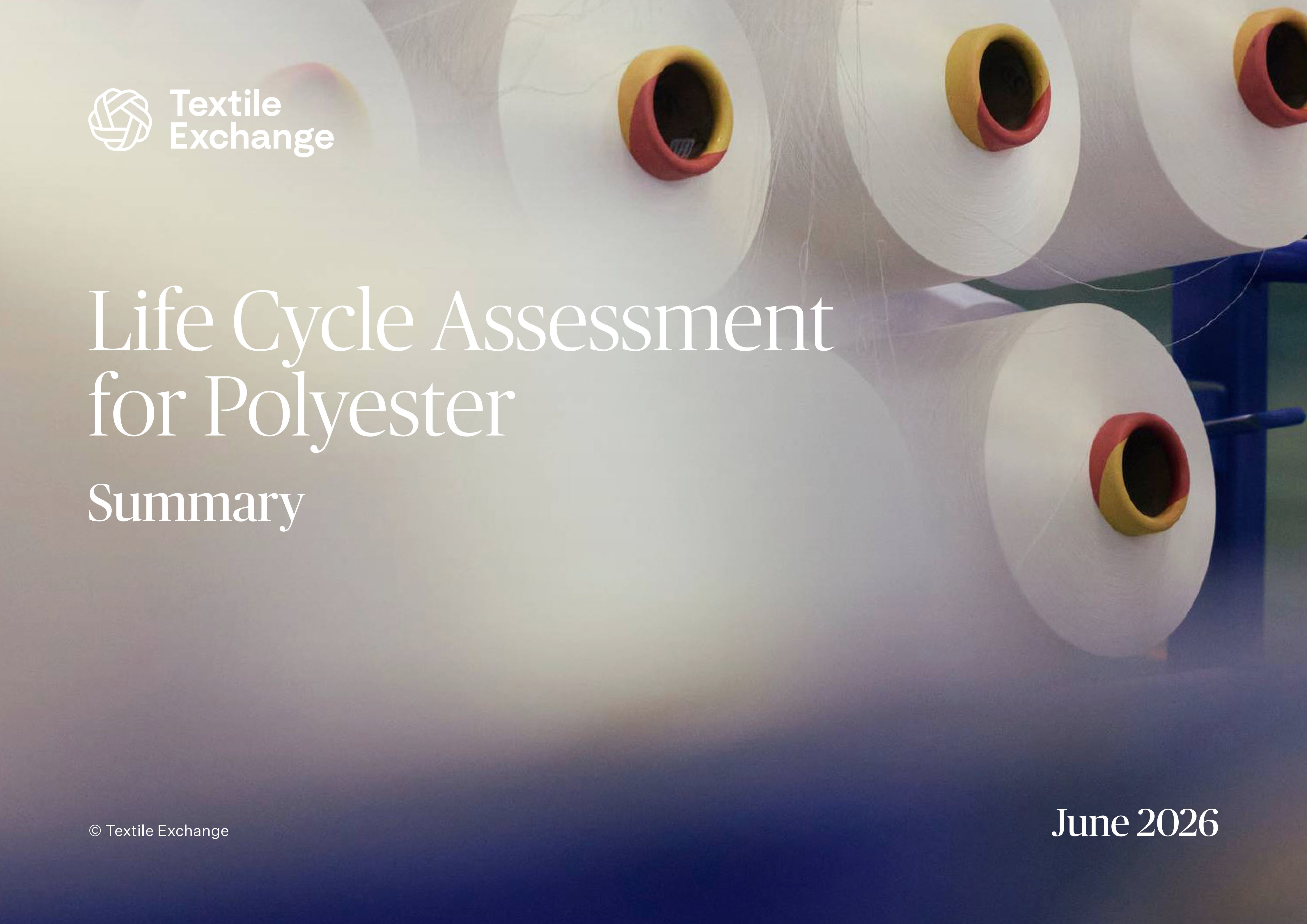


Textile Exchange

Life Cycle Assessment for Polyester

Summary

June 2026

Polyester LCA study goal and scope

Textile Exchange, with the support of consultancy SCS Consulting (SCS), has completed a comprehensive Life Cycle Assessment (LCA) study to develop robust and transparent environmental datasets for virgin polyester production and to better understand the environmental impacts of thermomechanical and chemical recycling methods. This study collected 2022–2024 production data from five polyethylene terephthalate (PET) producers, utilizing various thermomechanical recycling, chemical recycling, and virgin production technologies in Europe, the United States, Southeast (SE) Asia, and China. Chemical recycling included both post-consumer and post-industrial textile waste. Thermomechanical recycling primarily focused on the use of post-consumer PET bottles, but some post-industrial textile waste was also included.

Environmental impacts are assessed across several key categories, including climate change, acidification, ecotoxicity, photochemical ozone formation, and human toxicity. Additionally, Textile Exchange's LCA+ approach is included, incorporating a social assessment component.

The LCA study has been completed in accordance with ISO 14044:2006 Environmental Management—Life Cycle Assessment—Requirements and Guidelines. The study has undergone a critical review by an independent expert panel to ensure conformity with the ISO standard and the scientific robustness of the results. In addition, a Technical Advisory Group (TAG) provided ongoing guidance and input during the development of the study.

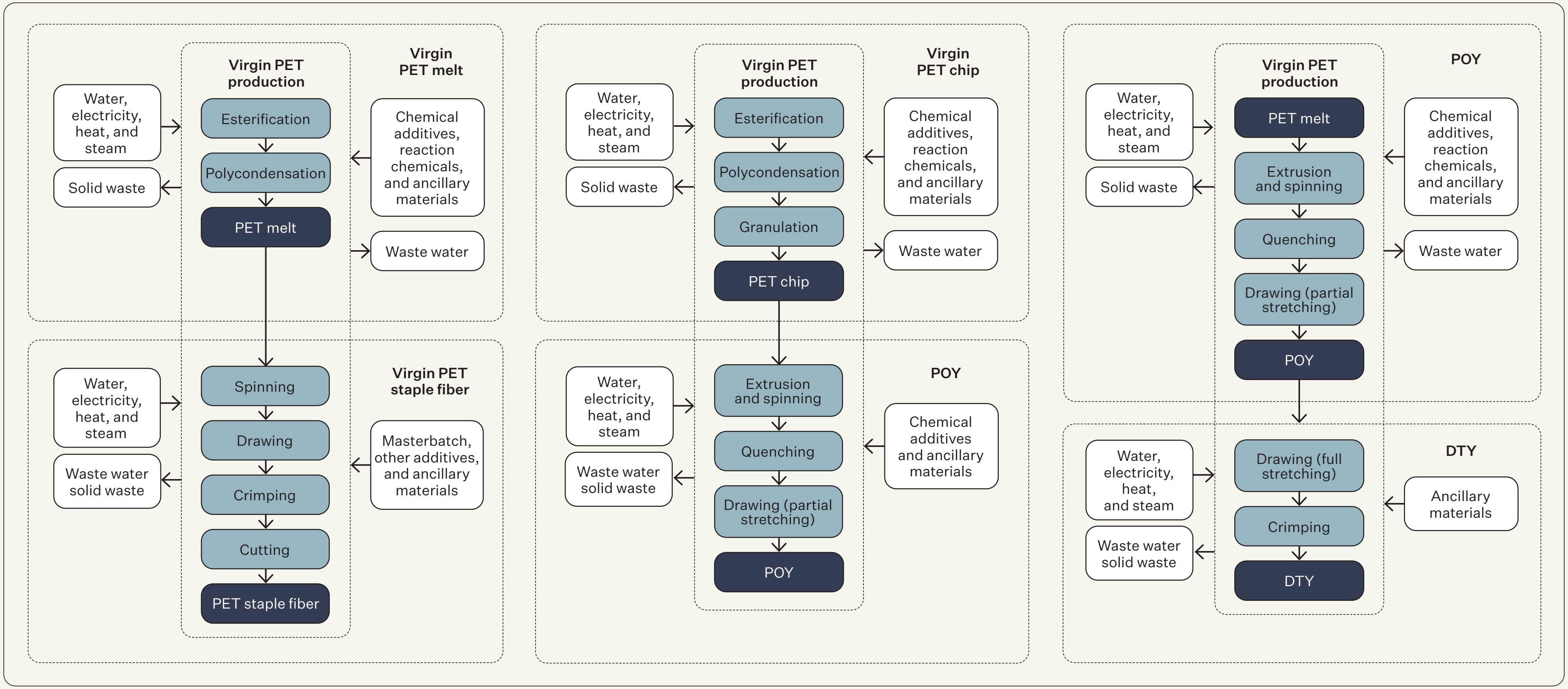
Life Cycle Assessment scope

The study follows a non-comparative, attributional LCA approach and focuses on a cradle-to-gate system boundary. Any downstream applications and packaging are excluded. Different functional units are considered depending on the type of product.[1]

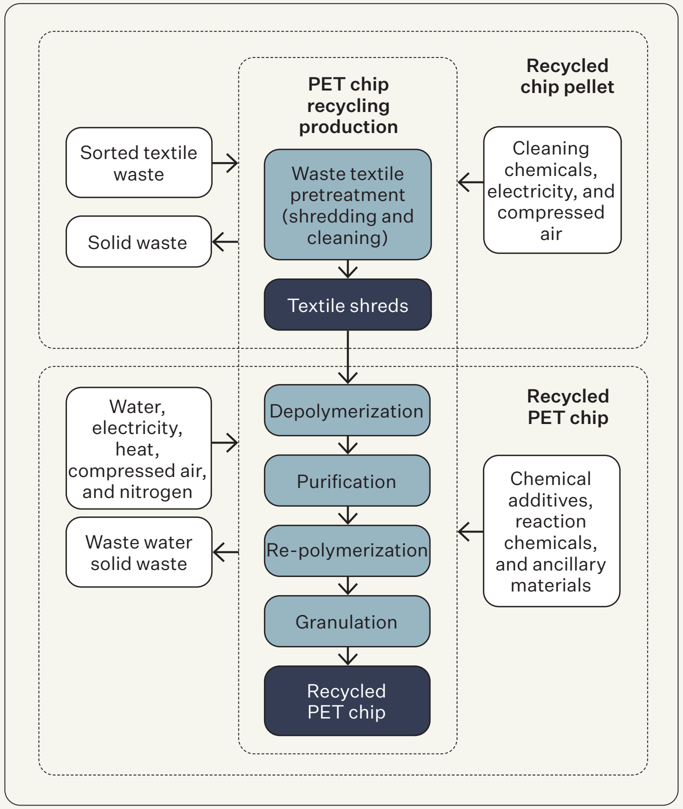
Photo (above and cover): Johnny Man

1 Functional units explored, depending on the technology type, are: 1 kg of PET chip, 1 kg of staple fiber, 1 kg of partially oriented yarn (POY), and 1 kg of drawn texturized yarn (DTY), all for use in textile applications.

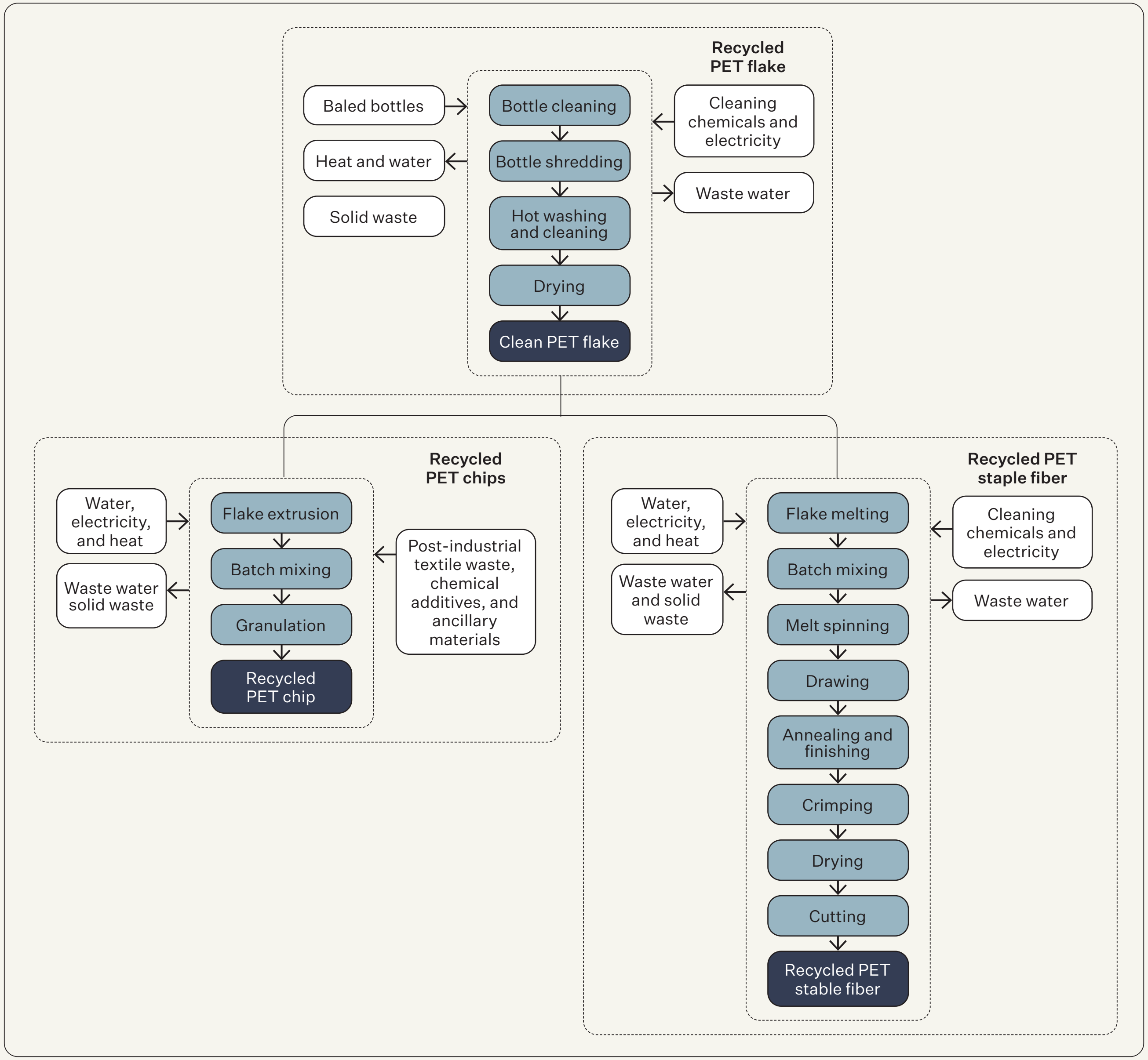
Virgin polyester



Recycled polyester—chemical recycling



Recycled polyester—thermomechanical recycling



Geographical scope

Country	Virgin	Chemical recycling			Thermomechanical recycling		
		Post-industrial textile waste	Post-consumer bottle waste	Post-consumer textile waste	Post-industrial textile waste	Post-consumer bottle waste	Post-consumer textile waste
China	○	●	○	●	○	●	○
Europe	○	●	○	●	○	○	○
Southeast Asia	●	○	○	○	○	●	○
US	○	○	○	○	●	●	○

NOTE: Recycled feedstock could be a mix of different feedstock types (for example, 93% post-industrial textile waste and 7% post-consumer textile waste).

For further information, refer to the full report.

No allocation between co-products was required. However, allocation was needed to partition the impacts between the primary producer of recyclable waste and the recycler of that waste into a valuable product. This study used the recycled content method (also referred to as the 100:0 method or cut-off approach), as required by both the Higg Materials Sustainability Index (MSI) and the Product Environmental Footprint (PEF) methodology for cradle-to-gate studies. All impact categories were also recalculated using the PEF Circular Footprint Formula (CFF).

NOTE: Further information can be found in sections 1.3 Scope of the study, 2. Methodology, and Appendix A—Circular Footprint Formula.

Key findings

Virgin polyester

- Polyethylene terephthalate (PET) production begins with the extraction of crude oil and natural gas, which are processed into purified terephthalic acid (PTA) and monoethylene glycol (MEG). The life cycle impact assessment (LCIA) results show that the production of PTA and the use of MEG to polymerize PET are the dominant contributors across all impact categories except freshwater ecotoxicity, for all five virgin PET products.
- Energy consumption (including electricity and heat) is the second-largest contributor across most categories.
- Freshwater ecotoxicity is driven by the production of non-polymerization chemical additives.

Recycled polyester

Chemical recycling

- Chemical recycling can be employed for both post-industrial and post-consumer textile waste and can remove chemical additives and dyes.
- However, given the additional challenges with sorting and cleaning post-consumer waste, most chemical recyclers are currently focusing on post-industrial waste. It is easier to collect and recycle than post-consumer waste due to its homogeneous nature and means textile blends that are challenging to sort can be avoided.
- The LCIA results revealed that for the two commercially operating chemical recyclers, energy consumption and the use of chemicals are the two largest contributors across the environmental impact categories, followed by the collection of the waste feedstock and waste treatment. For the pre-commercial recycler, much of the impact came from electricity, chemical use, and waste treatment.

Thermomechanical recycling

- Thermomechanical recycling is mainly used to recycle post-consumer PET bottle waste into textiles, but it can also be used to recycle post-industrial textile waste. It requires mostly homogeneous, high-quality waste inputs, as removing contaminants or additives within the PET is not possible in this process. Using thermomechanical recycling, PET waste can only be recycled a limited number of times before the PET becomes too degraded for further mechanical recycling.
- Electricity use is a significant contributor to impact. Feedstock collection also becomes significant when the transport distance is long.
- Freshwater ecotoxicity is driven almost entirely by surfactant-related cleaning chemicals.

NOTE: Further information can be found in sections 3.5, 4.5, and 5.5 Life cycle impact assessment (LCIA) results.

Photo: Johnny Man

Photo: Johnny Man

LCA+ approach

Social assessment

The social assessment in this LCA study is intended to examine the human rights impacts associated with polyester production. The outcomes should not be used for any claims or external communication, but rather to support in identifying the most relevant areas for action.

The findings show that the production of virgin and recycled polyester can have severe impacts on human rights, including harassment, violence, and abuse. However, recycled polyester shows promise for the future, already playing a key role in tackling the world's textile waste crisis. Despite the need for further work to better map and understand these supply chains and address their severe human rights impacts, there are many opportunities in this area. Recycling supply chains are often informal and poorly regulated, and while this can lead to severe human rights impacts, it also creates the potential for meaningful solutions.

NOTE: Further information can be found in Appendix B—Examining human rights impacts in polyester production: Social assessment for polyester.

Data challenges and limitations

- Ecoinvent v3.11 datasets were used to model all primary and secondary life cycle inventories, but they are not perfect matches to the actual operations that they represent.
- There were data uncertainties and constraints related to data availability. This includes a lack of data on upstream waste collection distances for post-consumer and post-industrial PET waste and solvent- and surfactant-related chemicals used by each recycler.
- One of the five data providers included in this study does not currently operate at commercial scale or produce a sellable product. Their input and output data is based on detailed mass and energy balances based on testing conducted at a pilot plant. The actual input and output data for a commercially operating plant may differ from this pilot plant. The representativeness of commercial-scale operation data used to estimate the impacts of data based on engineering plans is unclear.

NOTE: Further information can be found in section 7. Limitations.

Conclusions and recommendations

- This study represents a considerable advancement in the state of LCA data for polyester, providing comprehensive documentation, transparency, and robustness.
- LCA results remain sensitive to assumptions and contextual factors; the results should be interpreted within their limitations, and simplistic rankings or claims based on these results should not be made.
- The study emphasizes the importance of improving the traceability and the sorting and collection of post-industrial and post-consumer textile waste in order to improve data availability, and the importance of building on existing relationships with recyclers and their supply chains.
- The study recognizes the key role collective action plays in innovating recycling processes to reduce environmental impacts, such as introducing better sorting technologies, using renewable energy, and reducing truck transport (as investigated in the scenario analysis conducted as part of the study).
- Finally, it shows why it is important to consider the tradeoffs between chemical and thermomechanical recycling methods, which each have their own distinct advantages and limitations.

NOTE: Further information can be found in section 8. Conclusions and recommendations.

Photo: Johnny Man