



Contributing to closing the loop: the challenges of MMCF to textiles

2022 Linear to Circular

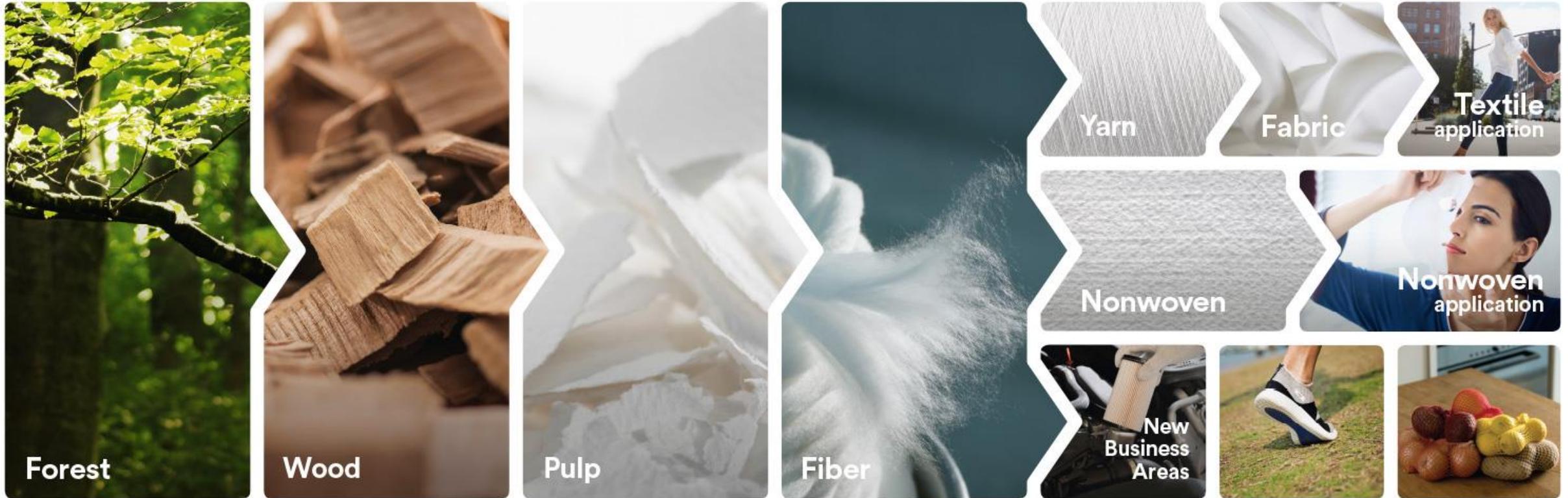


Martina Opietnik & Jo-Ann Innerlohinger
CBPM Symposium, Wageningen - 2022-06-16

Agenda

- Lenzing in a nutshell
- Textiles as recycled raw material in TENCEL™ fibers
- Steps towards alternative raw materials based on agricultural waste
- Take-home-message

LENZING™ fibers produced from the raw material wood



LENZING™ fibers / products and their applications

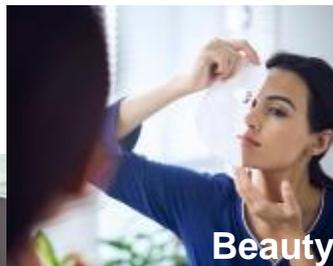
Textiles



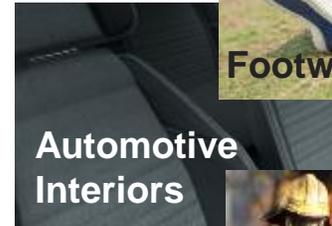
LENZING EcoVero™



Nonwovens



Industrials



LENZING™



Innovative by nature

The Lenzing Group in 2021

Financial year 2021 at a glance

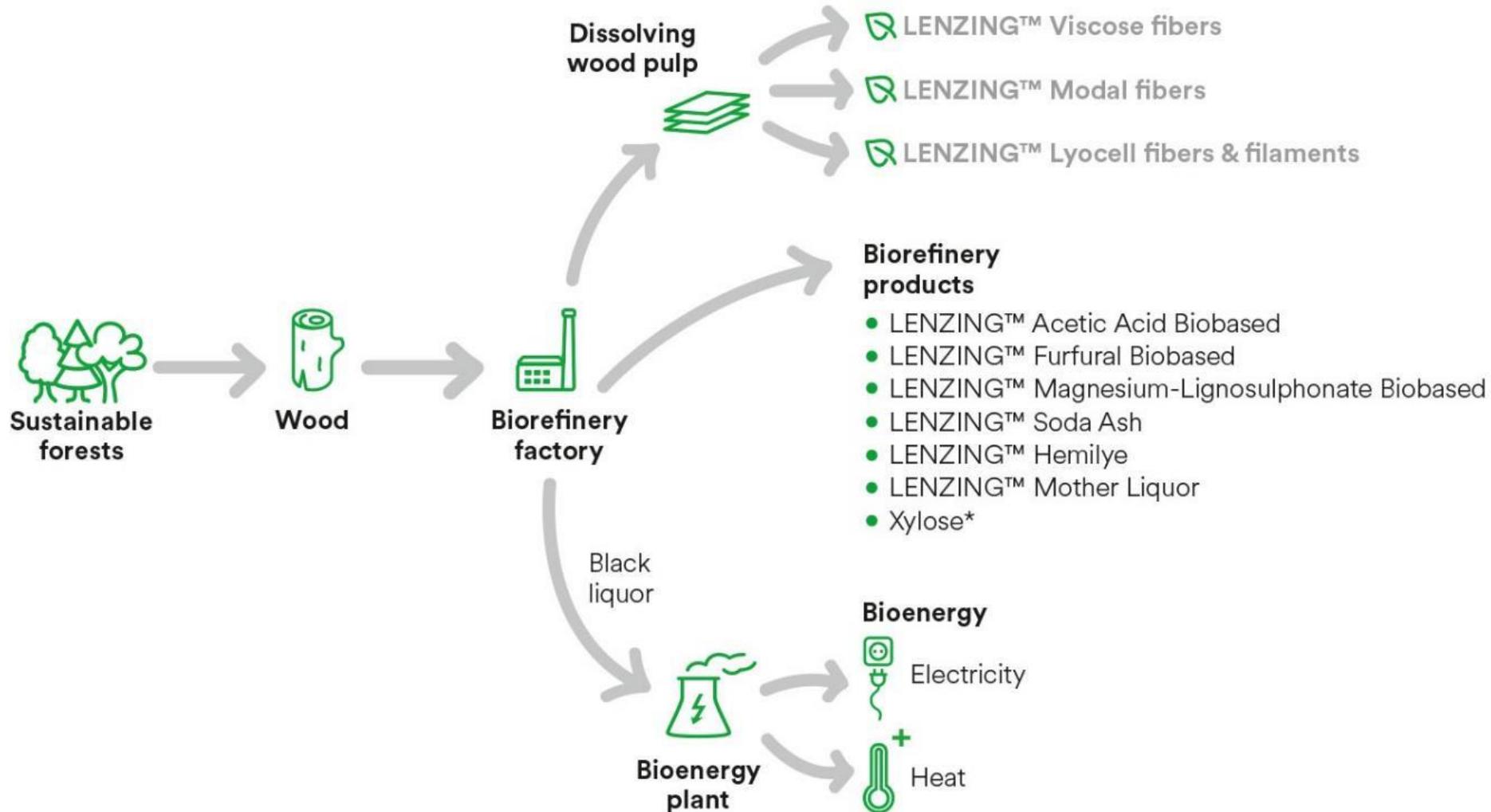
- Group revenue of EUR 2.19 bn
- EBITDA of EUR 362.9 mn
- Investments (CAPEX) of EUR 844.3 mn
- R&D expenditures at EUR 31.6 mn
- Number of employees: 7,958

Key developments & strategic highlights

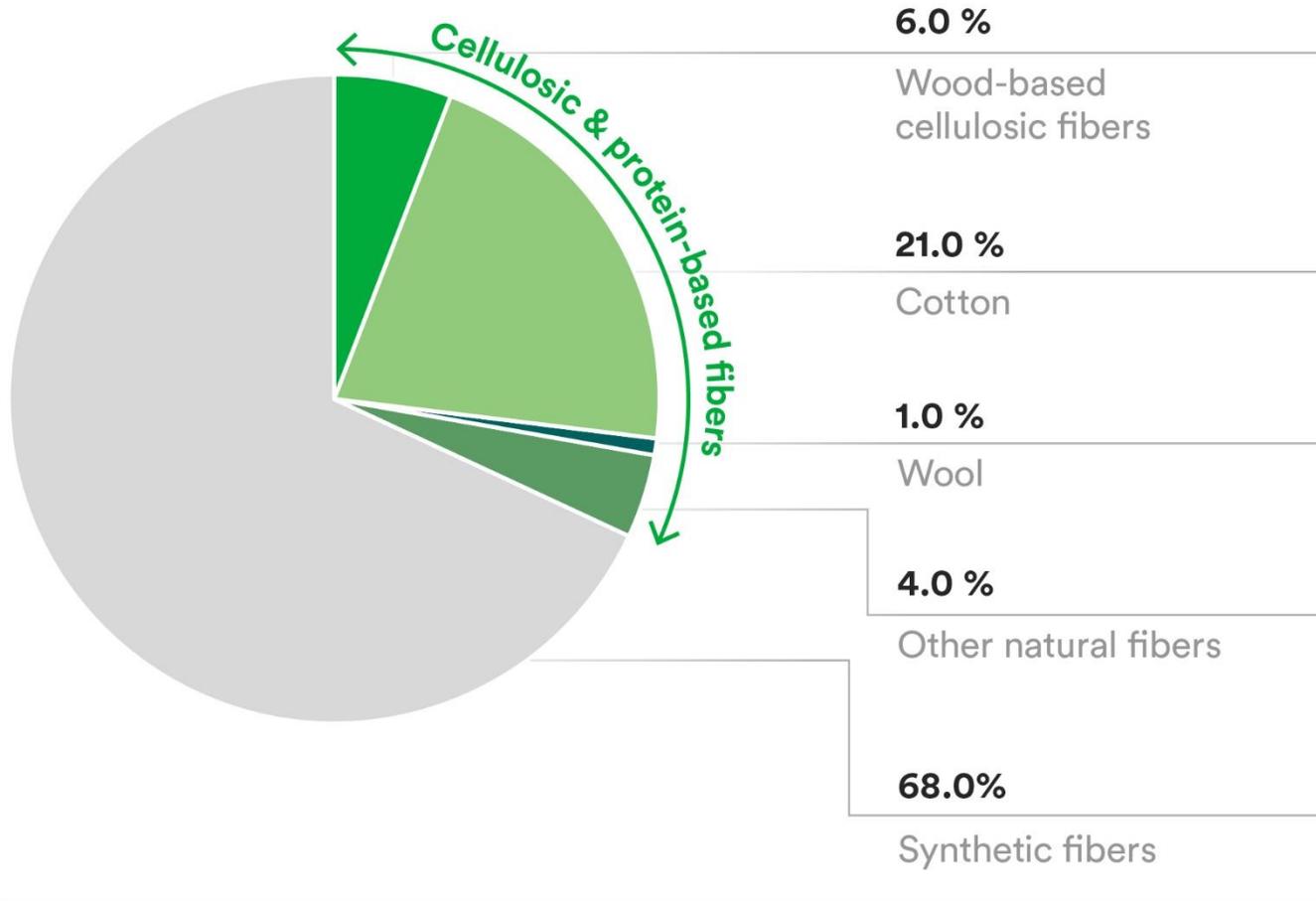
- Largest expansion program in corporate history fully on track
 - 100 kt Lyocell plant in Thailand opened in Q1-2022
 - 500 kt DWP plant in Brazil on schedule started in Q2-2022
- Various well-known rating agencies honor Lenzing as one of the most sustainable companies in the world



The Lenzing biorefinery - using the whole raw material



Globally 116 mn t fiber consumption (2021¹) - increasing



Average per head consumption yearly:

- Globally: 12 kg
- America: 35 kg
- Europe: 20 kg
- Asia: 10 kg

¹ Source: ICAC, CIRFS, TFY, Lenzing estimates

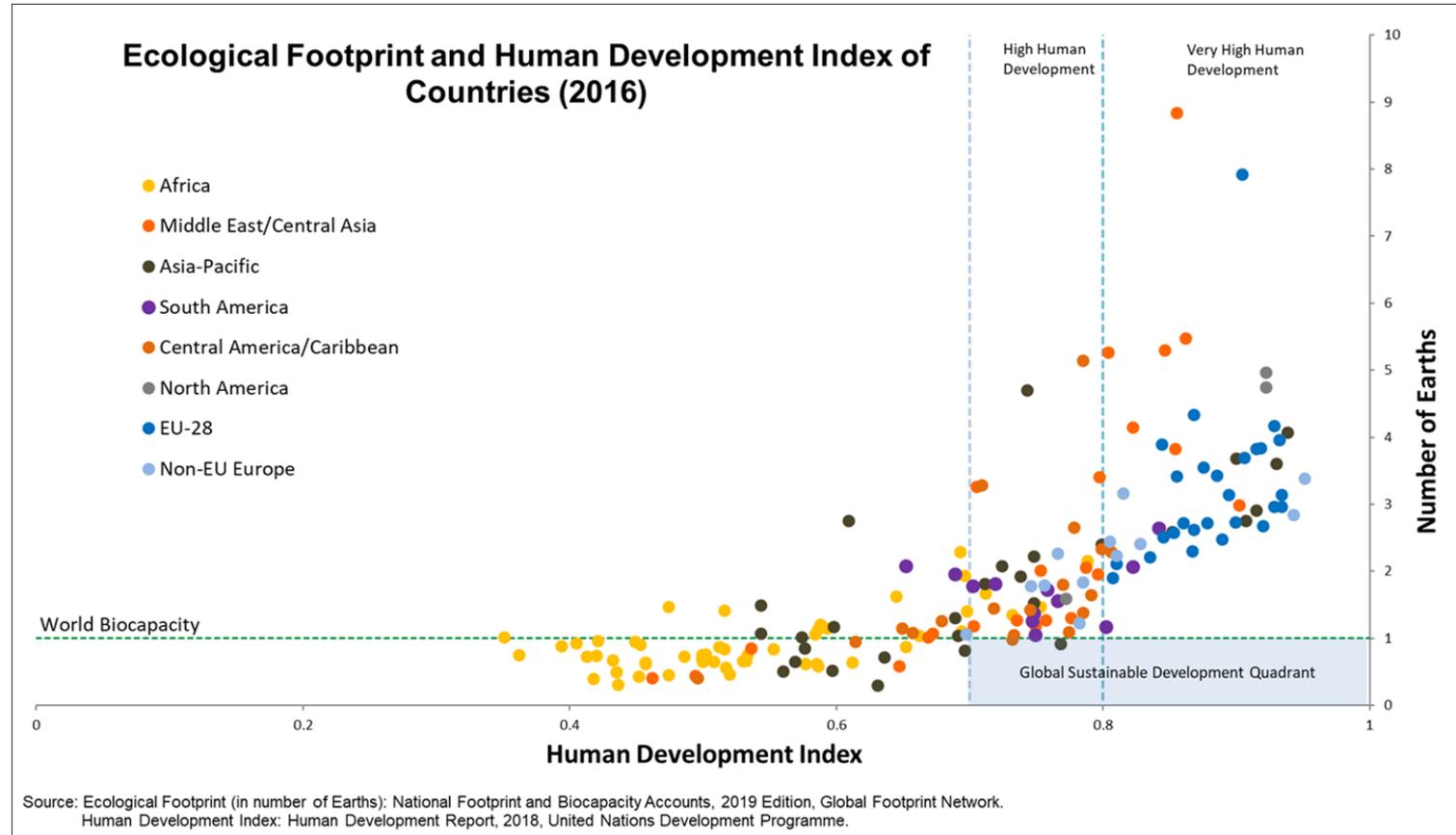
The higher developed, the higher the environmental impact



Source: tagesschau.de ([Atacama-Wüste in Chile: Müllhalde für Fast-Fashion | tagesschau.de](#))



Source: stockfood.de ([Landwirtschaftliche Felder, Luftaufnahme – Bilder kaufen – 984090 | StockFood](#))



Minor recycling in textile industry – up to now

Global material flows for clothing in 2015



73% waste

14% loss

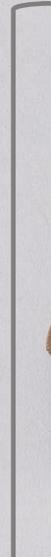
13% recycling

source: Ellen McArthur foundation; A new textile economy, 2018

What are TENCEL™ x REFIBRA™ fibers?



x



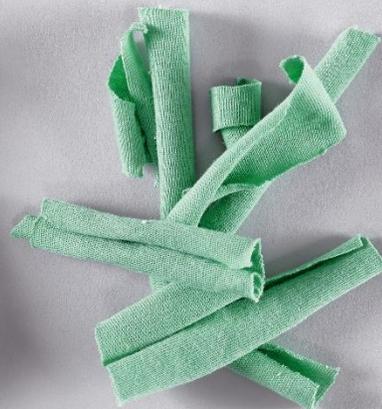
What are TENCEL™ x REFIBRA™ fibers?



x



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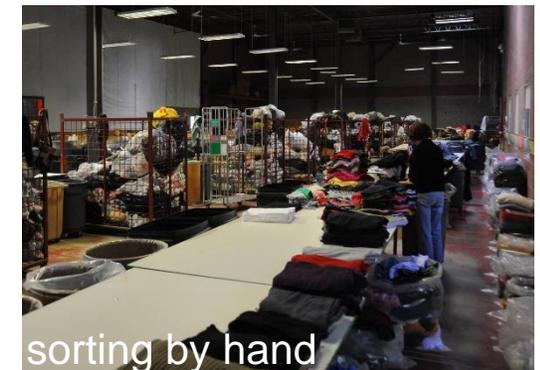
First step towards closing the loop



- REFIBRA™ as a **milestone** to close the loop in the textile industry. 2017 – **first commercial cellulosic fiber** with (chemical) recycling part
- Innovation and cooperation over the whole textile chain:
 - **30% recycled share**
 - **identical fiber properties as TENCEL™**
 - **traceability** up to the end consumer
 - certified acc. to Recycled Claim Standard
- Various well-known **awards** to honor Lenzing achievement

Post-consumer textiles as next step - new challenges

- **Cotton rags vs. post-consumer textiles**
 - Buttons, stichings, zippers,... w/o
 - 100% cotton vs. blends (typically with PES)
 - Similar materials vs. “unique blends”
- **Different after-treatment chemicals (~ 5000)** having a high impact on recycling processes
- Starting **2025 comprehensive separated collection** of post-consumer textiles within the EU planned.
At the moment no unified sorting, most things sorted by hand.



Joint way forward

- **Cooperation Lenzing and Södra (Sweden)** to push the technology for recycling of post-consumer textiles forward
- **Recycling of 25.000 t/a in 2025**
- **50% recycling share in fiber**
- **Up-cycling of used textiles as is**
 - buttons, zippers, ...
 - dyed and printed
 - not feasible for 2nd hand



Lenzing
Innovative by nature

Tencel™
Feels so right

x

REFIBRA™
technology

OnceMore®
by Södra

SÖDRA

Lenzing
Innovative by nature

Agricultural waste & yearly plants as raw material for man-made fibers

- A lot of material from agricultural waste or yearly plants is generated globally

Approximately three-figures mt/y with 20-50% cellulose content.



source: [Agralooop](#) (Agralooop — Circular Systems | Regenerative Impact)

- **Alternative raw materials** could arise from different waste feedstocks. Some examples are given, including cellulose content and volumes (estimated on waste content)
- **Agricultural waste**
 - Banana peels – 7.5% cell, 72 mn t/y
 - Sugar cane bagasse – 40-50% cell, 126 mn t/ya
 - *Orange peels* – 12% cell, 26 mn t/y
 - Pineapple leaves – 55-68% cell, 1.4 mn t/y
- **Yearly plants**
 - Bamboo - 50% cell, 20 mn t/y
 - *Hemp* – 40% cell, 153 kt/y in EU
 - Straw
 - Wheat – 29-40% cell, 15 mn t/y in Ger
 - Rice – 35% cell, 650-975 mn t/y

A lot of buzz on market with only very small volumes

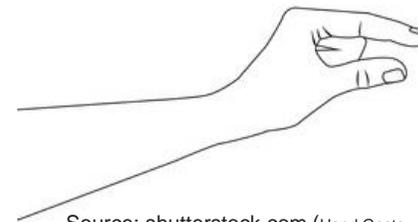
- Growing interest on the market regarding alternative raw materials for MMC fibers.
 - Foundation of numerous **start-ups to convert raw materials to fibers / textiles** or
 - companies with waste material searching for alternative processing routes.



**Increasing
number
of start-ups**

Source: vecteezy.com (Start der Rakete mit Dampf und Flamme. Start-up-Konzept 3441664 Vektor Kunst bei Vecteezy)

- **Startups for Fibers / Textiles – small volumes**
 - Agraloop BioFibre (pineapple leaves, wheat straw, sugar cane, rice straw, banana peels, hems, flax)
 - Expand Fiber – R&D level cooperation Metsä & Fortum
 - Pinatex – textiles made of pineapple leaves
 - Lyohemp (TITK) – 100% hemp pulp lyocell fibers

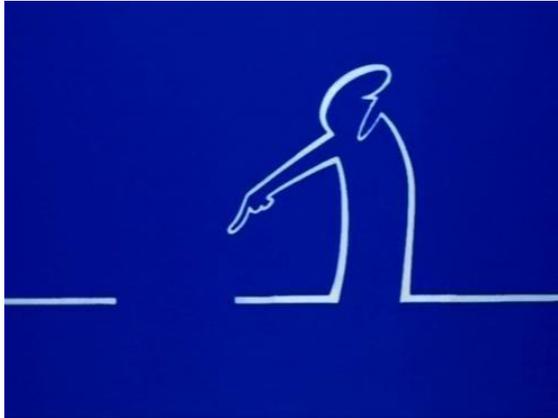


**Only small
volumes of
products**

Source: shutterstock.com (Hand Geste machen, während sie zeigen: Stock-Vektorgrafik (Lizenzfrei) 1954768087 | Shutterstock)

Agricultural waste and yearly plants in high volumes, but not in the quality needed for our processes

- **Missing link of raw material to fiber processing is pulp production** – shortage of pulp mills being able to process small volumes of this challenging materials to produce high quality dissolving pulp.
 - Mills producing alternative raw material pulps are generating paper pulp qualities (high on hemis & lignin, high on minerals)



Source: pinterest (13 idées de La Linéa | la linéa, souvenirs d'enfance, dessin animé)

Alternative pulp material has perquisite **properties**:

- **High purity** – high cell, low on contaminations (by-products, metals, sand,...)
- **Constant quality** with reliable properties and processability
- **Availability** and logistic aspects
 - Alternative raw materials having higher moisture contents leading to higher transportation costs, problems in storage (seasonality, decay...). Bagasse broadly used for energy gain – competitive application.
- Mobilization of residues from field to mill and isolation of cellulose not optimized as for wood, leading to lower yields and higher consumption of chemicals, successively leading to **higher pulp prices**.

TENCEL™ Limited editions

with Orange Fiber



with hemp share

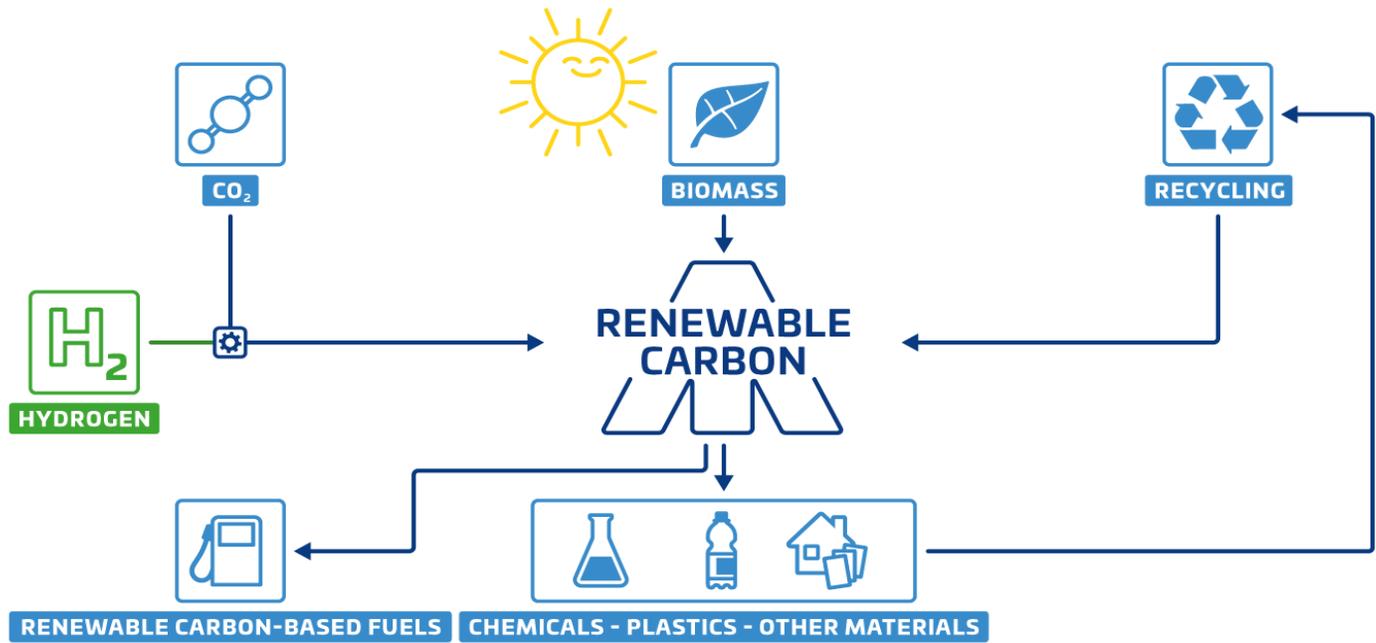


LAG Developments – TENCEL™ Limited Editions

- Fiber innovations regarding hemp and orange fiber for capsule editions - small volumes only
- Processing to man-made fibers leads to loss of unique properties of raw materials (smell or orange, stiffness of hemp,...)
- Higher prices of raw material pulps and production on smaller production lines due to limited volumes lead to higher prices of fibers.

? Ongoing **feasibility project with Wageningen University and Research** to estimate the economic potential and technical realization of these materials from plant to pulp to MMC fiber.

Renewable Carbon – the right approach for materials



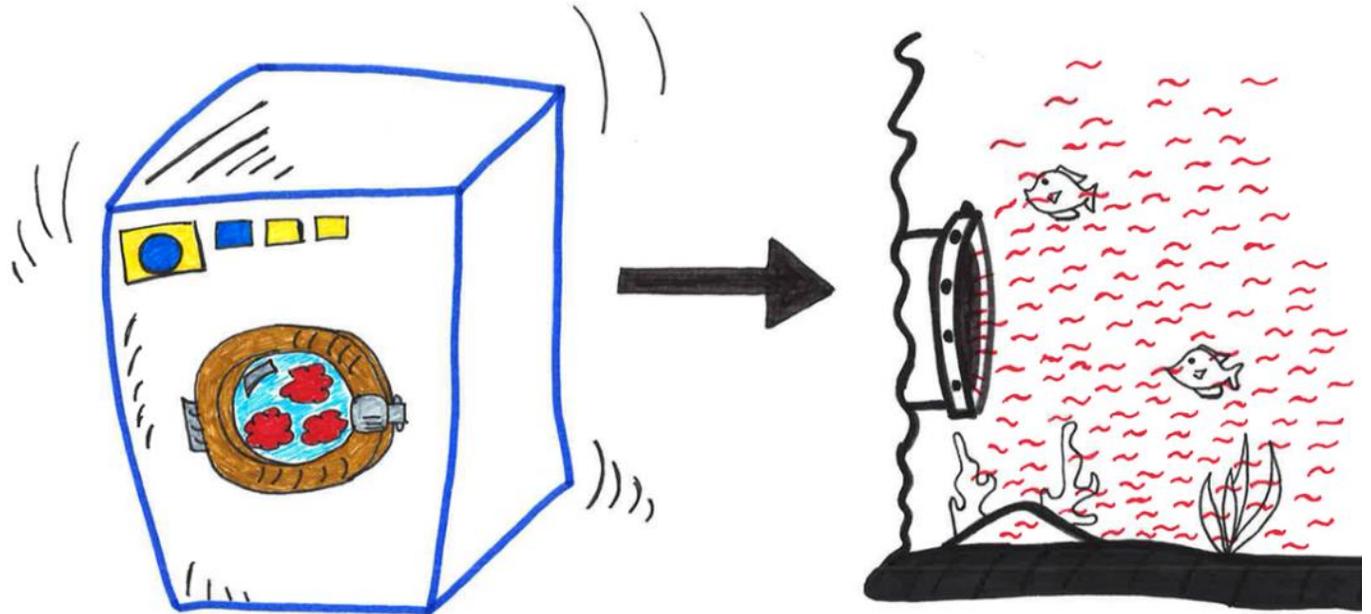
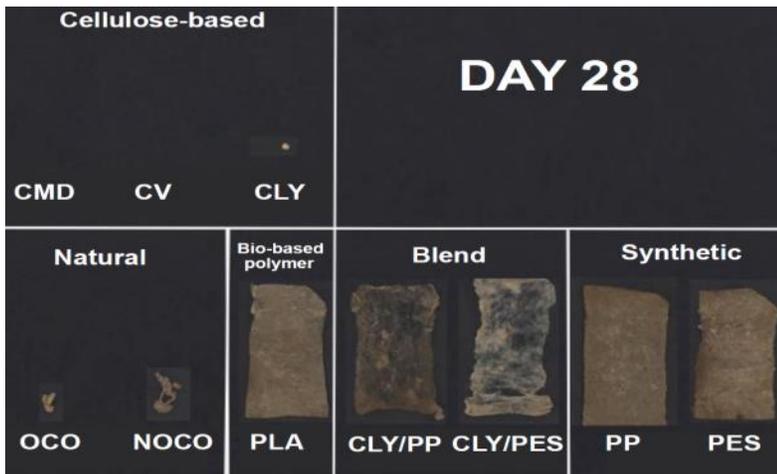
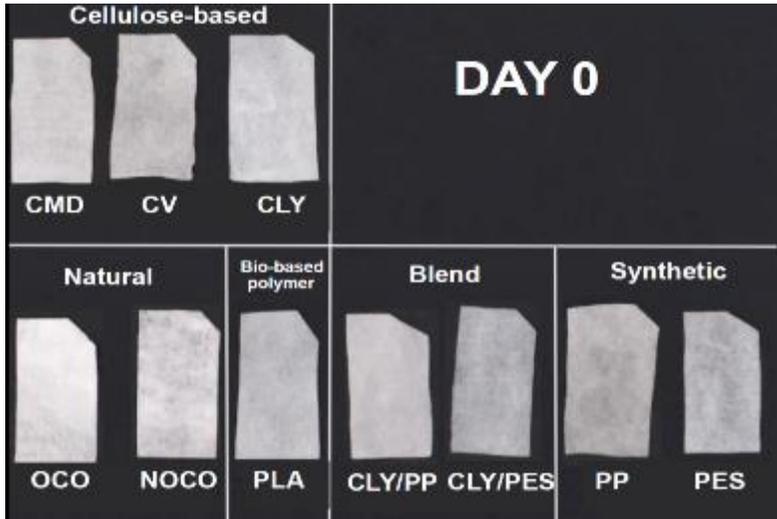
„It is not CO₂ that is at the core of the climate problem, but the additional fossil carbon that we take out of the ground and which gets released in the atmosphere as CO₂ or other emissions. If the inflow is prevented, the CO₂ content of the atmosphere will no longer increase.“

Michael Carus, May 2020

STOP
Fossil Carbon

Source: nova Institute

LENZING™ fibers – biodegradable, no microplastic



Take-home messages

- **Textiles**

- Lenzing's REFIBRA™ technology enables recycling of cotton scraps to textiles, without fibers to lose their superb properties
- Cooperation with Södra to enhance post-consumer recycling – fibers based on post-consumer waste with higher recycled content expected in the near future

- **Agricultural waste & yearly plants**

- TENCEL™ fibers with orange & hemp launched
- Fibers only available as limited editions in small volumes
- Feasibility of these feedstocks to be investigated in study of Wageningen University and Research

Alternative
raw
materials to
wood

Thank You

**& looking forward
to your questions...**



Back-up



Back-up – Literature sources

Cellulose from agricultural waste:

- **Banana peel** 7.5% cell¹, banana stem 64% cell², 120 mn t³ – **72 mn t** (60% waste¹⁰)
- **Sugar cane** (bagasse) 40-50% cell⁴, 279 mn t⁵ – **126 mn t**
- **Walnutshells** 22% cell⁶, 1 mn t⁷ – **550 kt** (55% shell¹¹)
- **Orange peel** 11,9% cell⁸, 75 mn t³ – **26 mn t** (35% waste¹¹)
- **Pineapple leaves**, 55-68% cell¹², **1.4 mn t** (76 mn t leaves¹³, 3% fiber – 2,3 mn t)
- **Apples pomace**, 17.7% cell⁹, 86 mn t² – **22 mn t** (26% waste¹¹)

¹ Industrial Crops and Products 2017,95,664-674 – [link](#)

² Bioresources 2006,1(2),220-232 - [link](#)

³ Global fruit production worldwide 2020 – [statistica](#)

⁴ Sugarcane – Technology and Research, doi: [10.5772/intechopen.71497](https://doi.org/10.5772/intechopen.71497)

⁵ Bioresources and Bioprocessing 2021, <https://doi.org/10.1186/s40643-021-00440-z>

⁶ Polymers, 2019,11(7),1130, <https://doi.org/10.3390/polym11071130>

⁷ Production of tree nuts worldwide 2021/2021 – [statistica](#)

⁸ Bioresources, 2014,9(2),1873-1885 – [link](#)

⁹ J Food Sci Technol 2019,56(9),4091-4100 – [link](#)

¹⁰ Molecules 2021,26(17),5285 – [link](#)

¹¹ www.weighschool.com

¹² Pineapple Leaf Fibers, Chapter 1 - [link](#)

¹³ www.eco.business.com

Cellulose from yearly plants

- **Bamboo** >50% cell¹, 20 mn⁸
- **Hemp** 40% cell², 153 kt/y⁷ in EU
- **Wheat straw** 29-40% cell³, 15 mn t/y⁴
- **Rice straw** 35% cell⁵, 650-975 mn t/y⁶

¹ Lenzinger Berichte 2021,96,6-18 – [link](#)

² internal report on hemp, otm, 2022 – [link](#)

³ internal report on straw pulp, Project [Horsens](#), gtj 2020

⁴ [Fibers 365](#)

⁵ Pulp and Paper Processing, 2017, DOI: [10.5772/intechopen.79014](https://doi.org/10.5772/intechopen.79014)

⁶ Biomass Conversion and Biorefinery, 2017,7(1),117-126 – [link](#)

⁷ Hemp production in the EU, 2019 – [EuropeanCommission](#)

⁸ Afr J Agric Res 2015,10(42),3977-3986 - [link](#)