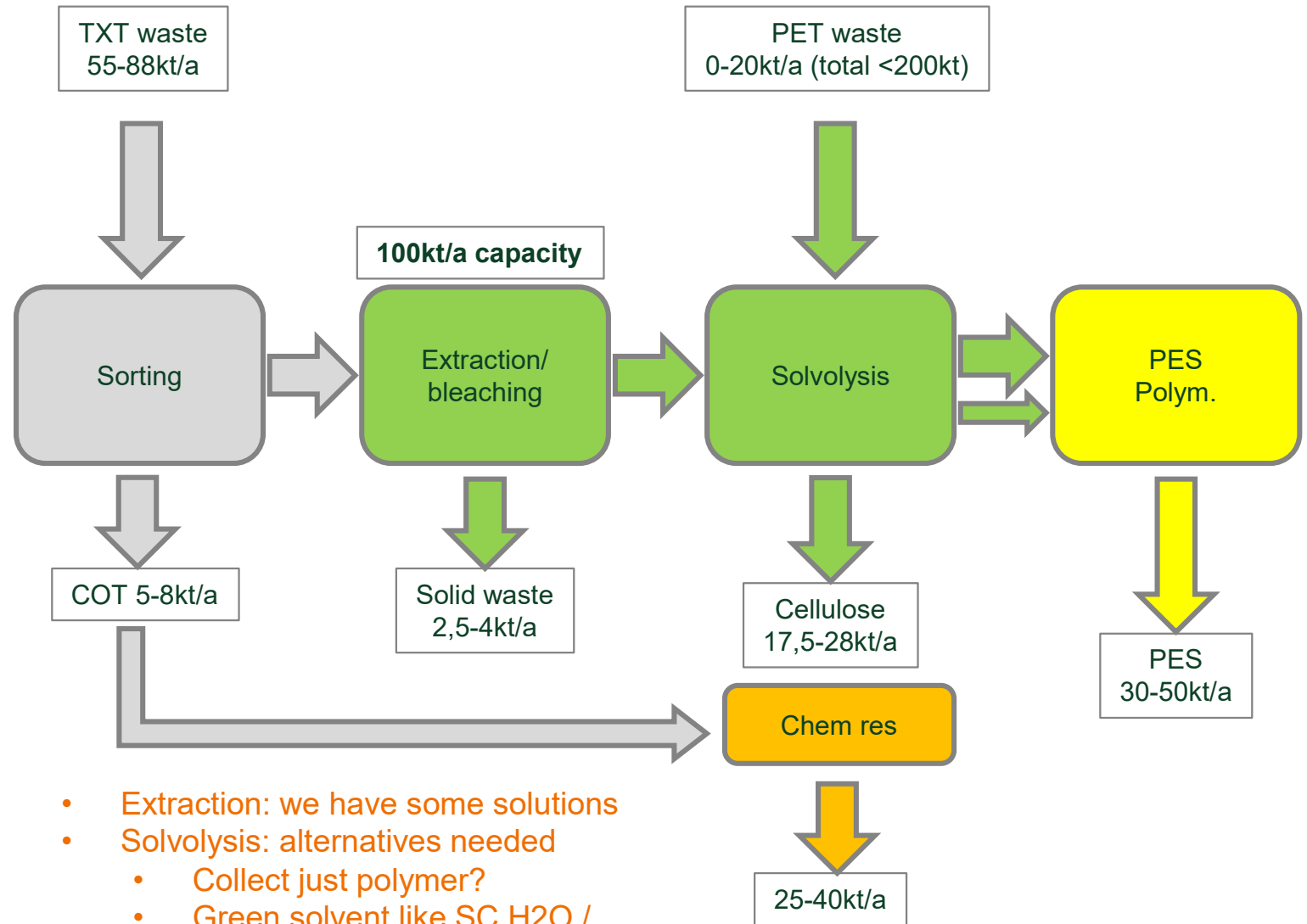




## Dual feedstock Concept

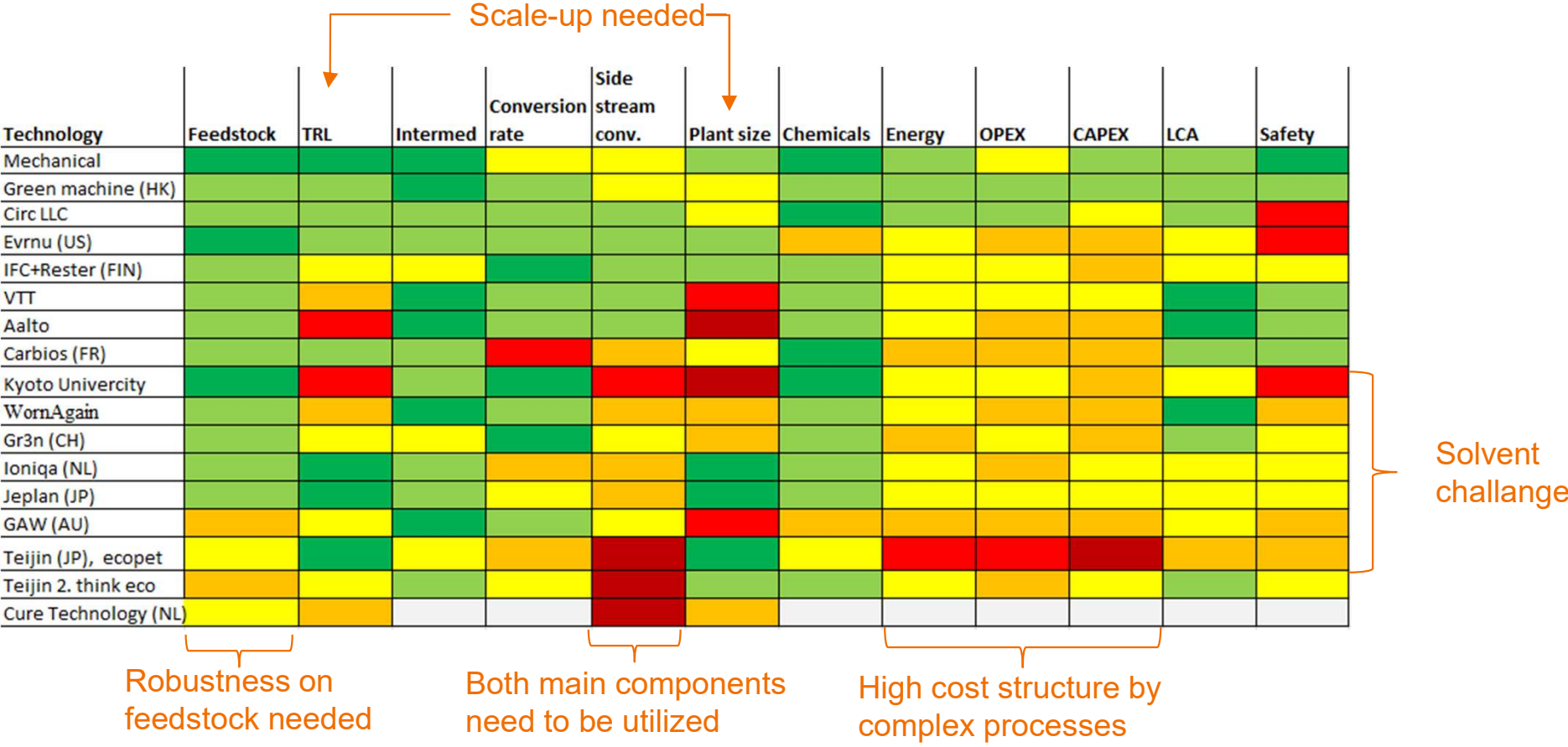
- Ability to benefit both packaging and textile waste:
  - Pretreatments
  - Comatability
  - Product slate

Known concept for mixed feed is combining glycolysis to thermoset resins as a product



- Extraction: we have some solutions
- Solvolysis: alternatives needed
  - Collect just polymer?
  - Green solvent like SC H<sub>2</sub>O / hydrothermatl (known)
  - Enzymatic solutions (partially known)

# Comparison of technologies



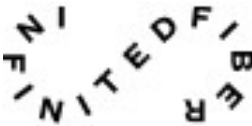
# Novel cellulose-based textile fibres are emerging and going towards industrial scale



Spinnova and Suzano to open commercial scale factory in 2022



Paimio recycle HUB, Rester and LSJH



We have created a miracle: a technology that allows textile waste to be used again and again, preserving 100% quality.

Free for publication 27.1.2022

The Finnish startup - Nordic Bioproducts Group - has successfully spun a new plant-based textile fibre.

Metsä Group and Itochu establish a joint venture that builds an industrial demo plant to produce wood-based textile fibres

Metsäliitto Cooperative | Press Release | 1.10.2018 10:15 EEST



## loncell® in a nutshell

- The loncell® process uses a novel solvent called ionic liquid. It's an environmentally friendly solvent that can be recycled and isn't flammable like many others.





Recycling of Textile Fibres is a Solution

# Rester Ltd

## Towards circular textile industry

Rester recycles end-of-life textiles into new raw materials

Rester opened the largest waste textile recycling plant in

Scandinavia in October 2021



Our process



A growing ecosystem



Refined fibers

### The Rester process reduces water use and emissions.

Per 1 tonne of fiber produced, Rester saves:

Water

2,127,500 liters



CO<sub>2</sub>

5,170 kg



[Learn more](#)

## 4,000 tonnes

of regenerated fiber by Rester

Water

8,510,000,000

liters

CO<sub>2</sub>

20,680,000

kg

That's the same as

3,404

olympic-sized swimming pools

That's the same as

131,218,274

km driving a passenger car

# Cellulose based textile fibre platform



## Fibre wet-spinning laboratory line

- Recycled or virgin raw material
- Today for Viscose, CCA and Biocelsol
- Cellulose dissolution and filtering units
- Up to 1000 g textile fibre in day
- Fibre characterisation laboratory

## Fibre wet-spinning pilot line

- Cellulose filtering units
- Staple fibre web production and post treatment units
- Up to 100 kg textile fibre in day
- Today for CCA and Biocelsol
- Spinning part can be modified to e.g. IL-solutions
- Possibilities to modify for many spinning technologies



Vipuvoimaa  
EU:lta  
2014–2020







# Turning waste into a source of joy.

Infinna™

## Infinite Fiber Company is

- A fashion technology powerhouse on a mission to make textile circularity an everyday reality.

## We offer

- A recipe for turning trashed textiles and other cellulose-rich waste into new textile fibers that look and feel soft and natural like cotton.
- A unique, premium textile fiber validated by top global fashion and nonwovens brands as a true alternative to virgin materials.

## Endorsement for our technology

- Talouselämän 10 lupaavinta startup-yritystä 2021.
- 2021 Global Cleantech 100 Company.
- Europas 2020 Hottest Sustainability Tech Award winner.
- WWF's Climate Solver network member since 2016.

**Full scale 30 000 tn pa by 2026 in Veitsiluoto**



# Muut kuidut:

## Runkokuidut, kuten villa hamppu, pellava, juutti, rami ja nokkonen

- **Hamppukuitu** on maailman vahvin kasvikuitu, märkäkestävä ja pitkäikäinen.
  - Komposiittien ja eristeiden lisäksi sopii cottonoituna vaatteisiin
  - Väärinymmärretty THC mahdollisuuden takia
  - Vaatii tehokkaan tuotanto ja jalostusratkaisun
- Villa on arvostettu tuote
    - Villavaate on pehmeä, lämmin ja ilmava, ja se eristää lämpöä ja hylkii likaa.
    - Villaa suositaan myös paloturvallisuutensa vuoksi
  - Haasteena siistauskapasiteetin puute ja
  - Tuottajan sama hinta villasta, koska suomalaisen villan laatu karkeaa
- **Pellava** Perinteinen suomalainen kuitukasvi
    - Ekologinen valinta
    - Edut: kestää kulutusta, on hengittävää, viileä helteelläkin
    - Erityisesti vuodevaatteissa ja asusteissa
  - Olemassa sekä öljy että kuitupellava
  - Tuotteille yrityksiä mm. Pohjanmaalla, Pirkanmaalla ja Satakunnassa



Laajamittaiseen tuotantoon

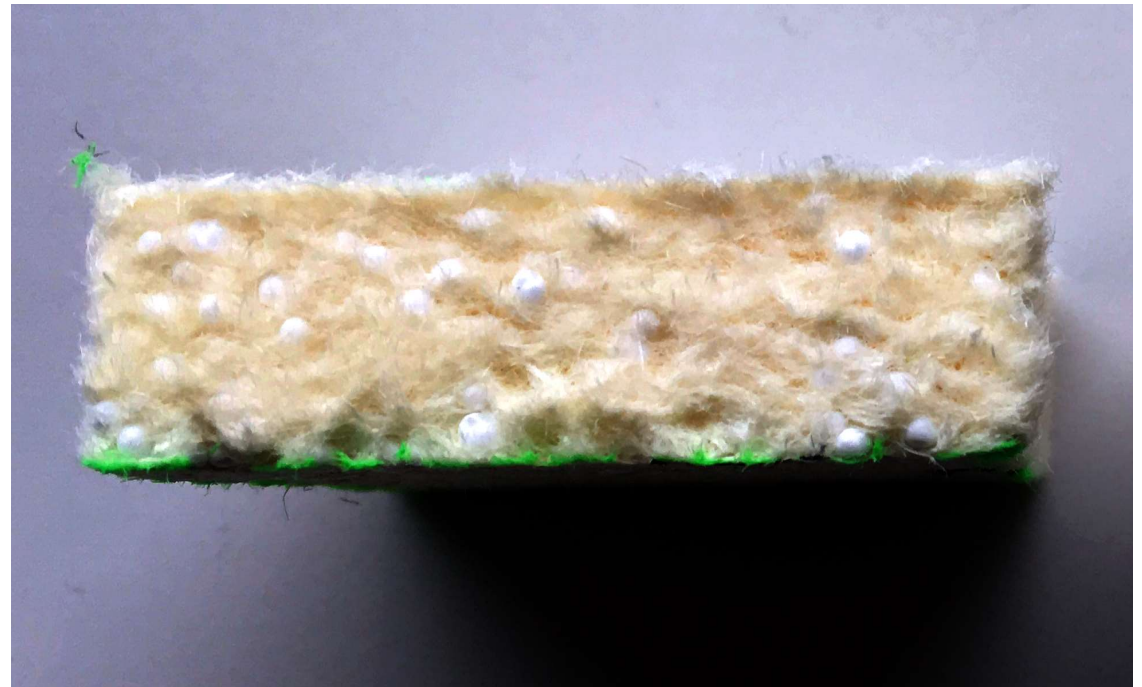


# Limited range of raw materials

Short cotton fibres from jeans/denim mechanical recycling process combined with pulp fibres in different ratios (up to 70% of textile fibres).



EPS particles randomly in fiber network



## Strengths



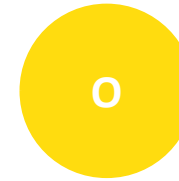
- Finnish **know-how on bio-based materials** is excellent
- Strong **technical understanding on digitalisation, circular economy and smart production**
- There are several interesting pilot projects and industrial production investment projects going on around the new and more ecological textile fibres as well as recycled textile fibres in Finland.

## Weaknesses



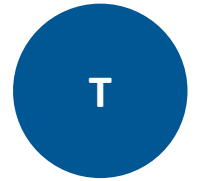
- Finnish market is not large enough
- Lack of skills in marketing and branding
- Narrow knowhow in international consumer business
- Gap between the possibilities and the current level of digitalization in Finnish textile companies

## Opportunities



- Finland has a chance to transform a huge and globally impactful industry as part of an international network
- Possibility to gain a global reputation as a leader in the circular economy and sustainable development
- Agile Finnish SMEs can become forerunners and can grow globally
- Investments worth of one billion euros and new jobs to Finland
- Formation of a new textile cluster

## Threats



- SMEs willingness and courage to pursue international growth and partnerships
- Lack of companies that links digitalization and textile industry

Combine strengths:

- 1) Renewable rawmaterials
- 2) Smart digital platforms:

DEMO

Novel customer perception and acceptance



## Käyttäjät

Tarjoamme maailman puhtainta ja täysin kierrätettävää materiaalia, tekstiilejä ja muotia yksilöllisiin tarpeisiin

Personoitu  
kokemus

## Brändit

Luomme puhdasta ja toimivaa muotia, työvaatteita ja teknisiä tekstiilejä sekä todennamme niiden vastuullisuus- ja kestävyystiedot

Kestävyys ja  
vastuullisuus

## Tuottajat

Tuotamme vastuullisesti maailman puhtainta ja kierrätettävää materiaalia tekstiileiksi, joissa on vahva tietämyspohja

Tietämys-  
pohjaisuus

## Toimeenpano

- Vastuullinen ja todennettu suljetun kierron pilotti ja sen ympärille rakentuva ekosysteemi
- Suunniteltu kestäväksi toimintatapa, joka laajentuu *Suunniteltu kestäväksi –standardiksi*

# Kehittämisen keskeiset tarpeet

- Saatavuuden edistäminen
- Kannattava mittakaava
- Myyvä tarina

# bey<sup>0</sup>nd

## the obvious