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North-West Europe

Fibersort

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RESOURCE
AND MATERIALS EFFICIENCY

Manual Sort of Post-Consumer Textiles in North-West Europe

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Executive Summary

The Fibersort team completed a manual sorting exercise to catalogue the contents of 5,000 kg of post-consumer textiles in September of 2017. There are several reasons to do this, the most important being to collect data on Fibersort input materials in order to refine the business case for a fibersorting facility (work package T2, deliverable 1.1).

The team found approximately 64% of the items sorted in this study were rewearable and 36% were a combination of non-rewearable items, bedding and waste. Out of all of the materials that were evaluated, an estimated 22% were recyclable.[1]

In comparing the rewearable to non-rewearable figures in this study to similar figures reported by other European projects and organizations, we see some similarities. Keeping in mind the reported range of rewearable items fluctuates from 40-89%, we estimate our rewearable figure is a reasonably realistic reflection of post-consumer textiles across North-West Europe. We will provide updates on this conclusion in later Fibersort Project reports.

Within the 36% of textiles that were deemed non-rewearable, nearly two-thirds were composed of either pure fibre blends or two fibre blends, making them candidates for potential textile to textile recycling. The remaining one-third was composed of three or more fibre blends, waste, non-rewearable items constructed from multiple textiles, bedding and non-rewearable shoes.

Another benefit of this study is that it begins to illuminate some of the lesser known aspects of post-consumer textiles for brands and retailers. While we found that within the non-rewearables sorted there were more pure fibre items than blends, it is helpful to understand how fibre composition impacts potential recyclability of a textile. Elastane was present in nearly one out of every five non-rewearable single material items sorted. These are interesting considerations for brands and retailers as they consider how to shift their design and product creation decisions toward circularity.

The Fibersort Project will continue to research and collaborate with other projects and industry stakeholders to grow our collective understanding of post-consumer textiles and the opportunities for technology to create a circular future. This is the first in a series reports for the Fibersort project. In the future, project stakeholders will receive early access to information and more detailed findings. Sign up here to become a stakeholder.
For more information on the project, go to: www.nweurope.eu/fibersort

[1] *More details on how these categories are defined are available in the report below. The results outlined in this report are based on a small sample size, and our team recognizes a wide range of variables can impact our findings. Therefore, we aim to share the sorting process used to collect this data in order to create a more robust and accurate set of figures for widespread industry use.*

Introduction

The future of the circular textile industry will, in large part, be built on textile to textile recycling.[2] This will decrease our dependence on virgin resources and non-renewable resources, while maintaining the value of textiles. Different recycling technologies are designed to recycle different fibre compositions, and most technologies require precise input materials. This is because the quality of their outputs, as well as the economics of the process, are heavily dependent upon the fibre composition of these feedstocks. Therefore, it is necessary to accurately sort post-consumer textiles by fibre type to achieve a circular textiles industry.

The Fibersort is a technology that automatically sorts large amounts of post-consumer textiles by fibre type. Without it, sorting recycling feedstocks must be completed by hand, which is less accurate and less productive than an optimized, automated sorting process. The Fibersort project is commercializing the machine, completing the research and creating the written documentation necessary to enable profitable uptake of this technology into the industry. This Interreg North-West Europe (NWE) funded project will bring the fibersorting process into operation and enable the industry to move closer to circularity.

This study is the first step in a larger exploration of the post-consumer textile stream. It was conducted to determine which fibre types are present in the post-consumer textiles collected in NWE. This information is necessary to refine the business case for the Fibersort and for textile recycling technologies to better understand the potential to source post-consumer textile feedstocks. Another benefit of this work is the additional details on fibre blends that can help brands to better understand how their design decisions impact the end-of-life opportunities for textiles.

This report presents data from a textile reuse and textile to textile recycling perspective, however it must be noted that a range of end markets for end-of-use textiles (including downcycling into nonwovens or use as inputs for processes in other industries) is needed to achieve an economically viable circular textiles system. This level of analysis is out of scope for this report, but will be addressed in future Fibersort reports.

[2] *The term textile to textile recycling is used in this report to describe recycling processes that use end-of-use textiles as an input and produce fibers or raw materials suitable for knit or woven textiles as an output. This is also commonly referred to in the industry as upcycling or high-value recycling. We will use the term textile to textile recycling in this report because this term is broadly understood by a wide range of industry stakeholders.*

Methodology, Limitations and Estimations

A manual sort of post-consumer garments was conducted at Wieland Textiles in collaboration with Smart Fibersorting in September of 2017. Approximately one tonne of textiles was received from each country in NWE (UK, France, Belgium, Germany and the Netherlands). Trained sorters at Wieland Textiles presorted the bales into the following categories:

- **Rewearable** - Products (including shoes) that can be reused in their original form. This category is known as "product reuse" among many textile collectors/sorters.
- **Non-rewearable/single material** - Products that cannot be reused in their original form and are made from one type of textile (material); being made from a single material increases the likelihood these items can be used as a textile to textile recycling feedstock. This category is known as "material reuse" among many textile collectors/sorters.
- **Non-rewearable/multiple materials** - Products that cannot be reused in their original form and are made from multiple types of textiles; being made from multiple textiles decreases their ability to be used as feedstock for textile to textile recycling. This category also falls within the "material reuse" category defined by textile collectors/sorters.
- **Other Materials -** Includes non-rewearable shoes, all bedding that was collected and waste[3]. This includes items in both "material reuse" and "product reuse" categories as defined by textile collectors/sorters.

The non-rewearable/single material garments were separated from the rest of the items by a skilled sorter, and then a separate team label checked each item to determine fibre content. All garments were label checked by volunteers from Circle Economy, Worn Again, Wargön Innovation and the Amsterdam Fashion Institute (AMFI).

Due to time constraints, only 30% of the non-rewearable/single material items in the Netherlands bale were label checked. Therefore, this data set was supplemented with the data set from recent research, *Measuring the Dutch Clothing Mountain.*[4] Both studies used comparable sorting and label checking methods so the datasets could be combined without adding unwanted variability.

Additionally, it is rumored in the industry that the actual fibre content in garments rarely match the labels. The fibre composition findings of this report are based upon what was

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[3] *Footwear and bedding recycling was out of scope for this test. This is because they are not compatible with the Fibersort process and because they are complex materials that should be evaluated in more detail for their viability as textile to textile recycling inputs in a seperate test. Waste includes non-textile items such as plastic, paper, broken toys, etc.*

[4] *Dutch Clothing Mountain (2017). Measuring the Dutch Clothing Mountain. Retrieved from: http://www.hva.nl/create-it/gedeelde-content/projecten/projecten-fashion/measuring-the-dutch-clothing-mountain.html*

printed on these labels. Further testing will be conducted using the Fibersort technology during the project to determine actual fibre types present in non-rewearable products. However, we will not deeply investigate and report on label accuracy specifically.

To define which items were "recyclable" vs "non-recyclable", this study assessed the capabilities of current textile to textile recycling technologies and those which are nearing commercialization stages. We differentiated between textiles that can be used as feedstock for textile to textile recycling and those that cannot based on two key criteria. The first distinction was between items that were made from a single material vs multiple materials. The second key criteria was the number of fibres included in the single material items.

This means only pure fibres and two fibre blends are included in the "recyclable" category. It is reported that some three fibre blends may also be used as textile to textile recycling feedstocks, while not all two fibre blends can be. The study defined a generic feedstock (recycling technology input material) criteria based on various recycling technology feedstock specifications.

Typically, end-of-use textiles that are destined to be downcycled do not need to be Fibersorted to enter these markets, which puts them out of the scope of this project. The scope of this project is to determine the potential end-of-use textiles that have the potential to be fibersorted and be used as feedstock for textile to textile recycling. For that reason, our definition of recyclable only includes those items with textile to textile recycling potential. It should also be noted that many items currently being downcycled could be diverted into higher value recycling routes by being properly sorted with the Fibersort.

Rewearable, non-rewearable and other material figures were collected by weighing items sorted into these categories and subtracting the weight of their containers. An average weight was determined for containers and this figure was used for calculations. Container weights vary, and it was not possible to weigh each container separately. Therefore, one weight per container type was used for this calculation. Fibre blend and elastane figures were recorded per piece, so calculations for these categories are based on number of items label checked. To avoid skewing figure totals, items without labels were excluded from calculations. Label checking was only carried out for the non-rewearable/single material category. It is important to note that the fibre composition figures apply only to this category and does not apply to rewearable items.

Although the five tonne sample is the largest the project partners have analysed to date, compared to the massive volume of post-consumer textiles collected in the NWE region, it is a relatively small sample set. Variables impacting the data include geographic region, demographics of neighborhood where items were collected, time of year and a range of other factors. Our team hopes to engage other groups in similar data collection projects in order to expand the sample size for this data in the future.

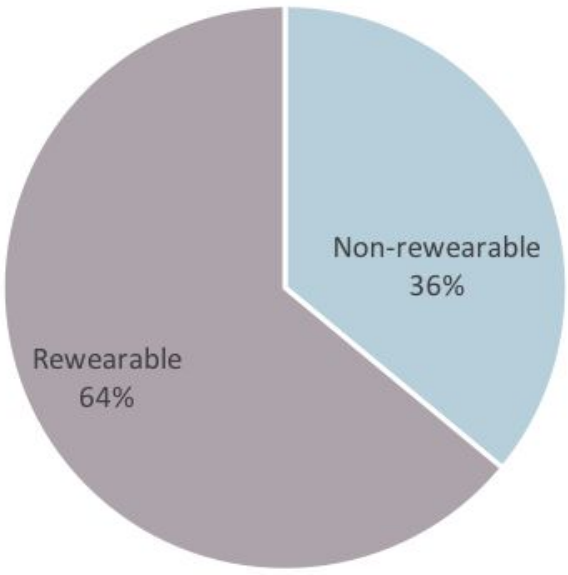
Results

This study categorizes post-consumer textiles within four categories: rewearables, non-rewearable/single material, non-rewearable/multiple materials and other. Results are presented as an average of NWE. Below we discuss the percentage of rewearable vs non-rewearable. We then break down the non-rewearable/single material fraction further to determine the portion of textiles that have the potential to enter textile to textile recycling streams. Currently, a large share of non-rewearable textiles lose their value because they are either downcycled, landfilled or incinerated.

Rewearables vs non-rewearables

Products that are deemed rewearable can be used in their current condition and have the most economic value as they re-enter a value stream or life cycle. Non-rewearable items cannot be worn or used again in their current state and must be altered to maintain their highest use value. Ideally, these materials would enter a textile to textile recycling process as a final option, which would preserve the value of the resources embedded in the original items by creating new textiles with similar or equivalent performance properties to those made from virgin resources. This is how the textiles sorted in this study measured out:

- 64% rewearables
- 36% non-rewearables + other



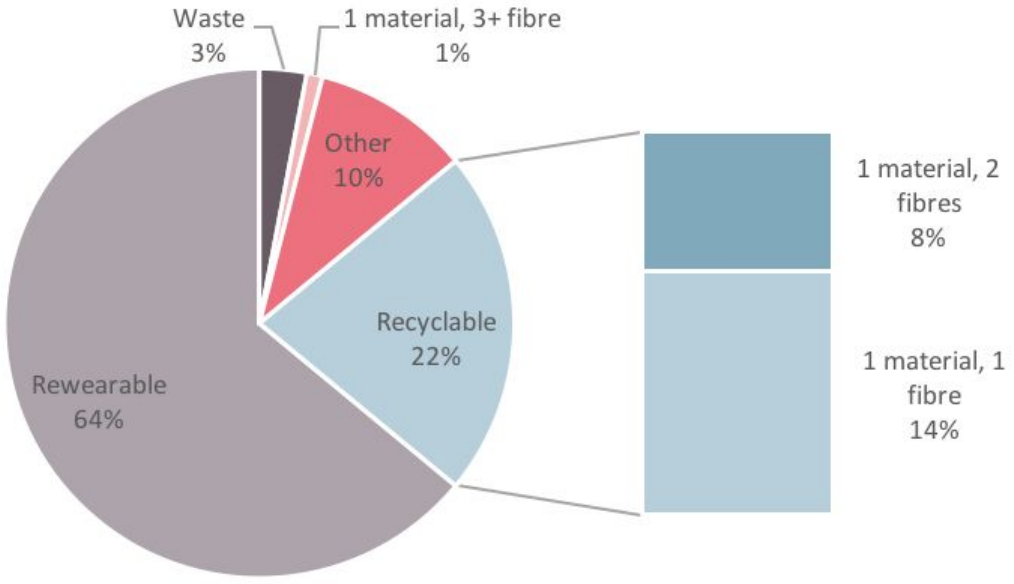
Rewearable items vs non-rewearable + other items

Non-Rewearables for Textile to Textile Recycling Feedstocks

It is not possible to use all of the non-rewearable fraction as feedstock for textile to textile recycling. The materials that can be used for these feedstocks, and are considered recyclable in this report, are non-rewearable/single material items made with pure fibres and two fibre blends. Textiles with three or more blended fibres, non-rewearable/multiple materials items, bedding and non-rewearable shoes have limited recycling opportunities, and are therefore excluded from the recyclable fraction in this report. More details on how these categories are defined in this report are available in the previous Methodology, Limitations and Estimations section.

Breakdown of the non-rewearable fraction (36% of all materials included in the study)

- 22% recyclable fraction
    - 14% single material, pure fibre blend
    - 8% single material, two fibre blend
- 1% single material, three or more fibre blend
- 10% other: non-rewearable/multiple materials, bedding and non-rewearable shoes
- 3% waste



Breakdown of non-rewearable/single material sorted textiles

The breakdown of these categories shows that 22% of post-consumer textiles collected in NWE have the ability to be turned into new textiles.[5] This fraction is composed of pure fibres and two fibre blends. The ability to recycle all of these materials is dependent upon technology and infrastructure development. Currently, less than 1% of textiles are recycled into new textiles when they reach the end-of-use phase.[6] With the right technologies and infrastructure in place, it is possible to increase the amount of end-of-use textiles used for textile to textile recycling to above 20%.

These figures can influence the business case for stakeholders, such as textile recycling technologies and textile collectors/sorters. The Fibersort project is working with these two critical stakeholder groups to help them better understand what these figures mean for them in the context of profitably sorting and recycling post-consumer textiles into new, high quality textiles. More information and insights on this topic will be included in future Fibersort Reports.

Other data and industry trends

64% of the total items collected for this study were deemed suitable for the reuse market in their current state. This is much higher than the 50% that has recently been discussed anecdotally within the second-hand garment industry. Findings from other industry reports show that the rewearable portion varies from 40-89%.[7] These figures vary due to many reasons such as: textile types included in the study, year of the report, collection and sorting methods, market conditions, categorization of textiles, regions of collection, differences in textile qualities, among others.

The ratio of rewearable to non-rewearable items is important, because rewearables represent the highest margin for textile collector/sorters, and it is often this fraction that subsidizes the cost to handle the non-rewearables. This is a figure we will continue to watch closely and address in future Fibersort Reports.

Presence of elastane

Elastane has become a popular fibre to include in blends due to its stretch properties giving additional comfort and improving fit to otherwise rigid garments. It continues to be an issue for both mechanical and chemical recycling processes. When too much elastane is

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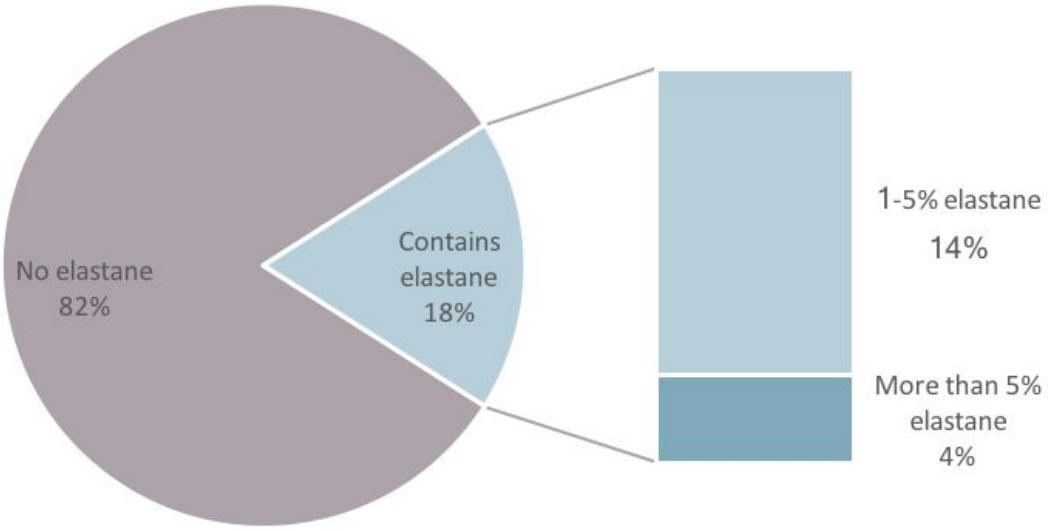
[5] *Current rewearable fractions include rewearable textiles that are exported to developing countries. Export bans are currently being discussed in certain countries. If these bans are implemented, the amount being exported will decrease and the portion of textiles deemed non-rewearable could increase.*

[6] *Ellen Macarthur Foundation (2017). A New Textiles Economy: Redesigning Fashion's Future. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report_Updated_1-12-17.pdf*

[7] *Friends of the Earth (2013). Less is more. http://www.foeeurope.org/sites/default/files/publications/foee_report_-_less_is_more_0.pdf; Nordic Council of Ministers (2016). Policy Brief: Exports of Nordic Used Textiles: Fate, benefits and impacts. https://norden.diva-portal.org/smash/get/diva2:1058123/FULLTEXT01.pdf ; WRAP (2012). Impact of Textile Feedstock Source on Value http://www.wrap.org.uk/system/files/private/Impact%20of%20textile%20feedstock%20source%20on%20value%20summary%20report.pdf ;*

present in mechanical recycling feedstocks, the quality of output decreases. When elastane is present in chemical recycling feedstocks, the process yield decreases, which makes recycling less profitable. The elastane becomes a waste by-product which has a disposal cost.

- 18% of the non-rewearable/single material items label checked contained elastane
    - 14% of non-rewearable/single material items had between 1 and 5% elastane content
    - 4% of non-rewearable/single material items had more than 5% elastane



Percentage of non-rewearable/single material items that contained elastane

Conclusions

This study collected actual data on Fibersort input materials to refine the business case for a Fibersort facility. It also began to illuminate some of the less well-known aspects of post-consumer textiles for brands and retailers. Due to the relatively small sample size and number of variables that impact what is found within post-consumer textiles, these numbers may vary from study to study, especially the rewearable vs non-rewearable fractions.

The high amount of rewearables found in this sample set is beneficial to collectors and sorters, as this represents the majority of their revenue. However, collectors and sorters report that textile quality has been declining in recent years and the portion of non-rewearables have been increasing. Because of this, they need to find new means to

increase the economic value of the non-rewearable portion of collected textiles. Being able to Fibersort and sell some of those non-rewearables as recycling feedstocks offers an opportunity to increase economic viability of collecting and sorting.

The findings from this study are also important for brands. The presence of high amounts of elastane and three and more fibre blends decreases the chance that a textile will be able to be recycled into a new textile.[8] These important aspects need to be taken into consideration when designing for circularity.

Being able to determine the amount of the post-consumer textiles that can be used for recycling feedstock is necessary for recycling technologies. Recyclers must know how much feedstock they will have access to. This study revealed a first indication of the potential to source textile to textile recycling feedstocks from within NWE. Within our sample set of post-consumer textiles, nearly one-quarter of all of the post-consumer textiles collected today have the potential to become feedstock for textile to textile recycling. This represents a large portion of post-consumer textiles that are often downcycled, landfilled or incinerated.

Even though this one-quarter of post-consumer textiles fit the qualifications for textile to textile recycling feedstocks, hand sorting non-rewearable items by fibre type is not accurate or efficient enough to produce the volumes necessary for commercial scale production. The Fibersort is needed to achieve a circular textiles industry. Very few recycling processes today are capable of textile to textile recycling, but having the potential input for these processes available could provide an incentive to invest in higher quality recycling research. With automated sorting technology incorporated into this new circular infrastructure, textile to textile recycling technologies we will be able to operate at scale using post consumer inputs, reclaim valuable resources and reduce the need for virgin raw materials across the industry.

This report is the first interim report published for the Fibersort project, and there are many more to come. Look for the upcoming Fibersort performance report in 2018. The full-length report will detail:

- The breakdown of the non-rewearable pure fibres and blended fractions
- The accuracy of the Fibersort process

Stakeholders will be the first to access this information. Your company insights and data can help develop future reports. It's not too late to become a stakeholder if you would like to participate.

Want to help advance circular textiles by collaborating as a stakeholder?
Sign up here or visit www.nweurope.eu/fibersort

[8] *Textile to textile recycling technologies are ever changing and massive improvements are made yearly. This is the current outlook at time of publishing.*