Knowledge gaps and opportunities for R&D in the bio-based textile sector

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Bio-based textiles Expert Workshop on latest research findings, market trends and policy needs

June 26, 2024

Venue: European Commission - DG Research & Innovation
Orban building, room 03/78, Sq. Frère-Orban 8, 1000 Bruxelles, Belgium

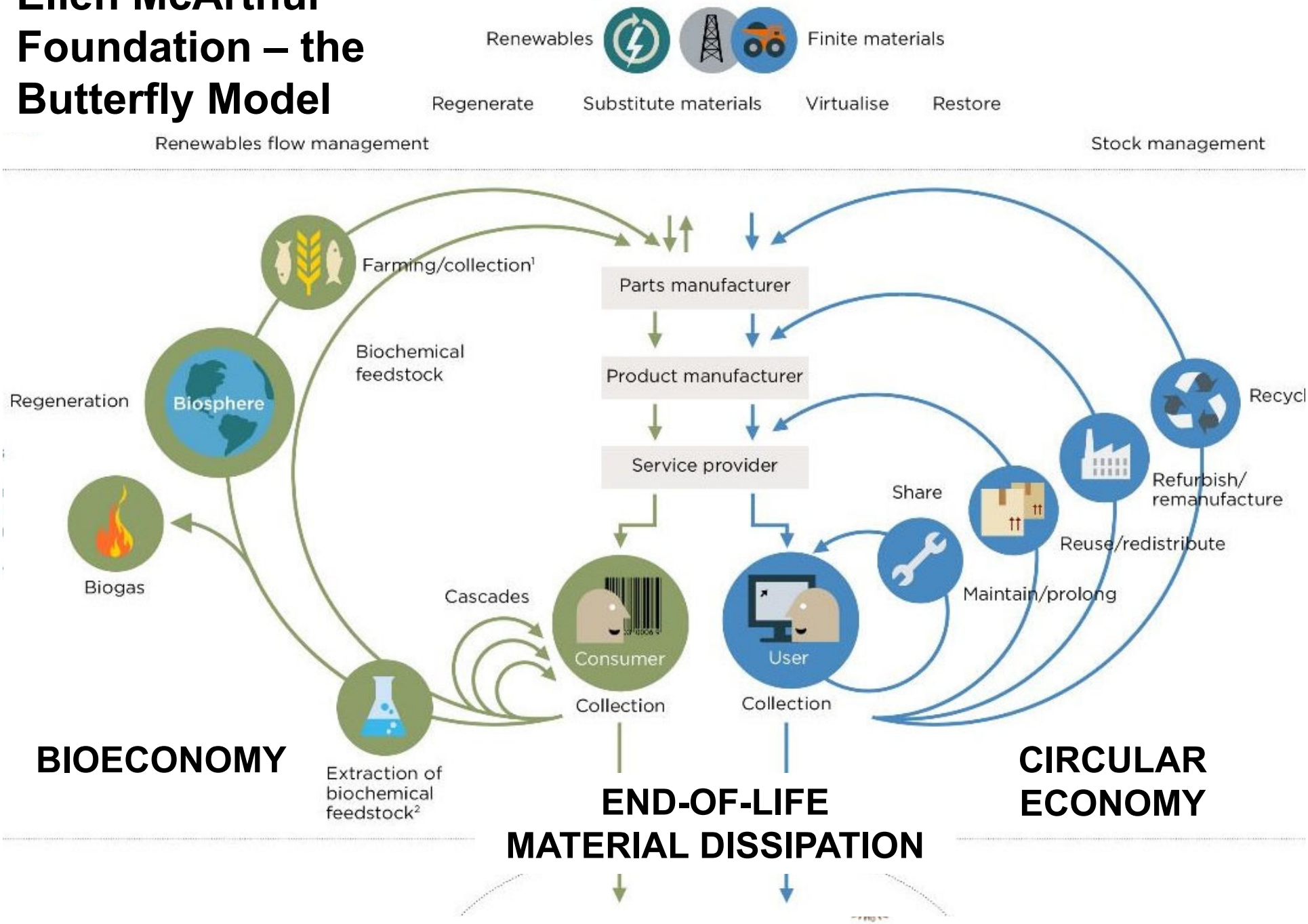
Bio-based textile fibre alternatives (excluding cotton, wool)

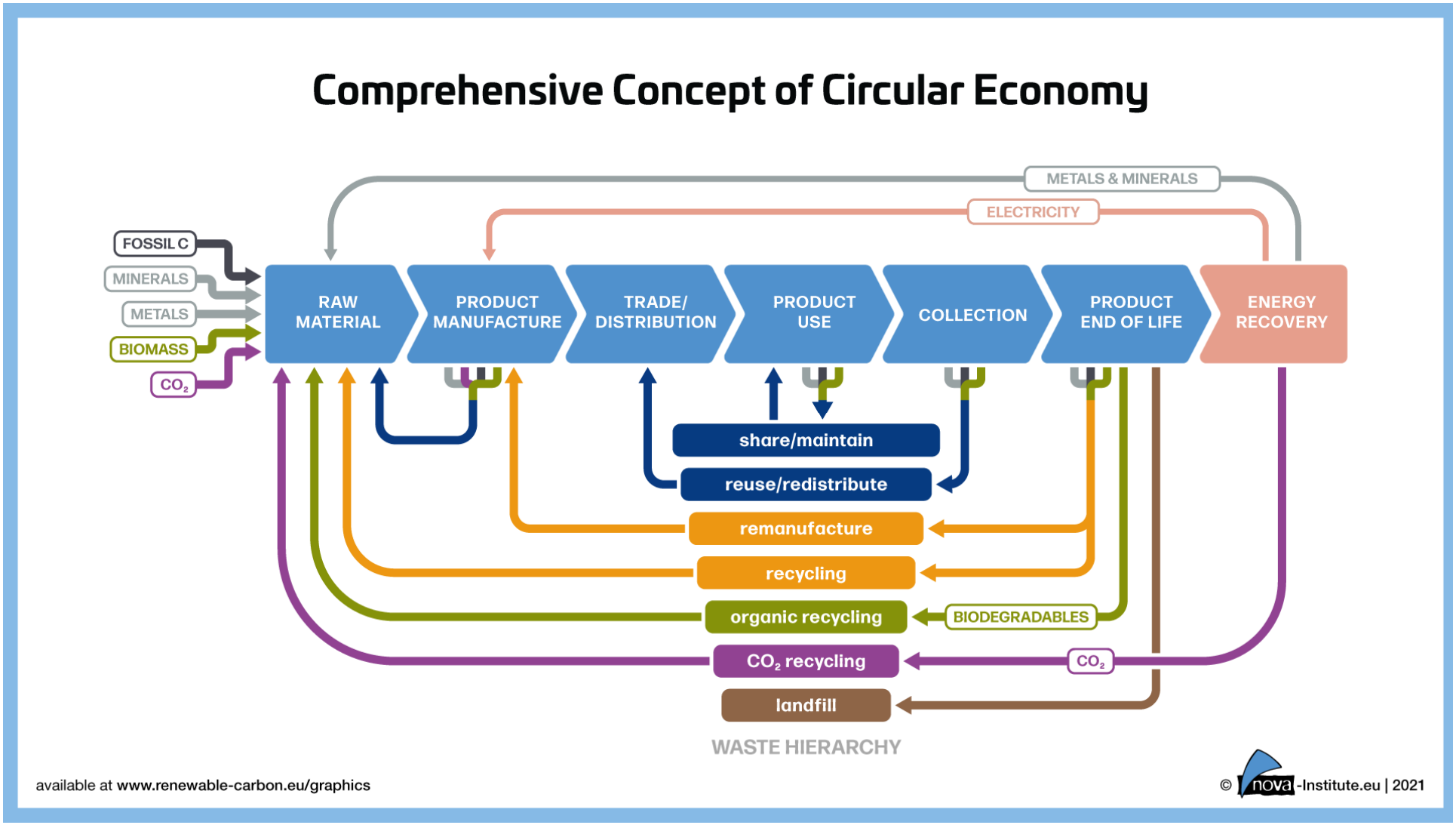
- Annual cellulose bast fibres:
  - Flax, hemp, jute,…
- Man-made cellulose fibres:
  - Viscose, Lyocell
  - Cellulose carbamate, cold alkali, ionic liquid
  - Microfibrillated cellulose
- Recycled end-of-life cotton and viscose fibres
- Bio-based synthetic polymer fibres:
  - Polylactic acid (PLA)
  - Partly biobased polyesters: PPT, PBT
  - Furandicarboxylic acid (FDCA) polyesters
- New fibres under development:
  - Polyhydroxyalcanoates (produced by microorganisms)
  - Protein based: casein, silk
  - CO_2 based polyesters

BIOPOLYMERS

Renewable bio-based fibres in the circular economy

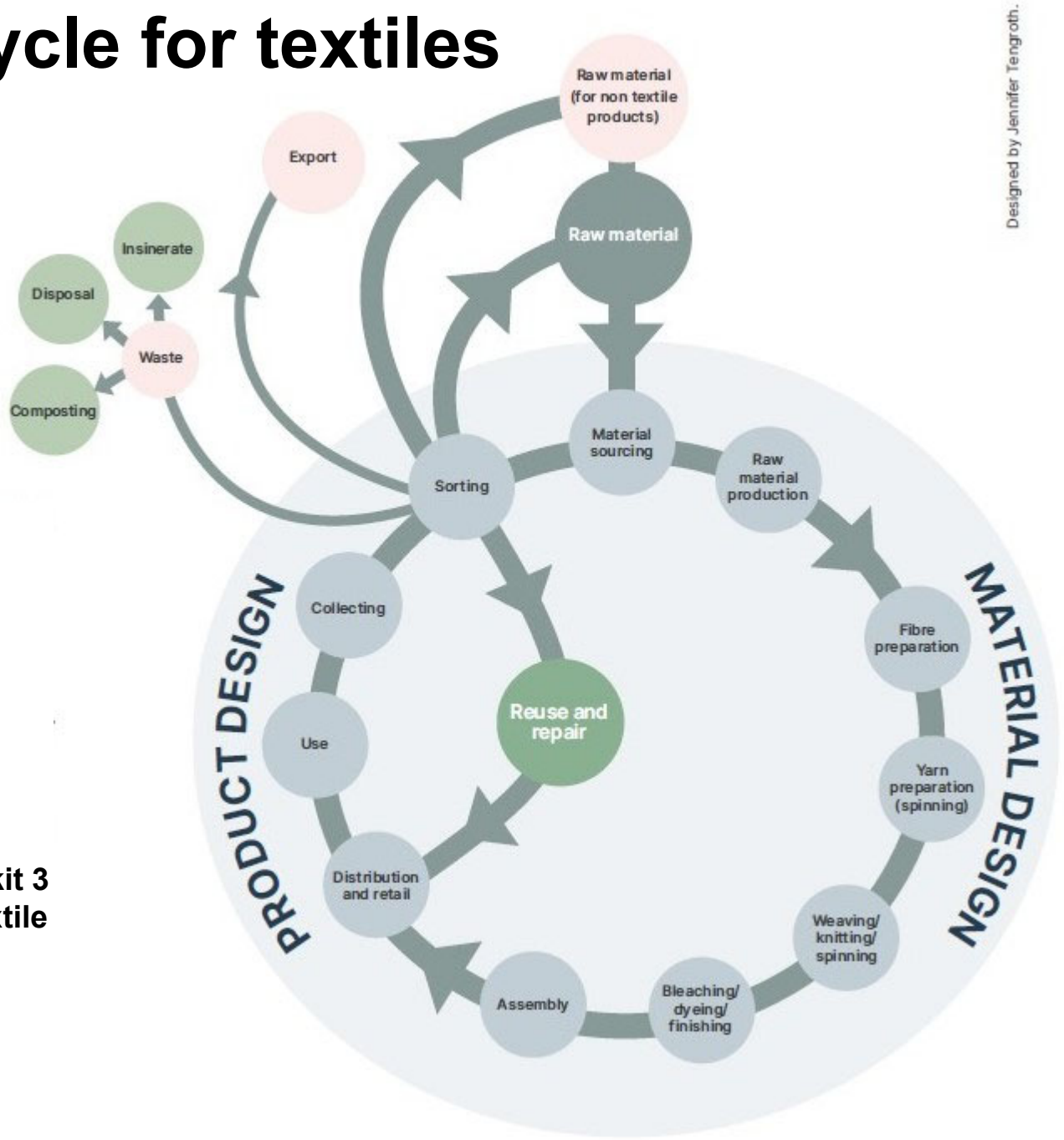
Ellen McArthur Foundation – the Butterfly Model





Source: Nova-Institute, http://nova-institute.eu/

Product life cycle for textiles



Source: Sustainable Fibre Toolkit 3 The Foundation for Swedish textile research - TEKO

MSK 20240609

Bio-based textiles value chain - overview

Natural fibres

- Annual plant bast fibres

Mechanical processing

Man-made cellulose fibres

- Viscose
- Lyocell
- Cellulose carbamate
- Cold alkaline
- Ionic liquid

Chemical processing

Bio-based synthetic polymer fibres

- Polylactic acid (PLA)
- Partly biobased polyesters: PPT, PBT
- Furan dicarboxylic acid (FDCA) polyesters

Large scale polymer processing and fibre melt extrusion

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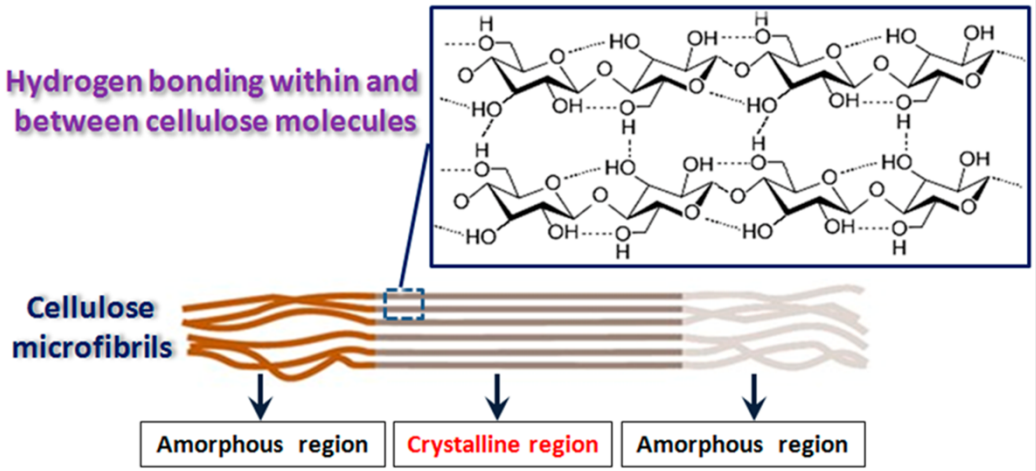
Biopolymers – the alternatives

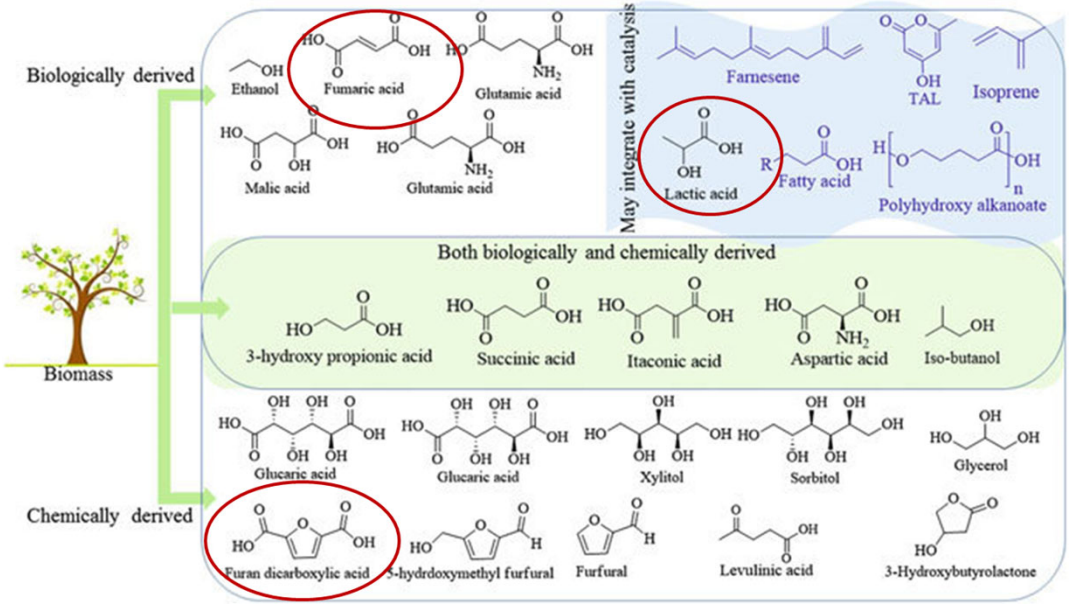
Extract polymers from biomass

carbohydrates, proteins, PHA polyesters, lignin



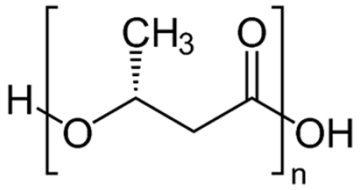
Extract chemicals from biomass and convert to polymers

lactic acid, plant oils, dicarboxylic acids

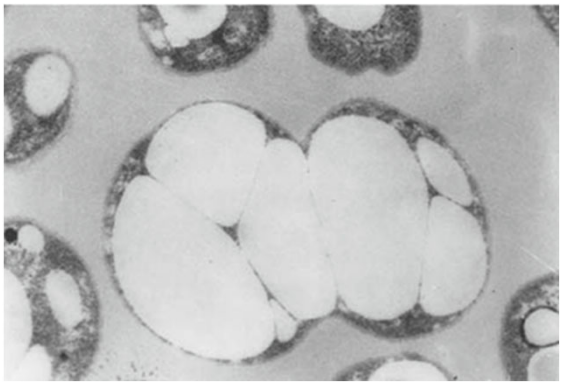


Biopolymers – the alternatives

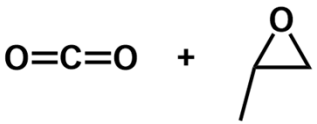
Polymers produced by microorganisms



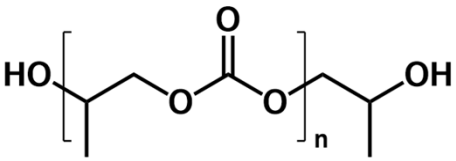
Polyhydroxyalcanoate polymers, (PHA)



Use CO_2 as carbon source for polymers



Carbon dioxide



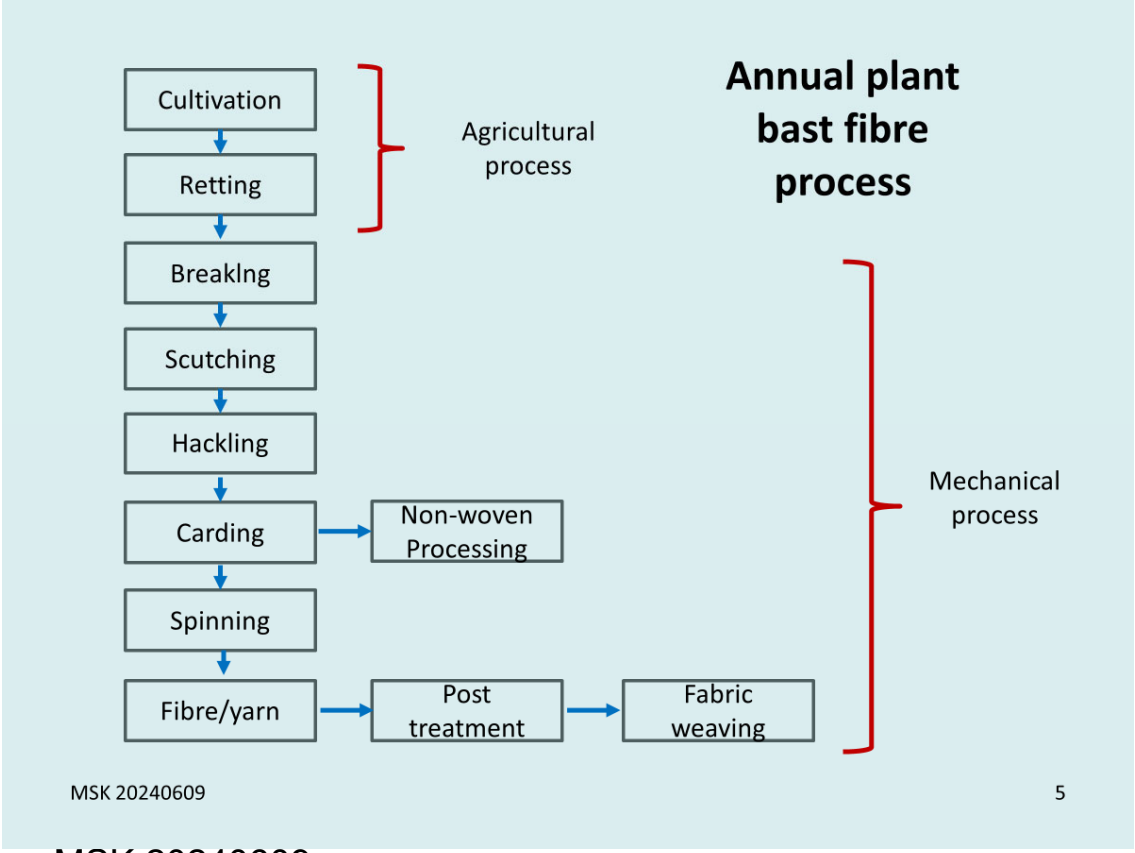
Carbonate polymer

Requires carbon capture and utilisation (CCU)

Annual cellulose bast fibres

Flax, hemp, jute,…

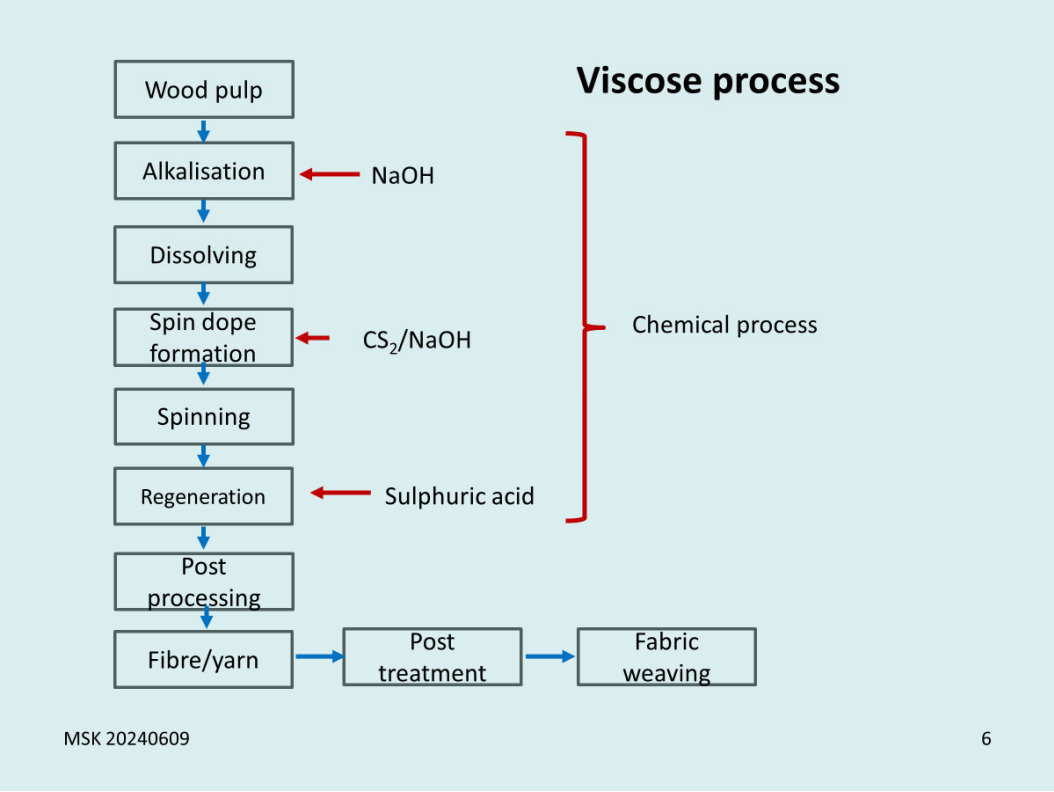
A mechanical process involving many steps, labour intensive, long historical use



Man-made cellulose fibres

Viscose

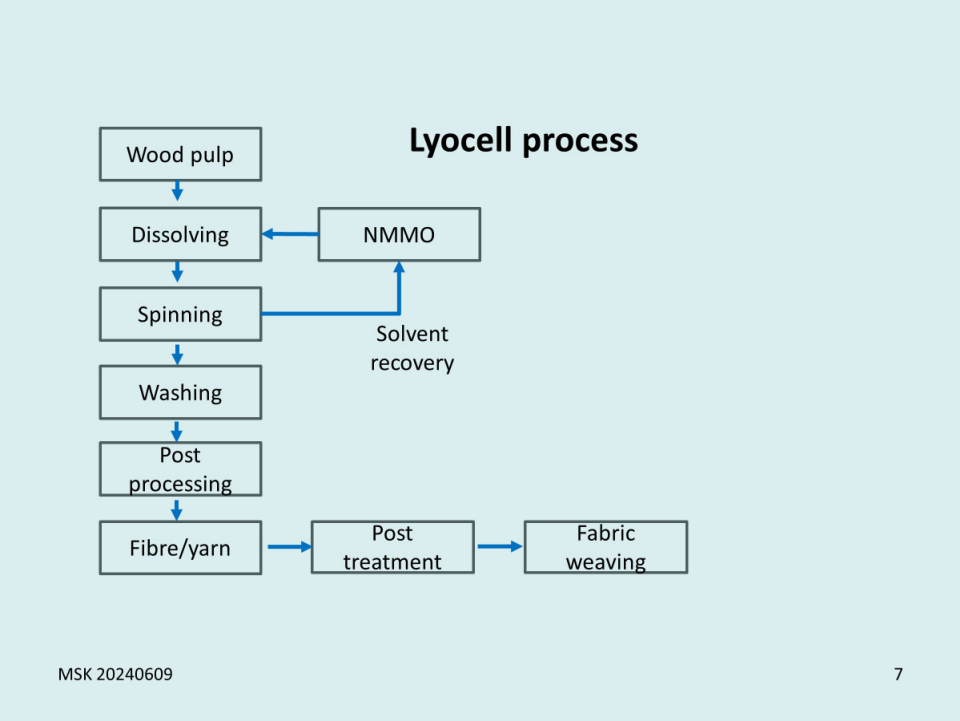
A chemical process involving dissolving and regeneration, in use scince 1893

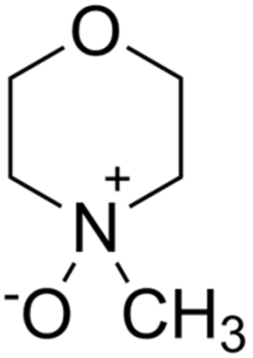


Man-made cellulose fibres

Lyocell

Cellulose dissolving by solvent and fibre precipitation



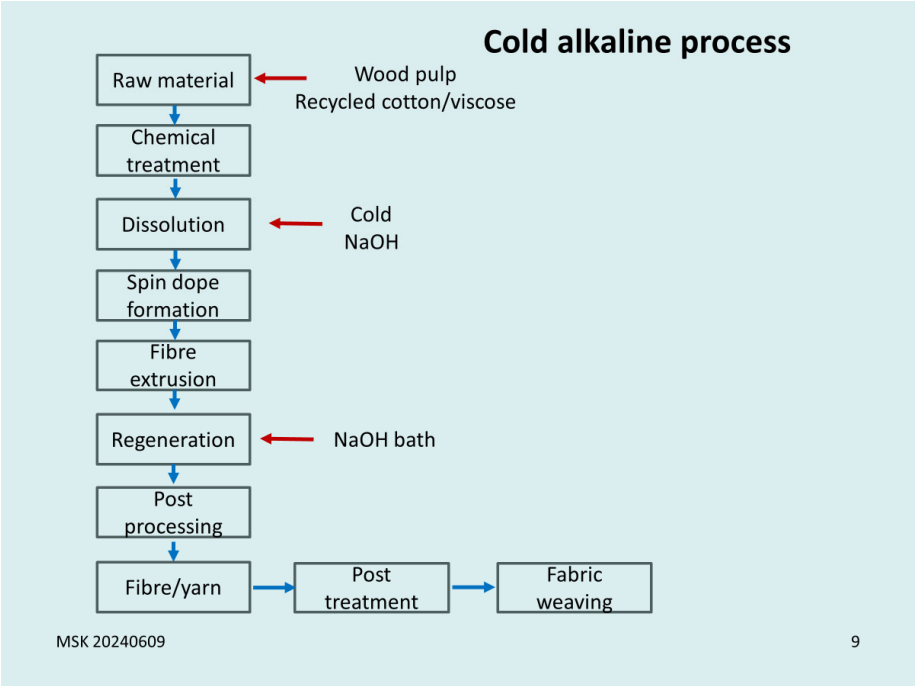


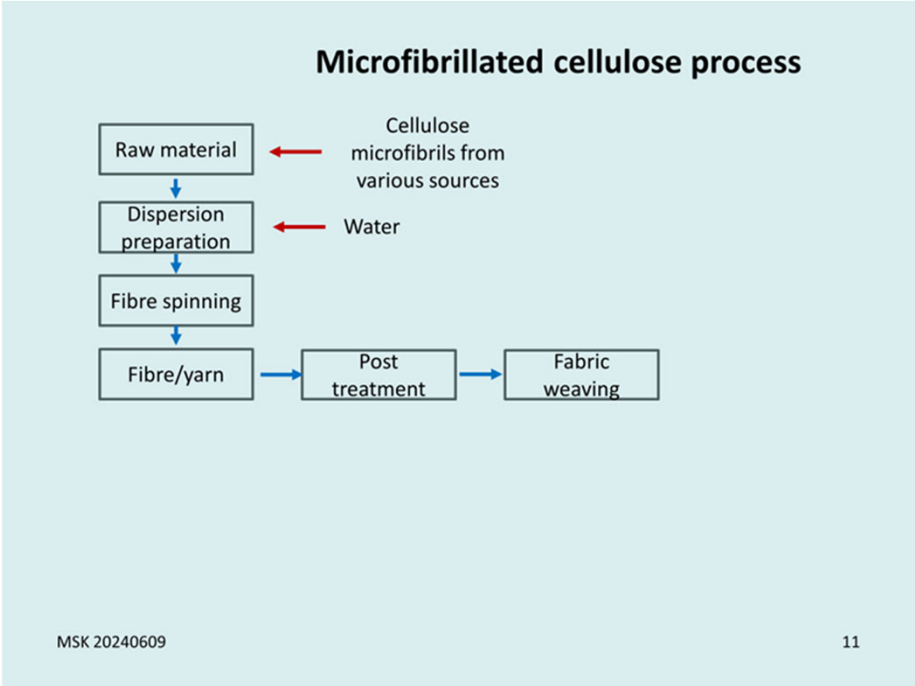
NMMO

Man-made cellulose fibres – new developments

Cold-alkaline process, cellulose carbamate process, ionic liquid process, microfibrillated cellulose process

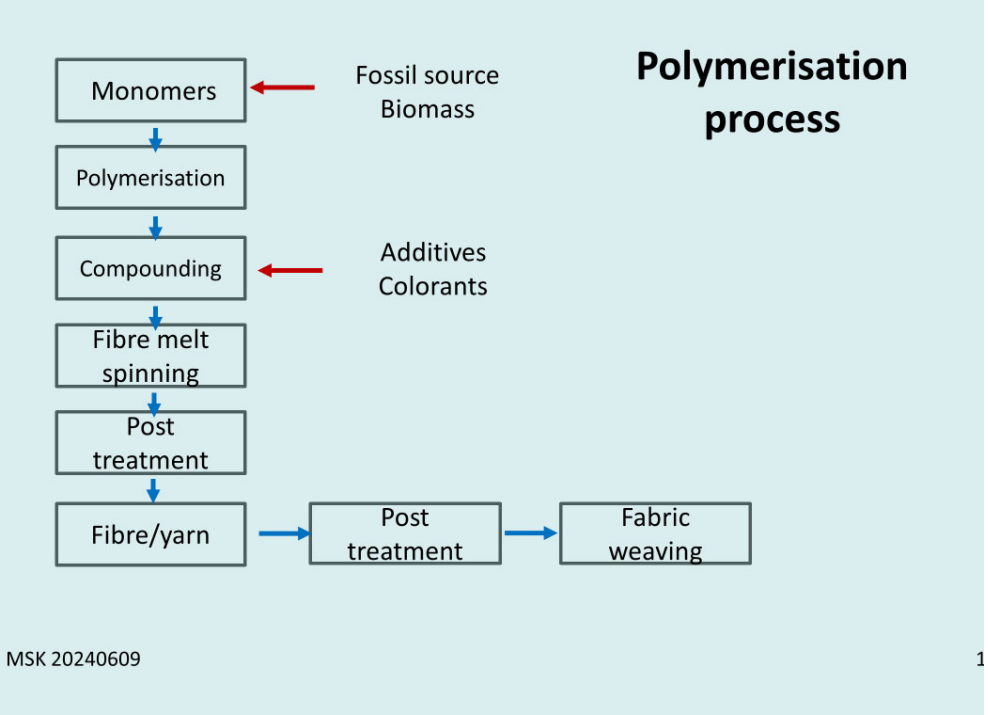
Chemical and mechanical processes, recent commercial introduction
Recycling of end-of-life textiles one driving force for development

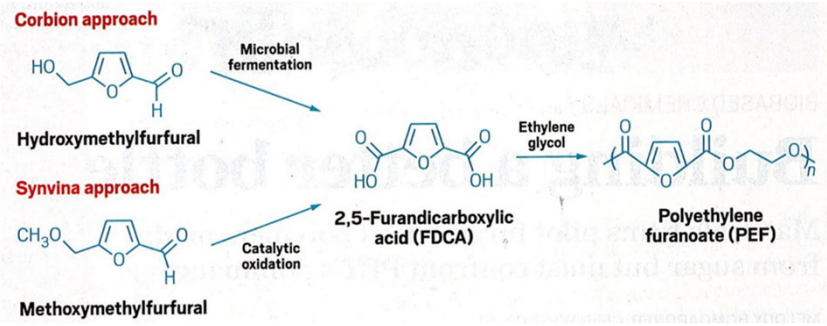




Synthetic biopolymer fibres

Polylactic acid (PLA), FDCA polyesters, PBT/PPT polyester,
Polymerisation of biomonomers, can be partly of biobased origin
Melt spinning extrusion into filaments
Biomass waste streams can be used for monomers





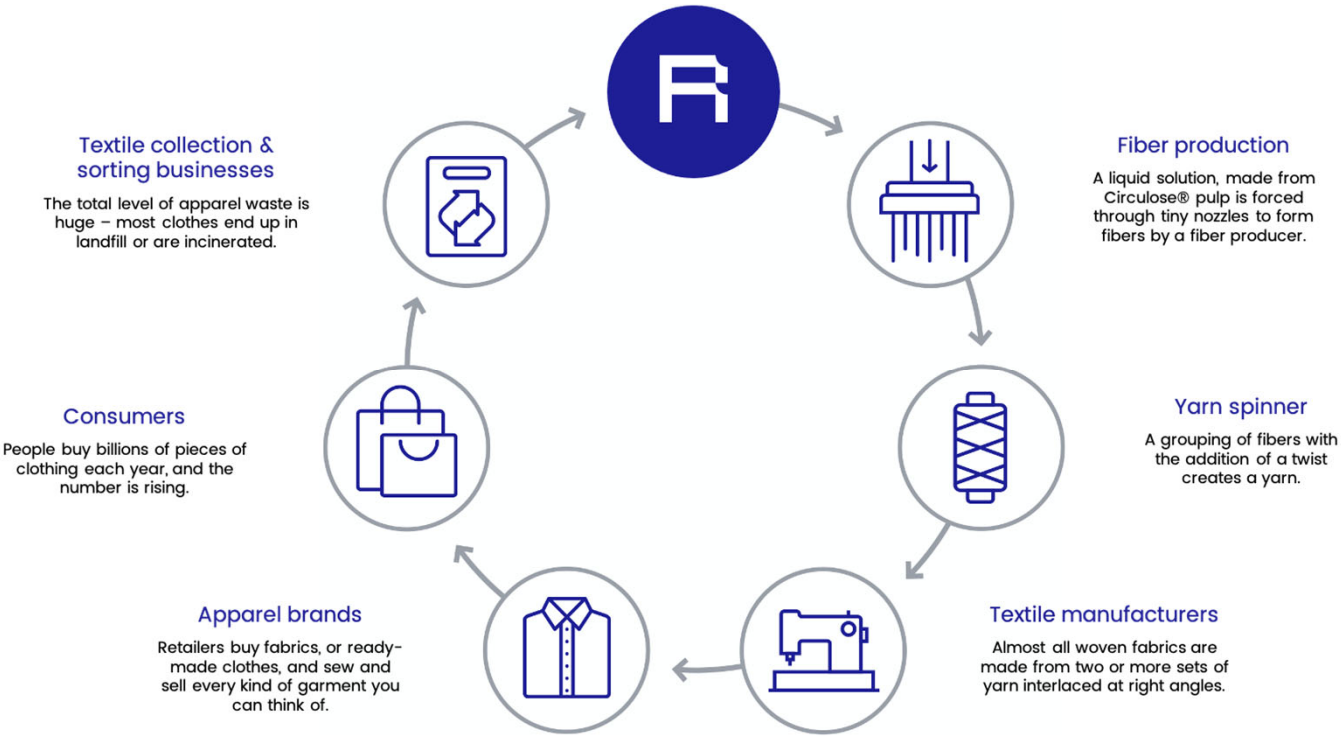
Value chains – Bio-based fibres

Characteristics to consider:

- Very different process steps depending on fibre type
- Huge variation in time of industrial introduction – from historical times to very recent times
- Large variations in production scale and production rates
- Production investment costs varies for different bio-fibres
- Environmental impact is different, and can be related to different stages in the value chain
- Can be very manual labour intensive, or highly automatized
- Process technology level can vary from rather simple to very advanced
- Can be integrated in other industrial production or can be on its own

New material technologies and concepts

Renewcell – Circulose dissolving pulp made from 100 % recycled textiles



Allows alternative production of regenerated cellulose textile fibres (Viscose, Lyocell) without using wood

End of life textiles can be recycled to new textiles

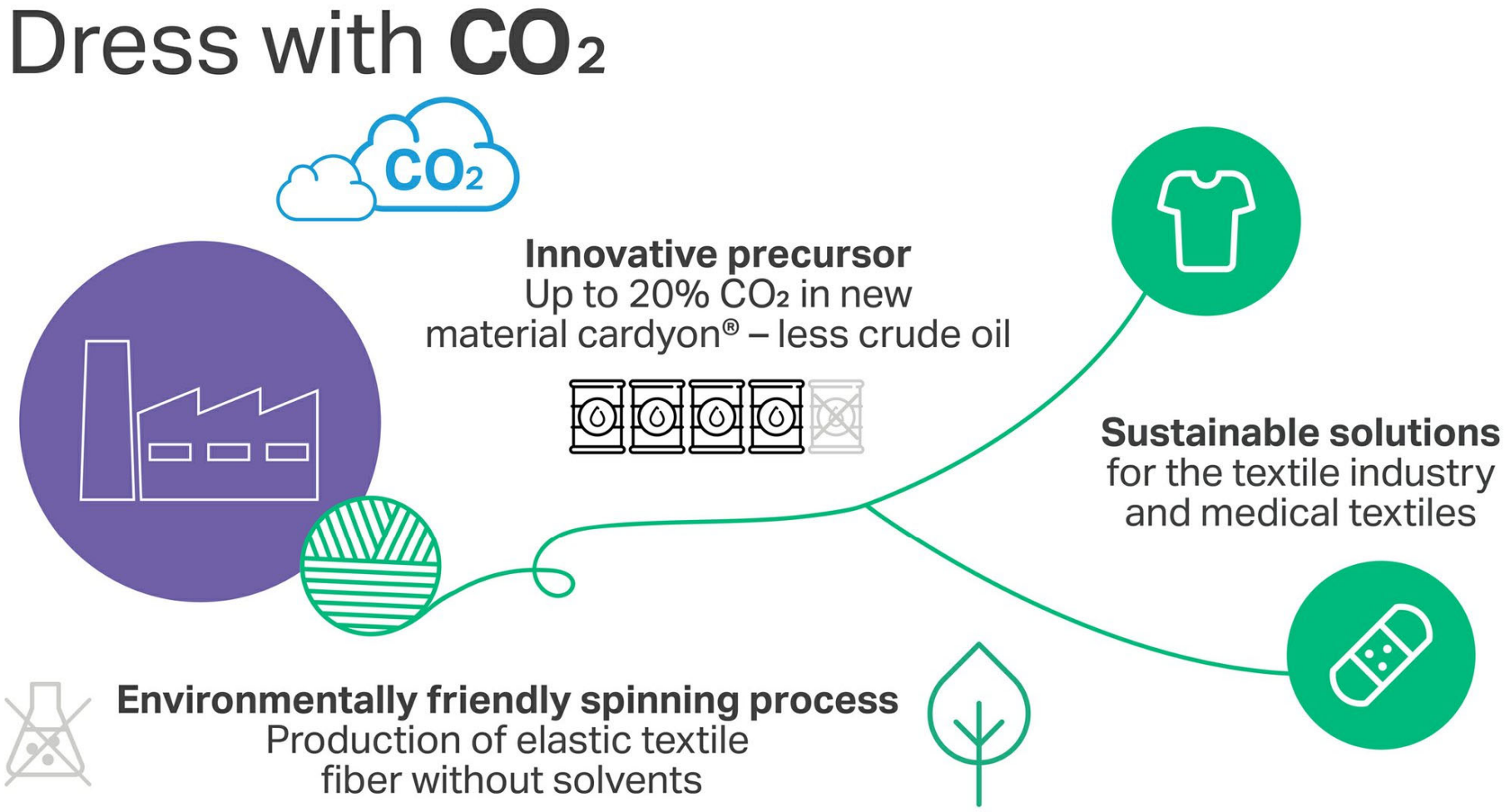
www.renewcell.com www.circulo.se

Waste and end of life products is seen as a material source – Pure Waste

Pure Waste – manufacturer of yarns, fabrics and garment made from 100 % recycled materials

www.purewaste.com

Covestro: Yarns from carbon dioxide – Cardyon®

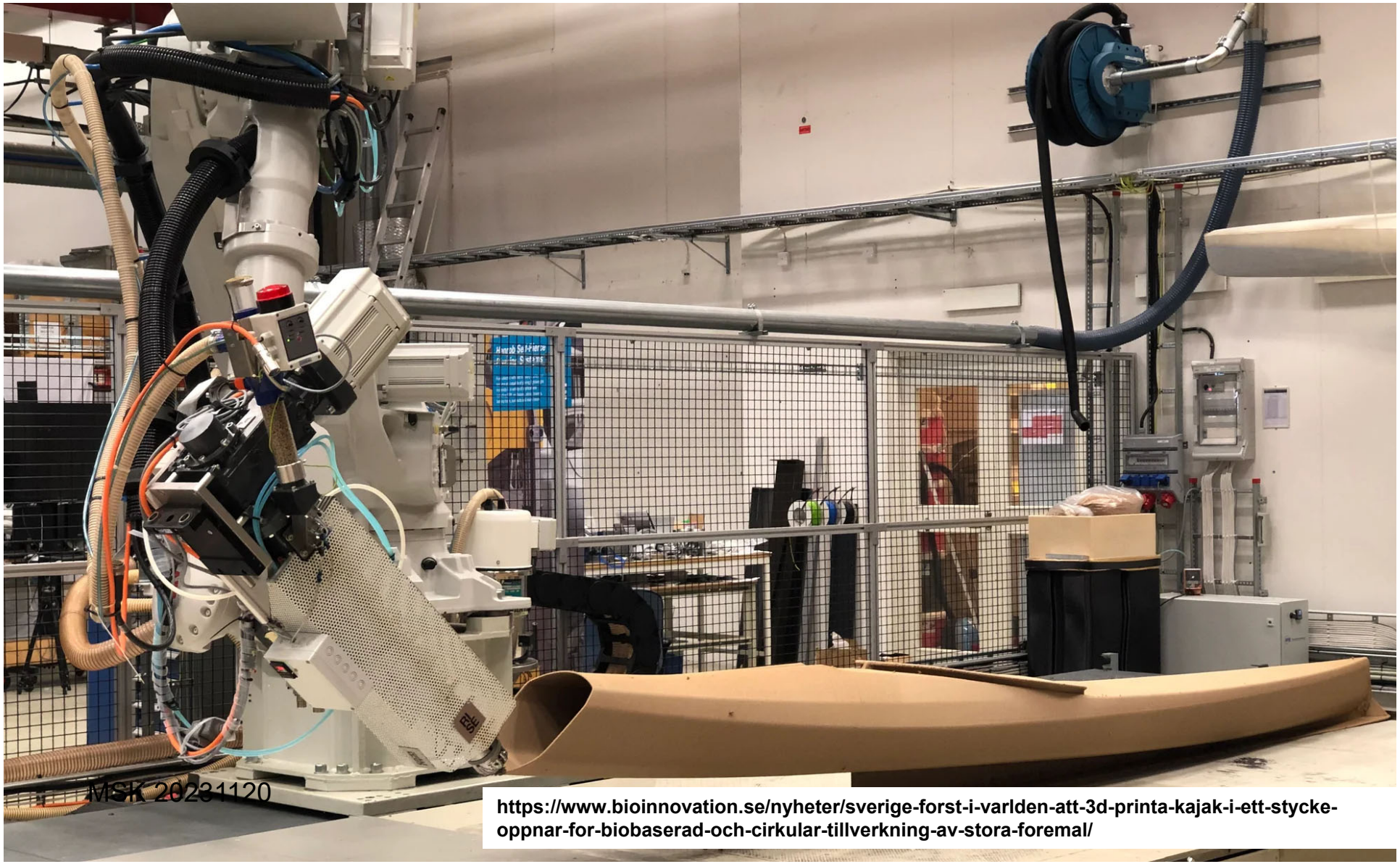


https://interplasinsights.com/covestro-develops-elastic-textile-fibres-made-from-carbon-di/

JEC Exhibition, Paris, April 2023
Natural fibres in composites

Emerging technologies – Additive manufacturing

3D printed kayak - Recycled plastic reinforced with wood fibre by Biofiber Tech, Melker of Sweden and RI.SE



MSK 20231120

https://www.bioinnovation.se/nyheter/sverige-forst-i-varlden-att-3d-printa-kajak-i-ett-stycke-oppnar-for-biobaserad-och-cirkular-tillverkning-av-stora-foremal/

Biomimetics – traditional and modern technical material solutions

http://www.educapoles.org/multimedia/picture_gallery_detail/arctic_people/1

https://www.npmarathon.com/polar-clothing

Challenges for bio-based textiles – to be discussed:

1. Resources and raw materials for bio-based textiles
2. Technology for conversion from raw material to textile
3. Production infrastructure and value chain from raw material to end-product
4. Fibre properties according to customer demands and market specifications
5. Existing or developing market demand with end-use customers
6. End-of-life handling methods and strategies
7. Position in the circular economy system
8. Market value and feasibility, end-use product costs

RÅS

Thank you for the attention!

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February 9, 2022

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