Textile Anatomy Case

Case provided by Dr. Heath Logan, Valentina Rossi, Prof. Dr. Anders Damgaard

Making better LCAs of real products –

Data provided by: Logan, H. M., Søndergaard, M. Z., Rossi, V., Hansen, K. K., & Damgaard, A. (2025). Nordic textile anatomy database. 10.11583/DTU.24581700

6.95 million tonnes

In 2020, the European Union generated roughly 6.95 million tonnes of textile waste (ETC CE, 2023). This number is rising exponentially, and with the introduction of ultra-fast fashion companies, it's getting harder to track.

8% sent to recycling

51% sent to landfills, 34% in energy recovery, 8% recycling, and 7% to reuse across the EU, but this varies from country to country. Less than 2% is fibre to fibre recycled (EC JRC, 2023).

2025 Mandate

2025 collection mandates for separate collection and treatment of textiles in the EU (EC JRC 2018). Separate collection will stimulate the collection of textiles but not necessarily increase the availability of textiles for recycling (Rossi et al., 2024).

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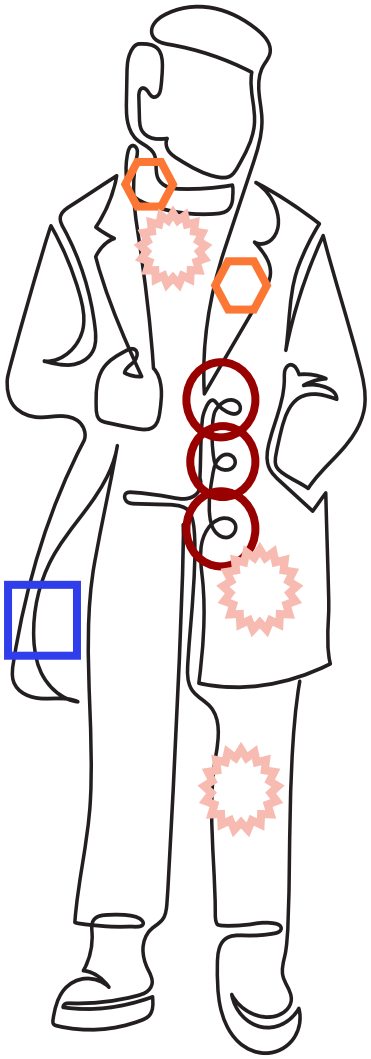
THE PROBLEM

LESS THAN 2% OF ALL TEXTILES ARE RECYCLED

- Textile production use and waste is increasing
- Active Lifetimes of textiles are decreasing
- Current reuse strategy relies on criteria for resale
- Recyling rates focus only on fibre compatibility
- Current recycling rates only estimate recyclability after sorting for reuse

Photographer: Valentina Rossi

Textile Anatomy



Fibre Blend:

The yarn blend used in knitting or weaving the base textile used to construct the garment. Textiles often consist of between 1-5 fibre types per layer.

Findings:

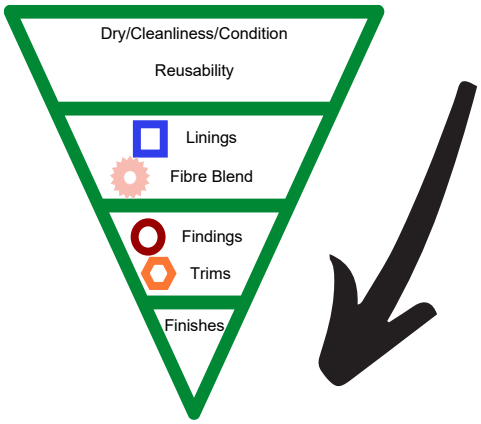
Hard parts (zippers, buttons, claps, etc.) attached to the garment, usually used for fastening, closing, and securing the garment. May also be used for decorative purposes.

Linings:

A layer of fabric usually located on the interior of the garment and used to improve the fit, function, or appearance of the garment during wear.

Trims:

Ribbons, lace, cuffs, hems, collars, etc. used to finish a garment. May also be used decoratively.



Textile anatomy refers to the composition and physical properties of textiles necessary to create a desired function (Logan et al, in press).

Yet today, LCAs and MFAs of recycling routes mostly focus on single blends or 50/50 poly-cotton mixes of textiles.

This fails to take into account the complexity of blends and the difficulty in separation.

It also misses all the necessary pretreatment needed to prepare textiles for recycling.

Such a focus led to a near collapse of the recycling market in the EU in 2024.

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The Dataset

To help address this, we at DTU spent 3 years conducting product characterization studies of textiles in the retail market and textiles in the Nordics' only industrial-scale waste sorting facility. From this work conducted and reviewed by more than 20 researchers and students, we produced the Nordic Textile Anatomy Database. This work primarily contains two datasets on material composition:

The Retail Mass Market (RMM) Dataset and The Post Consumer Textile Waste(PCTW) Market Dataset.

- Retail Mass Market Dataset
  - Gives a good representation of the market composition immediately prior to consumption
- Post Consumer Waste Market
  - Not representative of the market, but representative of waste stream composition
  - Can be extrapolated to the RMM dataset and gives details on specific compositions for key textile categories, specifically considering ***disruptors*** (zippers, buttons, and linings, which disqualify textiles from recycling).
  - Includes improved detail on garment type, placement of findings, and composition of findings.

A full explanation of the method and data can be found here:

Logan, H. M., Søndergaard, M. Z., Rossi, V., Hansen, K. K., & Damgaard, A. (2025). Nordic textile anatomy database: Composition of garments available in the nordic retail mass market and post-consumer textile waste market. Data in Brief, 60, 111512.
https://doi.org/10.1016/j.dib.2025.111512

The Flows

TABLE 4.1 Supply of textile clothing to Denmark in 2016 and 2022, presented in absolute and relative values.

Product category	2016		2022	
	Supply (t)	Relative share	Supply (t)	Relative share
Overcoats and anoraks	4793	8%	10239	10%
Suits and blazers	3198	5%	5112	5%
Trousers and shorts	13919	24%	24644	25%
Dresses and skirts	2707	5%	5299	5%
Shirts, blouses, tops	5750	10%	4157	4%
Underwear, socks, and night clothes	7136	12%	6889	7%
T-Shirts and vests	9048	15%	10889	11%
Sweaters and cardigans	9130	15%	14703	15%
Sportswear and swimwear	1343	2%	14400	15%
Handkerchiefs, ties, scarves, gloves, and other	2367	4%	2603	3%
Total	**59392**		**98935**	

Rossi et al., 2024

The Flows

TABLE 4.2 Estimation of collection streams. Adapted from Watson et al. (2018).

Textiles consumed by house-holds in Denmark (2016)	Amount collected (t)	Relative share	Collection stream
Separate collection	36000	47%	1st stream
Bulky waste	5600	7%	2nd stream
Small combustibles container	14300	19%	2nd stream
Household mixed waste	20000	26%	2nd stream
Lint loss during use	30	~0%	Lost to the environment
Total	75930		
	36000	**47%**	1st stream
	39900	**53%**	2nd stream

Rossi et al., 2024

The Flows

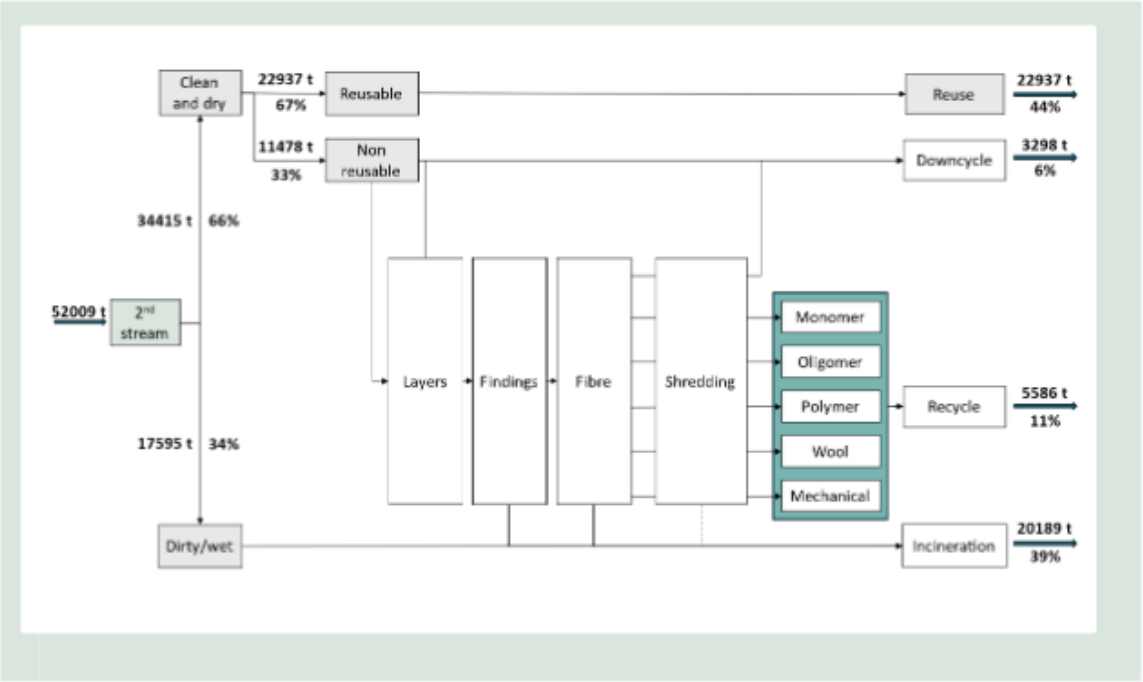

FIGURE 4-5. Material Flow Analysis (MFA) of separately collected clothing to the Danish 2nd stream, and steps associated with the textile recycling supply chain (alternative scenario). Dis-tinction is here made between open-loop recycling, identified by the box "downcycle", and closed-loop recycling, identified by the box "recycle"

Rossi et al., 2024

If we don't consider lifetimes, but we do consider anatomy, we result in the following flows for the system.

How would the system look different if we include lifetimes?

For more insight refer to:

Rossi, V., Damgaard, A., & Logan, H. (2024). Recycling potential of separately collected post-consumer textile waste. Miljøstyrelsen. Denmark. Environmental Project no. 2270. https://www2.mst.dk/Udgiv/publications/2024/06/978-87-7038-623-4.pdf

Lifetimes

Product lifetimes differ based on the retailer, economic status, or wearer, number of items in the wardrobe, and culture. However, in 2021, WRAP conducted a survey of 6,000 residents in the UK and over 44,000 items. The outcomes of this survey were published in 20022, and a general range of lifetimes per category has been adjusted to the grouping used in this study.

Product group	Lifetime Est in Years (WRAP 2022)
Dresses and skirts	4.2-4.9
Handkerchiefs, ties, scarves, gloves, and other	4.3
Overcoats and anoraks	5.4-6.3
Shirts, blouses, tops	4.1-4.8
Sportswear and swimwear	2.6-4.4
Suits and blazers	4.1-6.1
Sweaters and cardigans	4.0-4.8
Trousers and shorts	3.8-4.8
T-shirts, singlets and vests, hoodies and crewnecks	4.0
Underwear, socks, night clothes	2.6-4.4

WRAP, 2022, Banbury, Citizen Insights: Clothing Longevity and Circular Business Models receptivity in the UK, Prepared by WRAP. https://www.wrap.ngo/sites/default/files/2023-05/Citizen%20Insights%20-%20Clothing%20Longevity%20and%20CBM%20Receptivity%20in%20the%20UK.pdf

Units in Textiles

- Fibres – Fibre Production
  - Weight: g or kg
  - Fineness: denier (g/9000 m) tex (g/1000m)
- Yarns – Carding, combing, drawing, spinning, twisting
  - Fineness: denier (g/9000 m) or tex (g/1000m)
  - Twist: turns per meter (tpm), turns per inch (tpi)
- Fabric
  - Weight (density): grams per square meter g/m2
  - Width: cm (commonly 112 or 160cm width per bolt, most bolts are 50-60 meters long)
    - Lightweight: 30–150 gsm
      - Examples: chiffon, georgette, voile, linings
    - Medium-weight: 150–300 gsm
      - Examples: poplin, broadcloth, jersey, shirts, dresses
    - Heavyweight: 300–600 gsm and above
      - Examples: denim, canvas, outerwear, coats

Other considerations for MFA/LCA

- Weights
  - can be estimated by category type
  - To see how we estimated, refer to
    - Rossi, V. (2023). Assessing the environmental impacts of post-consumer textiles: Factors influencing the environmental benefits of reusing and recycling clothes [Master Thesis]. https://findit.dtu.dk/en/catalog/64e69faa7508f32052eb0fde
- Common Nomenclature
  - Many products can be defined under multiple categories, so likely import and export flows give a skewed view of the market
- Fabric weight determines drape and garment type
- Width affects fabric yield and placement
  - Direct influence on cutting losses
- Thread count influences texture and durability
  - Typically higher thread count = higher durability + more stiff fabric
- Gauge controls knit fabric appearance and function.
  - Larger gauge + less fine yarn = increases bulk (low meter count, low weight)
  - Larger gauge + fine yarn = less material (low meter count, low weight)
  - Small gauge + less fine yarn = more durable knit (stiff) (High meter count, high weight)
  - Small gauge + fine yarn = delicates with high elasticity (flexible) (High meter count, low weight)

References / Further Reading

- Data for this exercise can be accessed:
  - https://github.com/hmlogan/textileanatomy_dds
- The original data repository can be found:
  - Logan, H. M., Søndergaard, M. Z., Rossi, V., Hansen, K. K., & Damgaard, A. (2025). Nordic textile anatomy database. 10.11583/DTU.24581700
- The methods and background for the development of the dataset can be found:
  - Logan, H. M., Søndergaard, M. Z., Rossi, V., Hansen, K. K., & Damgaard, A. (2025). Nordic textile anatomy database: Composition of garments available in the nordic retail mass market and post-consumer textile waste market. Data in Brief, 60, 111512. https://doi.org/10.1016/j.dib.2025.111512
- More data:
  - Rossi, V. (2023). Assessing the environmental impacts of post-consumer textiles: Factors influencing the environmental benefits of reusing and recycling clothes [Master Thesis]. https://findit.dtu.dk/en/catalog/64e69faa7508f32052eb0fde
  - Rossi, V., Damgaard, A., & Logan, H. (2024). Recycling potential of separately collected post-consumer textile waste. Miljøstyrelsen. Denmark. Environmental Project no. 2270. https://mst.dk/publikationer/2024/juni/recycling-potential-of-separately-collected-postconsumer-textile-waste