Life cycle instruments for sustainable textiles

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Let me introduce myself

Who am I?

- I am a PhD student in Environmental Engineering at Politecnico di Milano
- My research group name is AWARE (Assessment on Waste and Resources)
- My research is focused on the management of textile waste in a life cycle perspective
- In my PhD research I collaborate with Regione Lombardia, so I am interested in the role that public policies can have in the circular economy framework

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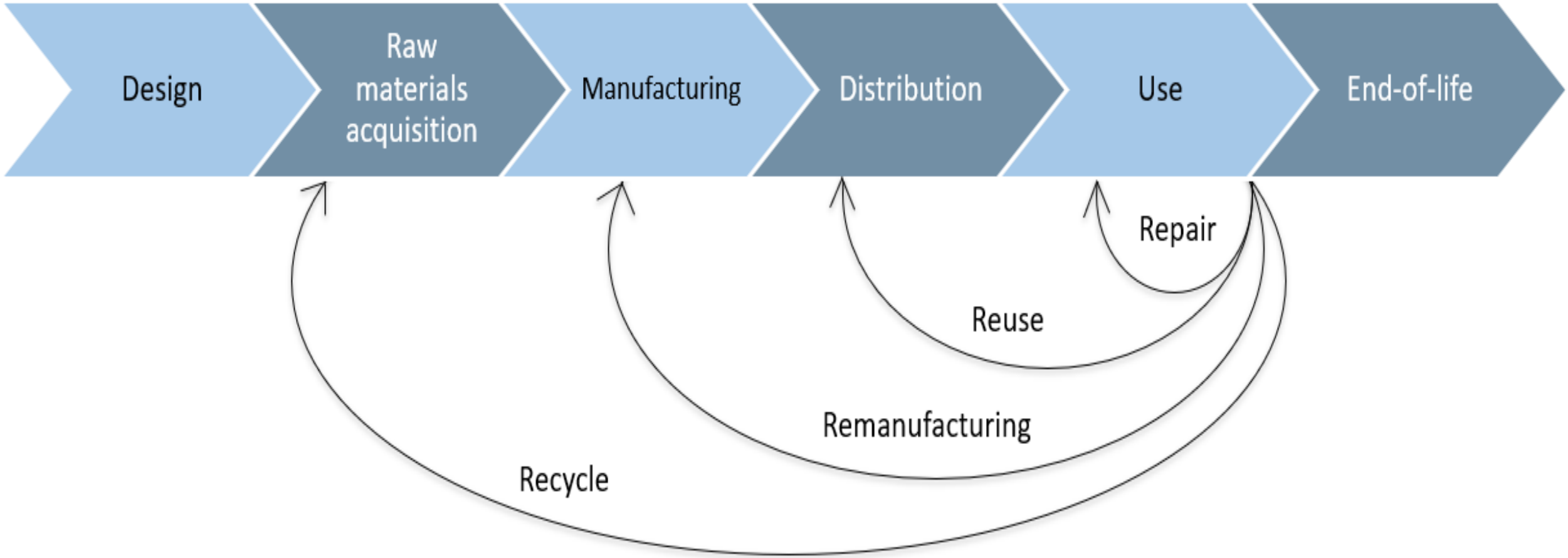
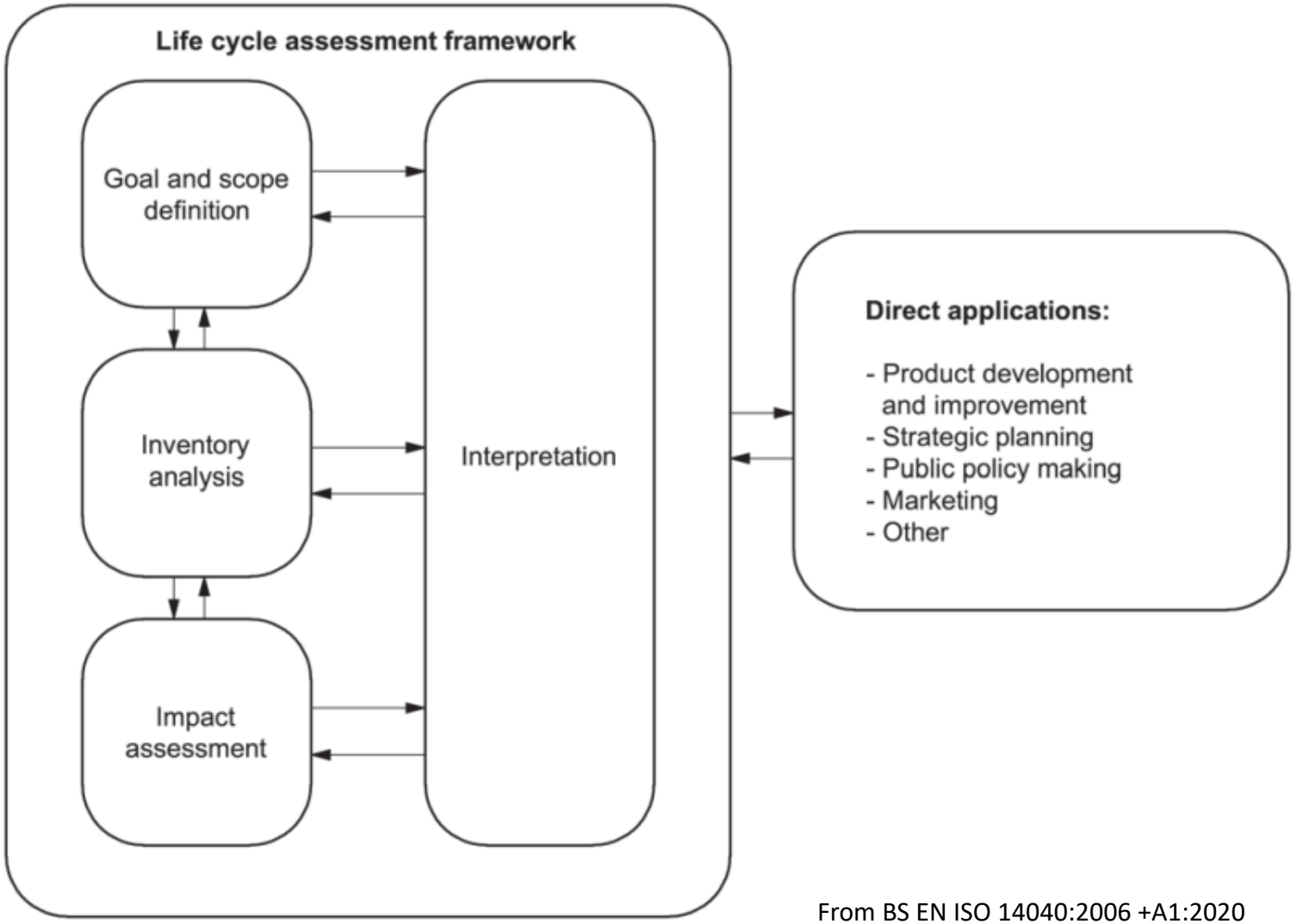
What is life cycle thinking (LCT)?



Sustainability: environmental, social and economic point of view

Life cycle assessment (LCA)



From BS EN ISO 14040:2006 +A1:2020

- **Standardised methodology**: ISO 14040, ISO 14044
- Systems of **indicators**: different impacts categories to **avoid burden shifting**
- Software and databases
- **Data** collection from different levels: primary data, data from literature studies, data from databases and estimated data

Textiles: challenges in a world of complexity

Global supply chain and difficulty in the traceability of the products

Environmental and social impacts of the textile industry

Fast fashion

Challenges for textile waste management: high variety of fibres and different qualities of discarded textiles

How can we apply LCT to textiles?

Article

Environmental Consequences of Closing the Textile Loop—Life Cycle Assessment of a Circular Polyester Jacket

Gregor Braun *, Claudia Som, Mélanie Schmutz and Roland Hischier

LCA on a product

LCA on a specific life cycle stage

Reducing environmental impacts from garments through best practice garment use and care, using the example of a Merino wool sweater

Stephen G. Wiedemann[1] · Leo Biggs[1] · Quan V. Nguyen[1] · Simon J. Clarke[1] · Kirsi Laitala[2] · Ingun G. Klepp[2]

LCA about different business models

Life cycle assessment of clothing libraries: can collaborative consumption reduce the environmental impact of fast fashion?

Bahareh Zamani [a], Gustav Sandin [b, *], Greg M. Peters [a, c]

LCA about waste management system

Environmental assessment of end-of-life textiles in Denmark

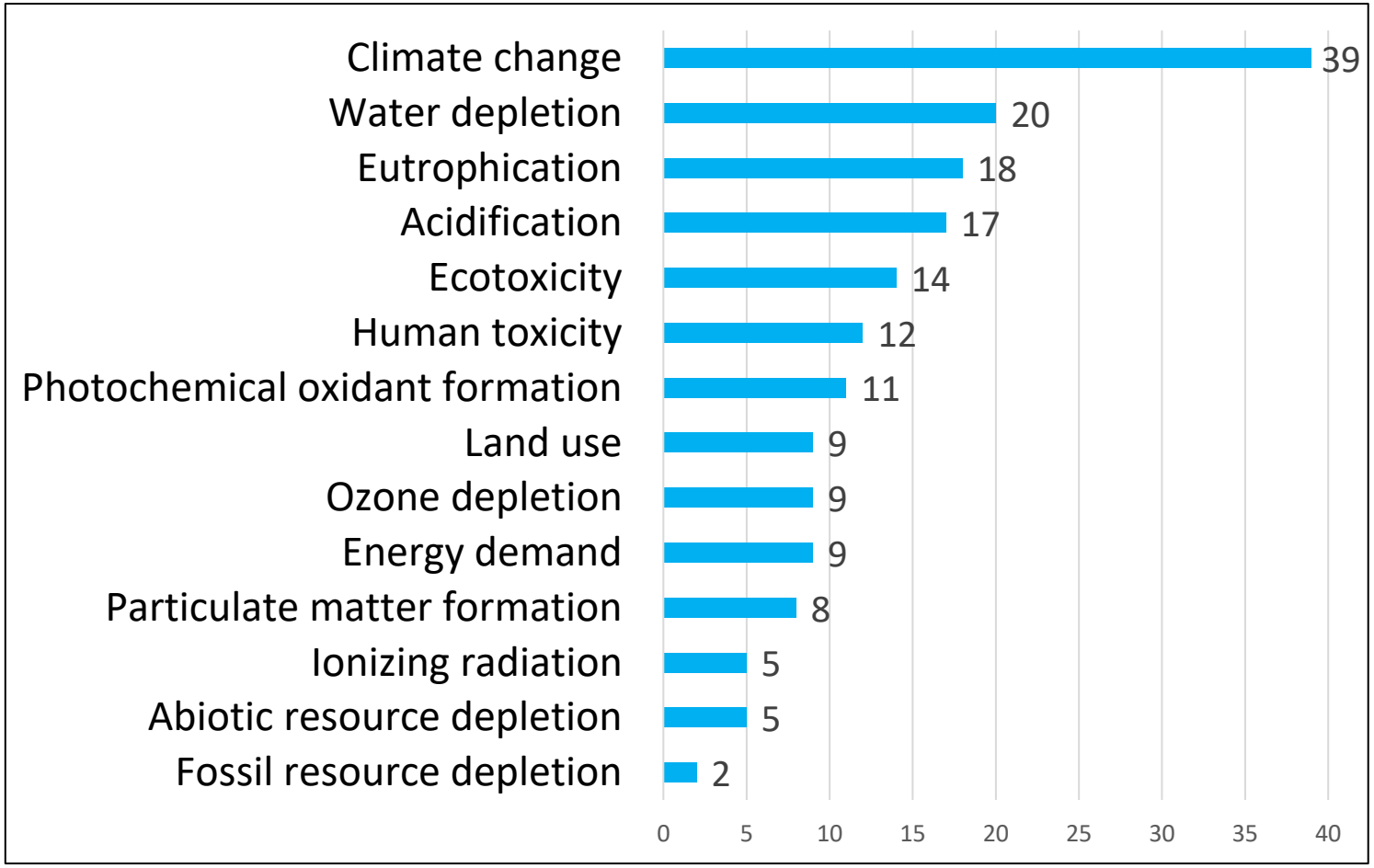
Athina Koligkioni[a]*, Keshav Parajuly, Birgitte Liholt Sørensen, Ciprian Cimpan

LCA of textile waste management

Review of 40 papers about LCA on textile waste management and circular economy practices

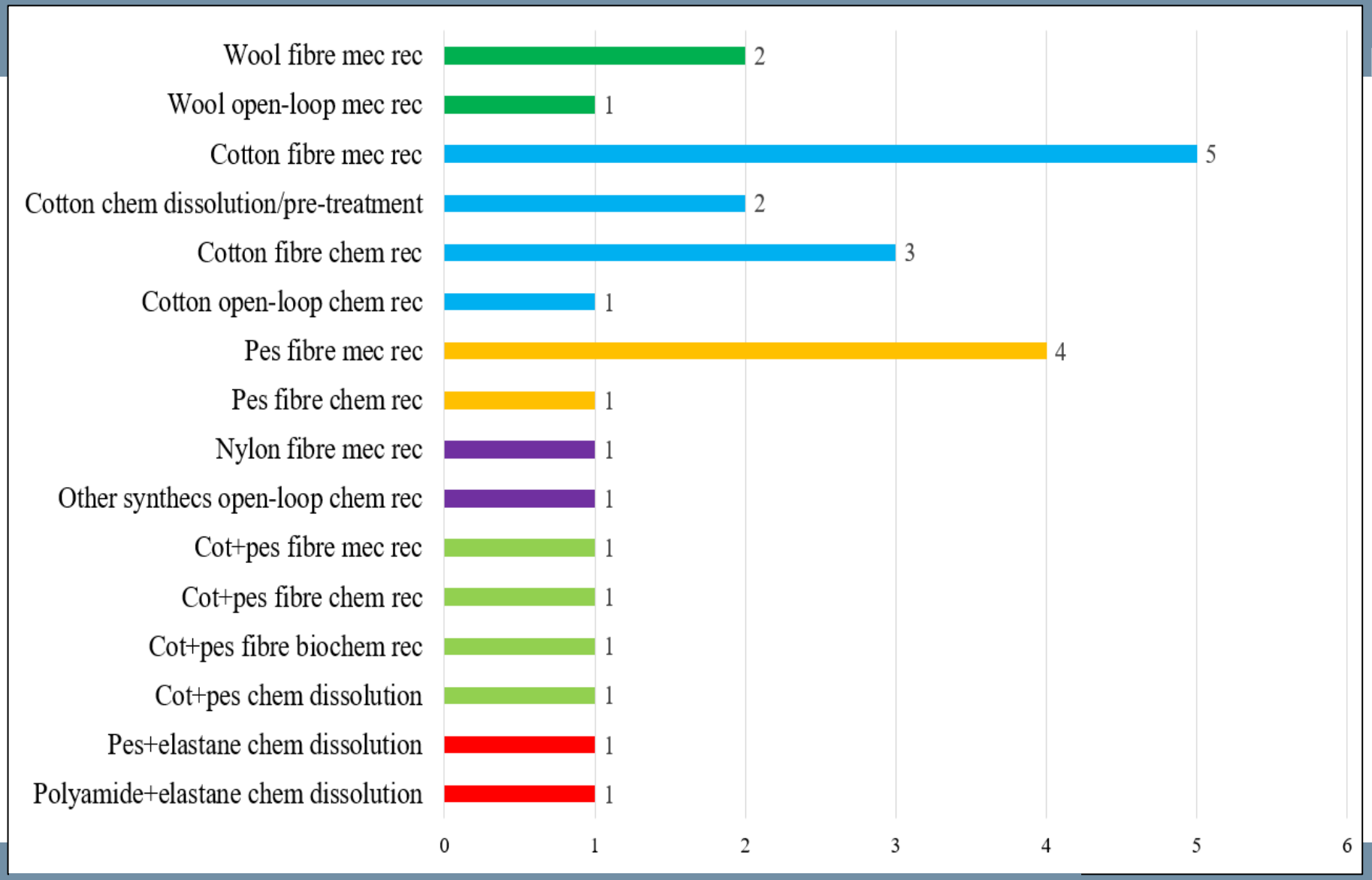
Goal and scope of the publications	N° of papers
Assess the environmental impacts of the **textile waste management system of a country**	8
Assess the contribution to the impacts of the **textile fraction in municipal solid waste (MSW) treatment**	4
Assess the environmental impacts of **specific recycling processes**	19
Assess the impacts of **different circular economy practices** applied to textile products (examples: reusable vs disposable products for healthcare, sharing platforms, reuse, recycling, good practices during the use phase)	9

Impact categories in the reviewed publications



LCA studies should cover an high number of impact categories to **avoid burden shifting**.

Recycling processes in the reviewed publications



The type of recycling process depends on the type of textile fibres.

Textile waste composition highly affects its fate and its environmental impacts, because each treatment has different impacts.

Research questions (RQ)

RQ1: what are the best options for a country to manage textile waste?

Reuse allows to save more impacts than recycling, but the two operations should be **integrated** because they are addressed to different waste quality.

RQ2: what is the contribution of textiles to environmental impacts when compared to the other MSW fractions?

Separate collection of textile waste followed by reuse and recycling saves several impacts: **when incineration is considered as end-of-life, only plastics result worse than textiles** for climate change.

RQ3: what are the effects of the recycling processes on the environmental impacts of textiles?

In general, **recycled fibres have lower impacts than virgin ones**, with some exceptions. The hot spots are usually the most energy intensive steps of the processes.

Research questions (RQ)

RQ4: what is the contribution that different circular economy practices can have on the lifecycle impacts of a textile product?

Most of the environmental benefits are given by the actions that **extend the service life of a textile product** (best practice during use phase, higher number of wearing events).

RQ5: what are the main variables that influence environmental impacts in LCA studies about textile waste management?

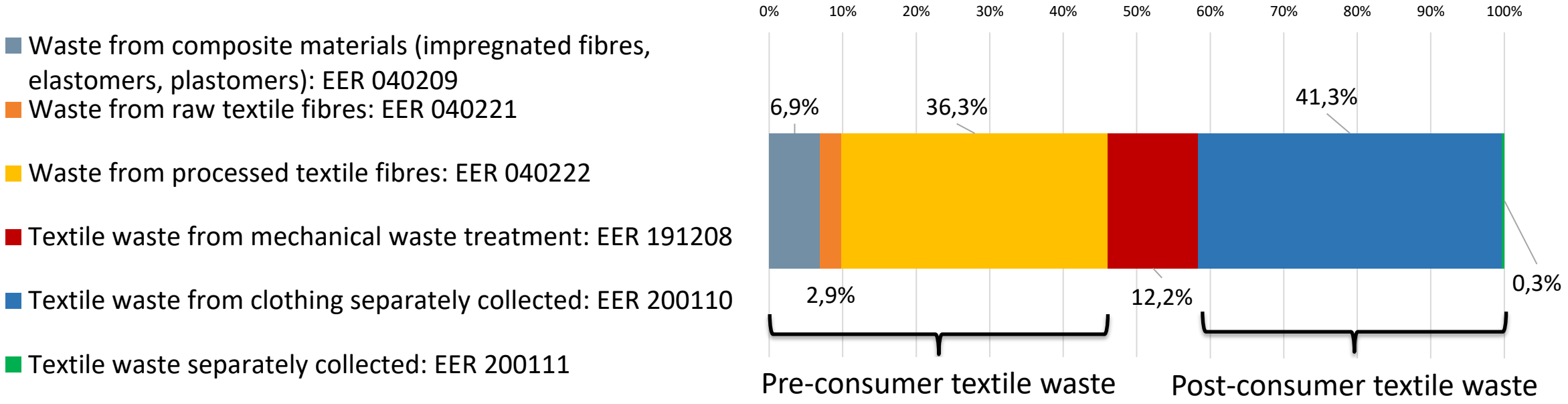
- Textile waste **composition**
- **Recycling process parameters** (yield, chemical and water demand)
- **Use phase** modelling
- **Virgin production** modelling for replaced products
- **Substitution factor** for reuse
- **Transportation** process modelling for **sharing business models**.

LCA applied to textiles waste management

1. Material flow analysis (MFA)
   - What
   - How much
   - From where
2. Analysis of the composition
   - Collected textiles quality
   - Fibre composition
3. Data collection from plants and companies
   - Waste management processes
   - Energy and material consumptions associated to the processes
4. Impact assessment and cost analysis
   - LCA model to calculate impacts
   - Indications about costs (EPR schemes)

What kind of textiles waste? How much? From where?

Textile waste in Lombardy in 2021



Analysis on post-consumer textile waste:

- **Source** of the waste: 86% is waste collected by municipalities
- **Extra-regional fluxes**: 14% of waste comes from other italian regions
- **Operators**: 7 operators/plants out of 71 declare to manage the 78% of the total waste
- **Type of operation** on the waste: 65% of the waste is stocked waiting other operations (R13), 30% is addressed to material recovery (R3)
- **How much**: 4.2 kg/inhabitant in 2021

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AWARE
Assessment on WAste and REsources

Regione Lombardia

Tanks for your attention

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