Textiles and Environment – Impacts, Hotspots and Sustainability

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Introduction

Background: The textile industry is associated with a large environmental footprint generating about 10% of global greenhouse gas (GHG) emissions. Life Cycle Assessment (LCA) can be used to quantify the environmental impacts associated with each stage of a textile product's life cycle, from raw material extraction to disposal. LCA can also be used to evaluate circular economy strategies, such as recycling and prolonged use.

Aim: This poster presents a synthesis of LCA applications of textile products made from natural and fossil-based fibres, as conducted by ifeu in the past years. It illustrates the environmental hotspots along the textile life cycle, including the provision of fibres, yarn and textile production, use, and disposal. In addition to the climate change impact, the studies cover other relevant environmental impact categories, such as water and land footprint.

Method: Screening-type life cycle assessments follow the international ISO 14040 and 14044 standards for Product Life Cycle Assessment and consider the environmental impacts of all input and output flows throughout a product's entire life cycle (cradle to grave). LCA consists of four main phases (Fig. 1). A key principle of LCA is life cycle thinking, which accounts for hidden and unintended environmental impacts and includes co-products coming from the same unit process or product system.

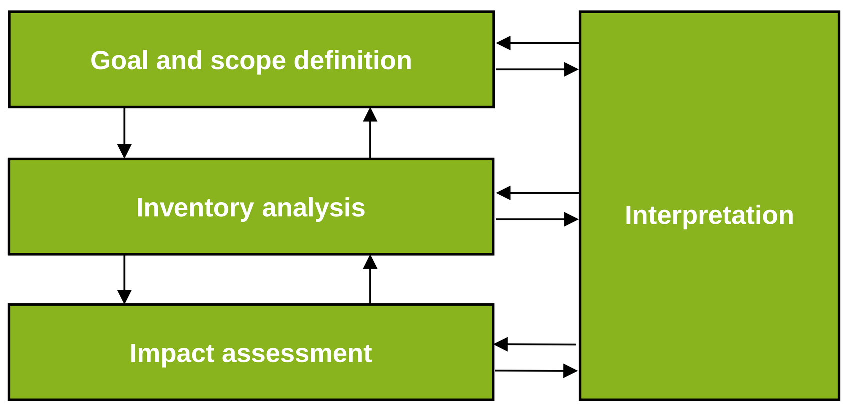


Fig. 1: *Stages of an LCA (ISO, 2006).*

Life cycle assessment of textiles

Selected results

The environmental impact of fibres

- Cotton fibres tend to have a lower carbon footprint than viscose and polyester (PES), but a higher water and land footprint (Fig. 2).
- The environmental impact of cotton production varies greatly depending on factors such as yield and water scarcity.

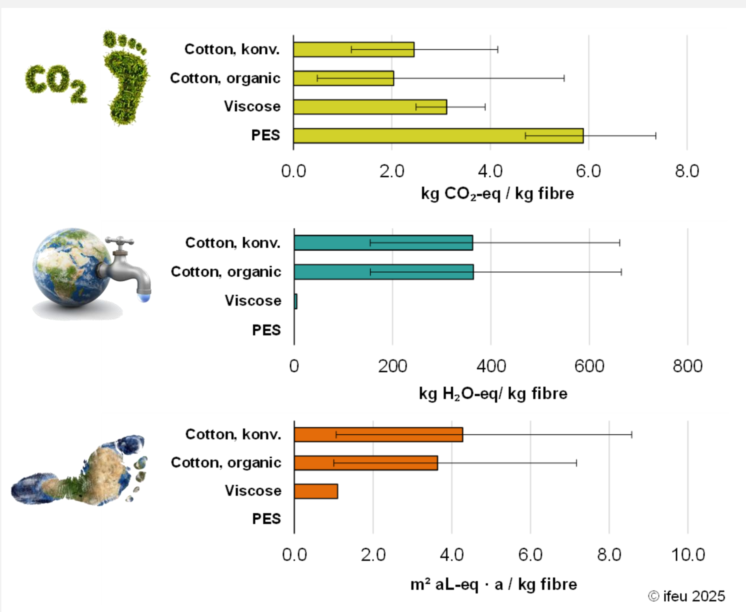


Fig. 2: *Environmental footprints of conventional and organic cotton, viscose, and polyester (PES) (Senn et al., 2022; ifeu, unpublished).*

The impact of recycling

- The environmental performance of recycling depends on the type of the fibre being replaced and the amount of energy consumed during the process (Fig. 3).
- Effects on other life cycle stages must be considered, such as on spinning and durability.
- New projects on textile recycling are ongoing, such as “ÜBER-AUS” and “The Key”.

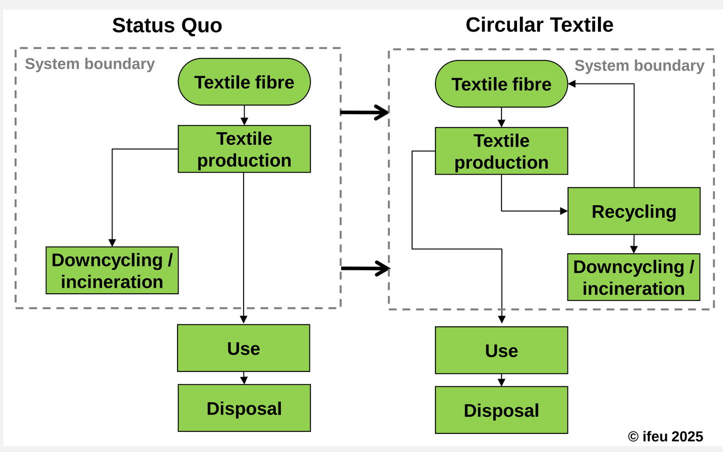
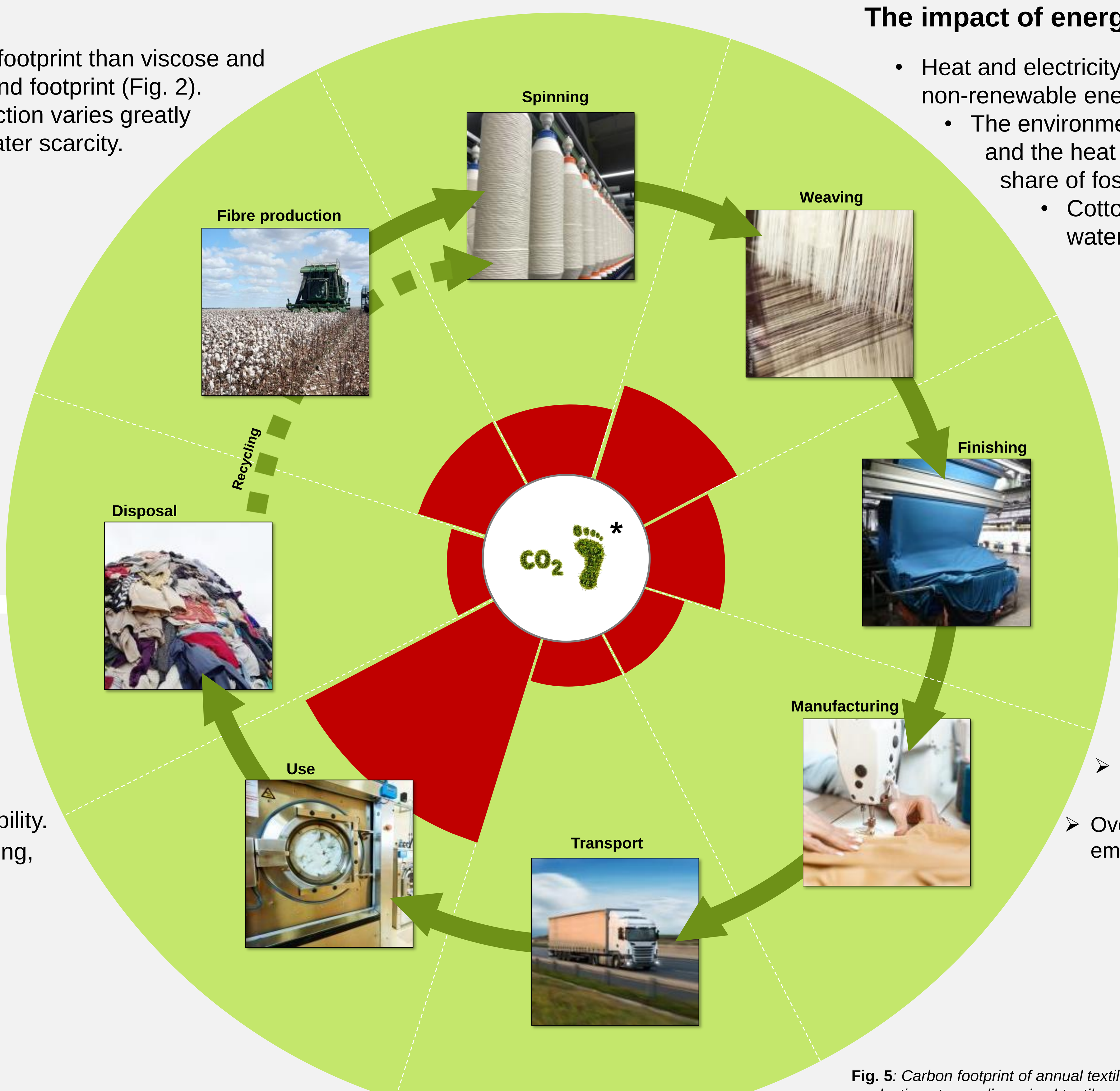


Fig. 3: *System comparison of conventional and recycled textile from cradle to gate (own draft).*



* Based on a business shirt (reference) and 50 washing cycles (Gärtner et al., 2022)

The impact of energy consumption on textile production

- Heat and electricity have the greatest impact on climate change, non-renewable energy resources and acidification (Fig. 4).
  - The environmental impact depends on energy consumption, and the heat and electricity mix (larger impact with large share of fossil energy sources in the country-specific mix).
    - Cotton provision has the largest impact on the water footprint.

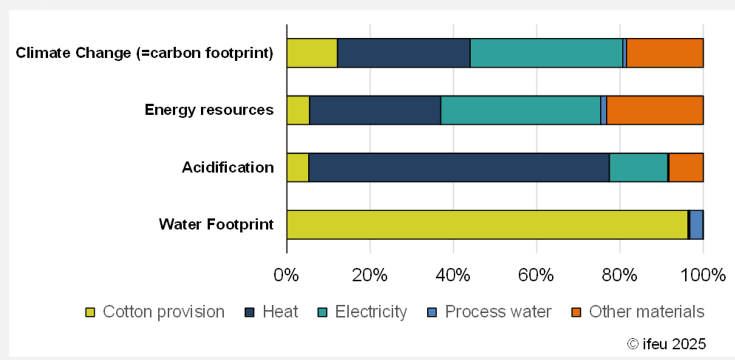


Fig. 4: *Contribution of energy and material inputs to environmental impact (from fibre to finished textile). Note: Indonesian heat and electricity mix; cotton from Brazil and USA (Karg et al., 2024; ifeu, unpublished).*

Organisational carbon footprint

- Depends on the company's profile (production focus, fibres, energy supply).
- Example of a medium-sized textile company in Indonesia (Fig. 5):
  - Electricity and heat: two thirds of the overall carbon footprint of annual fabric production.
  - Over 60% of GHG emissions are generated off-site, embedded in materials and electricity.

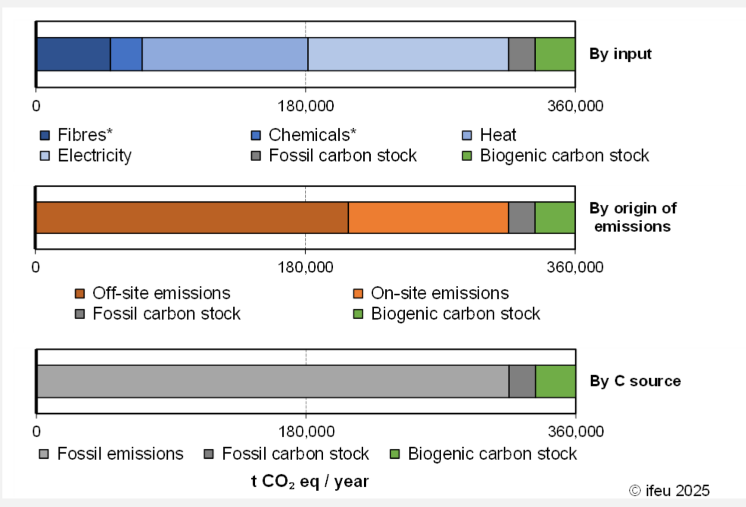


Fig. 5: *Carbon footprint of annual textile production at a medium-sized textile production site in Indonesia by input, origin of emission, and C source (tier 1,2 & 3) (Breyer et al., submitted).*excluding fossil-based carbon stocks.*

Conclusions

Summary

- **Environmental hotspots** in the textile life cycle include fibre provision, energy consumption during textile production, and washing during use.
- However, there is **large variation** in fibres and fibre production as well as in the proportion of fossil fuels in a country's energy mix.
- It is important to consider not only the carbon footprint, but also other environmental footprints, such as the **land and water footprint**.
- Although **recycling** can be advantageous when replacing virgin fibres that have a large environmental impact, it is important to assess its effect on other stages of the product's lifecycle and its durability.

Recommendations

- **LCA** identifies environmental hotspots in a textile's life cycle or at company level.
- Based on this information, measures can be taken **to reduce environmental impacts**, for example by using
  - **efficient technologies** and an **electrified heat supply**.
  - **renewable** and **sustainable energy** sources.
  - **recycled fibres** to replace virgin fibres that have a high environmental impact.
- To achieve sustainability targets in the textile industry, it is crucial to **reduce production and consumption,** and to **increase durability**.

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Check out our website on Sustainable Textiles:
www.ifeu.de/themen/nachhaltige-textilien

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Sources

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