Interreg North-West Europe

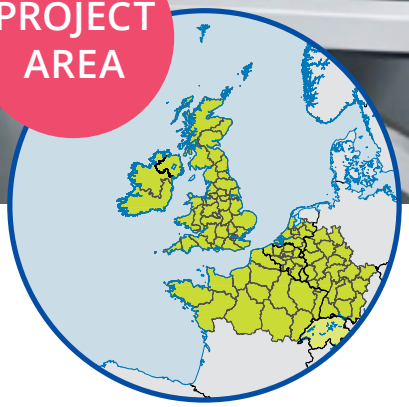
EUROPEAN UNION

Fibersort

European Regional Development Fund

RESOURCE AND MATERIALS EFFICIENCY

PROJECT AREA



Overcoming barriers for long-term implementation

March 2020

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EXECUTIVE SUMMARY

This report is the final publication of the Fibersort Interreg NWE project. As such, it explores the key barriers and critical success factors for an effective market uptake of post-consumer recycled textiles and automated sorting technologies, such as the Fibersort, in the long term in North-West Europe.

KEY BARRIERS

1. **Making recycled the new norm: exploring socio-cultural barriers.** Culture, whether organisational, national or community-driven, shapes individual perceptions which impact consumer and industry practices. The lack of urgency in appropriately handling the growing mountain of textile waste as well as the negative perception on recycled content in textiles must be addressed.

2. **Creating new materials from post-consumer textiles: overcoming physical barriers.** Textile-to-textile recyclers are in need of reliable feedstock for their processes. While sorting by fibre composition and colour through automated near-infrared technology enables these materials to be sorted accurately; consistency, quality and chemical safety of the post-consumer textiles are essential.

3. **Making recycling a sound business choice: reducing economic barriers.** To secure a thriving end-of-use value chain for textiles, it is crucial to be aware of market demands, costing and pricing of sorted post-consumer textiles. Accelerating the development and implementation of recycling technologies as well as ensuring price parity with virgin alternatives will determine its financial feasibility.

OPPORTUNITIES

- **Develop a thriving collection and sorting industry** by ensuring there is a business case to collect and sort the growing mountain of post-consumer non-rewearable textiles.
- **Create a market pull for recycled content** by incorporating recycled content in new textile products developed.
- **Assess and communicate the urgency of action** within your organisation as well as to citizens and consumers.
- **Maximize quality and consistency of** post-consumer **inputs** by providing the accurate feedstock for the relevant recycling technologies.
- **Safeguard the value of sorted materials as recycled content** by testing these materials for diverse applications and ensuring product safety.
- **Accelerate implementation of recycling technologies** by investing in their development and scaling.
- **Ensure price parity of recycled with virgin** by lowering processing costs of post-consumer textiles and recognising the true cost of virgin alternatives.

KEY STAKEHOLDERS

Collectors & Sorters are struggling to secure a business case to increase collection rates and sort locally due to a growing amount of non-rewearable textiles in the context of a saturated second-hand market. Automated sorting technologies present an opportunity to turn this growing volume of textiles into feedstock for textile-to-textile recyclers.

Recyclers play a key role in ensuring post-consumer non-rewearable textiles can be reintroduced as input to the textile value chain. Hence, the availability of textile-to-textile recycling technologies, their feedstock requirements as well as the market demand for materials containing recycled content needs to be fully understood, and financial and technical barriers need to be overcome.

Brands & Manufacturers have a responsibility and commitment to change their strategies and operations to secure a sustainable and circular future for the industry. Ensuring sorted post-consumer textiles find the end-markets that would enable their cyclability into new textiles requires further awareness-raising, consumer engagement, testing and use of recycled materials.

Policymakers at all levels have an operational, regulatory and/or legislative role to play to ensure collected textiles find a suitable destination as waste management is a public responsibility. Creating a conducive environment for textiles requires the deployment of regulatory, economic as well as soft instruments at all levels of governance.

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1. Introduction

In Europe we are facing a growing mountain of used textiles. The accelerating consumption and disposal practices cause textiles entering the market to reach their end-of-use rapidly. In North-West Europe (NWE) alone, research shows that around 4,700 kilo tonnes of post-consumer textile (PCT) waste is generated every year.[1] Still, only around 30% of PCT in NWE is collected separately while the rest is lost in household waste. In the best-case scenario, these textiles are sold in the second-hand market both locally and internationally. In NWE this average of rewearable textiles is around 64% of collected textiles. The remaining 36% is considered non-rewearable textiles due to their unsuitability for the second-hand market or the market saturation that second-hand clothing is currently facing.[2] Almost all of these textiles are currently being downcycled, incinerated or landfilled while less than 1% of all textiles produced are currently recycled into new ones.[3]

Automated sorting technologies could enable the industry to turn non-rewearable textiles that currently have no other destination than downcycling, landfill or incineration into valuable feedstock for high-value recycling. One of these technologies is the Fibersort, a Near Infrared (NIR) based technology able to categorise textiles based on their fibre composition, structure and colour. While the technology is promising, identified socio-cultural, physical, economic and regulatory barriers must first be overcome to ensure its successful implementation. In May 2019, the Fibersort Interreg NWE project published an overview of these potential barriers for the implementation of Fibersort technology for collectors and sorters.[4] This overview reflected macro trends in textiles, and identified their implications for the importance, fit and potential of the Fibersort technology.

This report is the final publication of the Fibersort Interreg NWE project. As such, it explores the critical success factors to address these key barriers (socio-cultural, physical, economic) for an effective market uptake of recycled PCT and automated sorting technologies, such as the Fibersort, in the long term in North-West Europe. The research builds on interviews with industry stakeholders[5] as well as publicly available data and previous project research. At the end of the report, recommendations are formulated for stakeholder groups across the value chain (collectors, sorters, recyclers, manufacturers, brands and policymakers) to address the barriers outlined.

2. The Fibersort Journey

The Fibersort technology has been under development throughout the last decade. The Fibersort Interreg NWE project (2016-2020) has allowed for it to be optimised and validated for commercialisation. In the next pages of this report, you will discover the improvements and updates made to the technology since the start of the project.

After this long journey, the partners that initiated the concept and development of this innovation, Smart Fibersorting and Valvan Baling Systems, reflect on the road travelled as well as the one that still remains ahead to ensure the successful implementation of the technology in the long-term.

"We started the Fibersort after a visit to India back in 2006-2008, where I witnessed firsthand the incredible amounts of textiles in landfill, as well as the working conditions, mainly child labour, involved in dealing with our (European) waste. After this encounter I decided we needed to change the way we handle our discarded textiles and started looking for a technical innovation that could provide us a more ethical and sustainable alternative.

After working together with a Dutch textile recycling company, between 2009 and 2012 on an innovation project called Textiles for Textiles -T4T to develop an industrial automated sorting machine with NIR technology and not achieving the expected outcomes, we decided to ask Valvan Baling Systems to join us in this endeavour and develop a solution to these issues.

Valvan has been developing, building and testing its own textile database and analysis software to enable the sorting application, under the brand name Fibersort, for several years now. This technology offers us the solution to find an alternative, high-value destination for our waste. In 2016, Valvan Baling Systems and ourselves, together with four other partners (Circle Economy, Leger des Heils ReShare, Procotex Corporation and Worn Again Technologies), have received funding support from the European Commission INTERREG NWE programme to optimise, validate and launch the FIBERSORT technology in the global market. On the 14th of March 2018, at Wieland Textiles, the consortium was able to present the Fibersort technology for the first time at a Demo Day. This year, on March 12th we will present the industry with the optimised version of the Fibersort, proving the potential and addressing the remaining challenges of automated sorting of post-consumer textiles, based on reusing post-consumer textile content in new garments. A real circular process and a solution for low quality textile waste."

Hans Bon, Director, Wieland Textiles & Smart Fibersorting

"Throughout the Fibersort NWE Interreg project we have learned a lot, made a lot of mistakes and developed the machine further. Today I am happy to say that the Fibersort technology is working very well. As a company specialised in developing machinery for making bales and sorting textiles, Valvan has had the responsibility throughout the project to produce the technology of the machine and ensure that it is accurately sorting on fibre composition and colour.

Further, we started the project with a manual feed-in system which we were now able to update to an automated feed-in system powered by robot arms that has enabled the machine to improve its productivity levels.

Nevertheless, sorting textiles in an automated manner is not an easy endeavour. After all of these years, we can assure that we have developed a complex technology that caters to a wide variety of textiles that come in multiple shapes, colours, compositions and material blends. In this regard, continuous improvement will be constantly required and we are determined to continue the journey to make the Fibersort better and better each day."

Maurits Vandeputte, Project Engineer, Valvan Baling Systems

3. The Fibersort Today

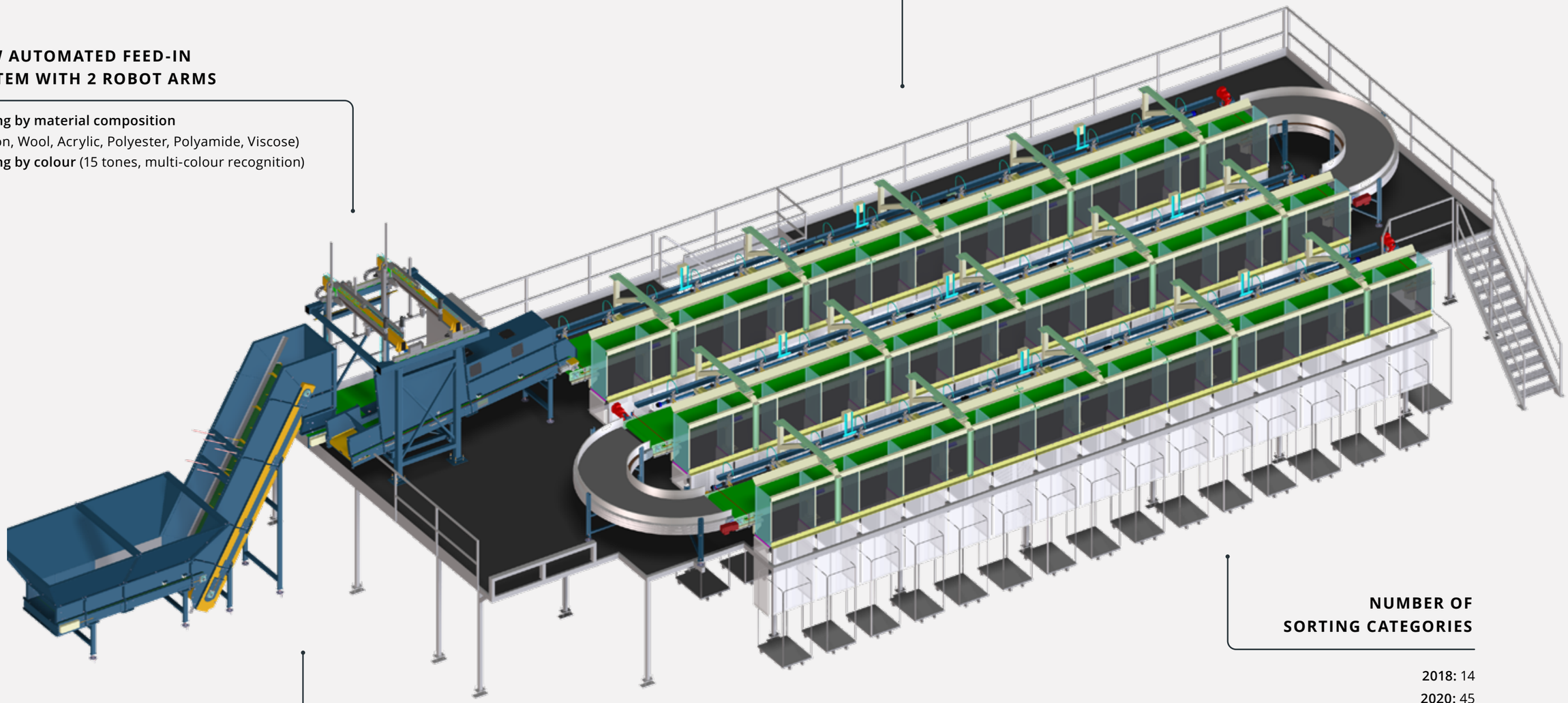
The Fibersort is an automated sorting technology that enables the categorisation of textiles according to their fibre composition and colour. Based on NIR technology, the machine is able to provide accurate and reliable feedstock to textile-to-textile recyclers. For sorting accuracy please refer to the Fibersort Fact Sheet published in July 2019.[6]

NEW AUTOMATED FEED-IN SYSTEM WITH 2 ROBOT ARMS

Sorting by material composition
(Cotton, Wool, Acrylic, Polyester, Polyamide, Viscose)
Sorting by colour (15 tones, multi-colour recognition)

THROUGHPUT ACCURACY

2018: 60%
2020: 60%



PRODUCTIVITY

2018: 6 sec/piece (with manual feed-in) - Theoretical capacity: 1 sec/piece.
2020: 1.5 sec/piece - Theoretical capacity: 3 sec/piece per robot. Robots are modular and expandable up to 4 on the same line.

NUMBER OF SORTING CATEGORIES

2018: 14
2020: 45

4. Making recycled the new norm: exploring socio-cultural barriers

When implementing new technologies, culture, whether organisational, national or community-driven, shapes individual perceptions towards these technologies. These in turn, impact consumer, industry and community practices.

4.1 Develop a thriving collection and sorting industry

Only a small portion of PCT is currently collected separately. Nevertheless, textile collectors are struggling to secure a business case to increase collection rates due to a growing amount of non-rewearable textiles in the context of a saturated second-hand market. The textiles collected have diverse potential to be reinserted into the market, and automated sorting technologies present an opportunity to turn this growing volume of textiles into feedstock for textile-to-textile recyclers. But firstly, the collecting and sorting industry needs to be empowered by all industry actors in order to thrive. Take a closer look at what regional waste management organisations are doing in the Netherlands to shift the business-as-usual practices:

Who is Cirkel Waarde?

Circulus-Berkel[7] is a publicly owned waste management company for nine municipalities in the Netherlands. Founded in the year 2014 by a merger, it currently provides services for 443,234 inhabitants, and employs 736 people. Together with ROVA,[8] a waste management company operating in 23 municipalities in the centre and east of the Netherlands, and AVU,[9] the Utrecht Waste Disposal joint regulation, they have spearheaded the Cirkel Waarde Initiative.[10] This strategic alliance has the ambition of sharing, aligning and scaling the circular waste management efforts of 57 municipalities in the Netherlands.

What are they doing?

Building on the awareness that currently only a small portion of used PCT is collected separately, the guiding question for their work is "What happens if we start collecting more?" They have recognised that the current system does not question the destination or future use of textiles after they are collected. However, through close cooperation with their collector they can now acknowledge that around 24% of the textiles that are collected are still currently downcycled or incinerated. In order to reduce this percentage and ensure the correct management and reutilisation of textiles, a joint effort to combine municipal ambitions for textile collection in the Netherlands is being rolled out.

What have they learnt?

ENSURE TRANSPARENCY THROUGH FINE SORTING

Transparency in the collection, sorting, reuse and recycling of PCT is essential to ensure waste is not shipped across borders and materials are handled appropriately. A regional sorting process that clearly defines rewearable from non-rewearable textiles is a critical activity in this process as there is a need for consensus on the categorising of materials as well as their future uses. In preparation for diverse recycling technologies, automated sorting is an essential step to scale an effective handling process for non-rewearable textiles collected.

CREATE THE RIGHT INCENTIVES TO COLLECT

Beyond the current collapsing market for secondhand textiles and the poor business case for textile collection, the environmental impact of mishandled textiles at their end-of-use is substantial, with most of them currently being landfilled or incinerated. Contracts between municipalities and textile collectors need to be redesigned to move away from a focus on financial reward alone to more focus on transparency and accountability on the future destination and uses of these textiles.

OPTIMISE COLLECTION & SORTING METHODS

A centralised collection and regional sorting system is needed to implement a rationale for collection and sorting that ensures that all textiles are reused at their most optimal cycle (resale, repair, remanufacture, recycle) in accordance with the Waste Hierarchy stipulations. This includes agreeing on new operational models between collectors, sorters, waste managers and second-hand stores.

4.2 Create market pull for recycled content

Several brands are already using recycled textiles on a small scale. However, the vast majority of them are not yet sourcing PCT. Ensuring sorted PCT find the end-markets that would enable their cyclability into new textiles requires further testing and investment in research and development as well as consumer and brand engagement. Take a closer look at the recycled PCT that an independent label is already able to achieve, produce and commercialise:

loop.a life

Who is loop.a life?

The Dutch Loop.a.life[11] label is a circular textile company that creates fibres, yarns and textile products from PCT since 2016. Through their Brightloops Textiles white label company they also facilitate the development of circular yarns and end-products for other fashion and textile companies. The label uses no water and chemicals in the recycling process and produces in a closed loop in Europe.

What are they doing?

After in-depth research into the issue of textile waste, the label has focused on the mechanical recycling of non-rewearable textiles to create a local solution for a post-consumer material, resources that are currently considered waste in the Netherlands. By working in close collaboration with local sorters, recycling partners, spinners and knitwear producers, they have developed yarns and products with wool and cotton waste, including a 100% recycled collection of wool, polyamide and cotton blends. With a strong focus on natural fibres and knitted products, applications for their yarns are broad and mainly dependent on choices made throughout the spinning process, all of which is dependent on finding the right partners to co-create with. At the moment they are also working on other materials as well, as they are convinced that every textile in the waste stream should be handled appropriately and potentially reused.

What have they learnt?

THE MARKET DICTATES THE OUTPUT

Automated sorting technologies provide the opportunity to source more accurate materials. Through a collaboration with Smart Fibersorting they have received cotton feedstock that was 93.7% cotton, complemented by other cellulose-based materials such as viscose, a significantly higher percentage than usually received through manual label sorting. However accurate the sorting technology may be, the organisation suggests that other indicators such as structure and quality of the textiles also need to be part of the choices assessed within the automatic sorting process. Sorting on woven qualities for instance or separating bales of lower and higher qualities of woolen textiles, could enable them to be used for different product applications, and hence avoid waste being created later in the value chain. This is only possible after enough volume is created. The label is convinced that at this moment, the way to move forward is to start working with the materials within product development, co-creating value and volume with other industry partners of the existing Fibersort capacity to sort PCT.

SECURE INVESTMENT IN R&D

Investment in research and development of new materials and processes is time and resource consuming. This is especially challenging for innovation-focused companies that develop valuable knowledge by working with the materials and creating new applications and end-products. These companies are mostly in the start-up phase where financial limitations become more visible, since long-term investment in product and process development is harder to secure. Ensuring availability and access to innovation grants, financial incentives and co-development opportunities with larger brands would support and accelerate the creation of new materials, with enhanced performance and potential applications.

BUILD TRUSTED RELATIONSHIPS IN YOUR LOCAL CONTEXT

Leveraging value chain cooperation locally by partnering with textile collectors, recyclers, manufacturers and municipalities presents an opportunity to develop further the reuse and recycling potential of PCT while creating employment opportunities and stimulating local manufacturing. The company is currently working in close cooperation with Wieland Textiles and Smart Fibersorting to set up a local production line including automated sorting, cleaning and fiberising of PCT into high-quality resources and yarns, essential to be able to respond to market demands and upscale, an intrinsic need for the Fibersort to become financially feasible.

4.3 Assess and communicate the urgency of action

Awareness-raising efforts and goal setting are still not enough to drive a real shift in consumption and production practices. In order to gain momentum that drives significant investment in the collection, sorting and recycling practices of postconsumer textiles, brands and manufacturers need to also change their strategies and operations to secure a sustainable and circular future for the industry. Take a closer look at how a global retailer group is working on shifting their strategy and sourcing practices towards circularity:

Gap Inc.

Who is Gap Inc.?

Headquartered in the United States, global retailer group Gap Inc.[12] offers products through seven brands in 90 countries, employs approximately 135,000 people and works together with over 700 vendors around the world. The group operates over 3,100 brick-and-mortar stores, e-commerce sites as well as almost 400 franchise stores. They are participating in several pre-competitive industry initiatives that foster circularity, including Ellen MacArthur Foundation's Make Fashion Circular with the Jeans Redesign Guidelines[13] as well as with textile collection pilots,[14] Fashion Positive,[15] the Alliance for Responsible Denim[16] and the Global Fashion Agenda's 2020 Circular Fashion System Commitment.[17]

What are they doing?

In order to address the impacts of a product throughout its lifecycle, the global retailer has focused on strategic innovation to reduce their dependence on traditional inputs and decouple input resources from the ability to generate profit. Their circularity strategy, currently under development, is focused on four pillars to guide Gap Inc. 's work: design, materials and manufacturing, advanced resource recovery, and new business models.

What have they learnt?

INTEGRATE RECYCLED CONTENT - A LITTLE GOES A LONG WAY

Some of Gap Inc.'s brands have been working with recycled materials for at least five years, including recycled synthetics (polyester from PET bottles, and polyamide) as well as wool. Since 2019, they have been working with recycled cotton, using over 41 tonnes of pre- and post-consumer recycled cotton to produce 975,000 units of denim with at least 5% recycled content. Starting at this lower percentage has enabled them to avoid any potential negative impacts on performance, price and aesthetics, while introducing recycled cotton in their collections. The assortment including these materials is expected to continue growing in 2020.

SUPPORT THE DEVELOPMENT OF AN ECOSYSTEM FOR TEXTILE COLLECTION

Gap Inc. highlights the importance for brands to ensure the availability of feedstock in the future. Collection and sorting infrastructure become a matter of utter importance when envisioning a scaled circular system. Supporting opportunities to scale at municipal level, while integrating to the systems that are already in place, hence, makes the most sense. Automated sorting technologies and traceability systems support these opportunities in collection and sorting to obtain high-quality input.

ADVANCE RESOURCE RECOVERY TECHNOLOGIES

A global shift in how businesses operate requires collective action and industry alignment. The commercialisation and scaling of new technologies, processes, and materials still needs to happen to make this shift possible. Gap Inc. is contributing to this ecosystem by dedicating time and expertise to achieve the proof-of-concept of advanced resource recovery technologies.

BRING THE CONSUMER ON BOARD

The consumer plays a significant role in shifting practices in collection, sorting, and recycling. The global retailer points out that, when knowledgeable about the environmental and social impacts of textiles, their consumers have a positive perception of recycled textiles and are supportive of consuming sustainable or circular products. Still, they will not compromise on quality and performance. Storytelling and communication about social impact stories are key to encourage a shift in consumer behaviour.

5. Creating new materials from post-consumer textiles: overcoming physical barriers

Sorting by fibre composition through the updated NIR technology scanners at a significantly increased productivity rate, will result in a reliable and consistent feedstock for textile-to-textile recyclers. Colour sorting will only enhance the potential the technology has to support a new circular textiles industry, especially for mechanical recyclers. Still several barriers need to be overcome in relation to the consistency and content of these inputs.

5.1 Maximize the quality and consistency of inputs

Concerns with using PCT mainly relate to the quality, consistency and availability of these materials. Nevertheless, several brands and manufacturers are already incorporating recycled content in their collections. Recycling technologies are also seeing a surge both in the number of recyclers as well as the amount of materials processed. Take a closer look at what the Fibersort Interreg project partner has learnt after several recycling trials:

Who is Procotex?

Procotex Corporation[18] is a family-owned company specialised in mechanical textile recycling and in the preparation of flax fibres for the spinning industry. Founded in the year 1965 in Belgium, it currently also operates through sister companies in Turkey, Lithuania and France.

What are they doing?

Holding deep knowledge and expertise in recycling textiles to fibre for future use in automotive, mattress, geotextile and other industries, Procotex has led the mechanical recycling work as a partner in the Interreg funded Fibersort project. Through this work, the organisation and the consortium of partners has developed specific knowledge and insights within the textile-to-textile recycling landscape. In order to analyse and validate the textiles sorted with the Fibersort machine, Procotex has removed hardware, cleaned, opened and garnetted the materials received and has worked closely with spinners and knitters to test the potential of these fibres to create new yarns and textiles.

What have they learnt?

SOURCE AUTOMATED SORTED TEXTILES PER MATERIAL AND COLOUR

Automated sorting technologies help ensure reliable and accurate input to a scalable recycling process. Further, automated colour sorting is essential to ensure the feasibility of textile-to-textile mechanical recycling.

FIND VIABLE PRE-PROCESSING SOLUTIONS FOR RECYCLING

Hardware and label removal are critical activities in the preparation of textiles for mechanical recycling. Through the project trials, the conversion costs to remove all hardware and labels from textiles manually were significantly high (0.62€/kg), making it not feasible in the NWE region at this cost. Procotex has a division in Turkey where this pre-processing could be done and the costs for this should be further tested. Sheltered workshops undertaking pre-processing activities or mechanical hardware removal solutions should be tested and their potential further researched.

SCALE THE PROCESS TO GAIN EFFICIENCY AND CONSISTENCY

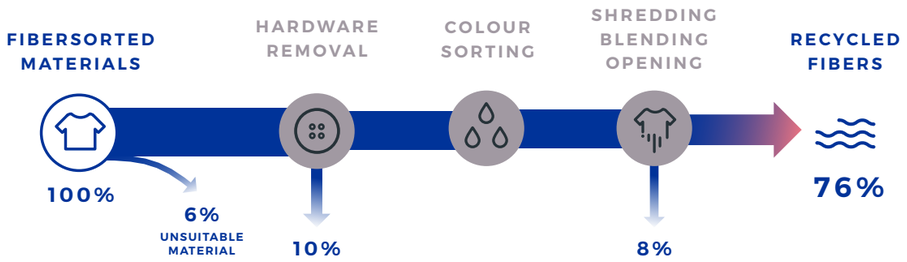
The optimum volume for Procotex to recycle is around 5 tonnes per fraction. This is mainly because cleaning the carding drums between different colour/material fractions may take up to 8 hours, producing a one day stop in production. Further, only when producing a sufficient quantity in the blending rooms can certain consistency in colour be guaranteed. Additionally, machines have to be adjusted to different opening settings depending on the material to be recycled. The estimation is that current recycling costs could be halved if at least 5 tonnes were processed at the same time.

FACILITATE COLLABORATION TO LEVERAGE ON EACH PARTNER'S EXPERTISE

Developing a close collaboration with other stakeholders in the value chain that have complementary expertise is key to ensure the entire value chain has the relevant know-how to implement and develop recycling processes.

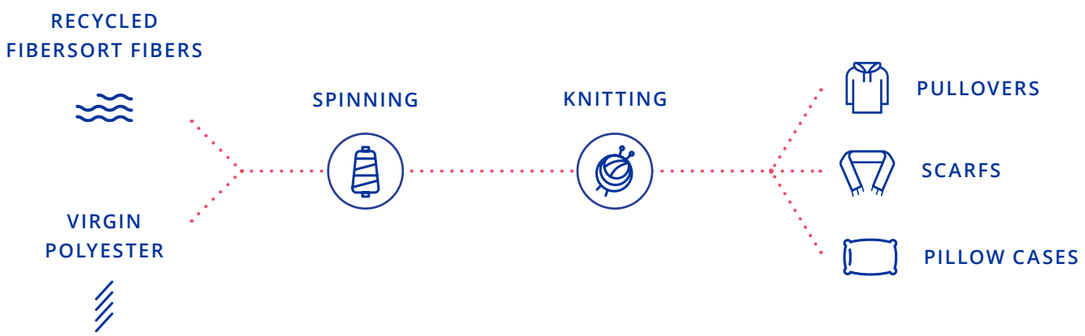
FROM GARMENT TO GARMENT

In February 2018, Procotex received 4,740 kg of Fibersorted textiles. These textiles were from 12 different compositions and were sorted into ~10 different colours. From the received volumes of textiles, 16% consisted of labels, buttons, zippers and other unsuitable materials that had to be removed in order to recycle the textile material. After recycling these textiles, 43 bales (3,614 kg) of a variety of fibre composition and colours were created. An 8% was lost during the opening of the material and had to be removed as dust from the condensers of the pulling line.



A second recycling trial was conducted in March 2019 to test the accuracy improvements of the updated Fibersort scanner. The accuracy of the material composition has been tested and the results are available in the Fibersort Fact Sheet[19] published in July 2019. The input-output efficiency of the process has been raised up to 82% during the second trial.

In March 2019, Procotex sent a selection of the recycled fibres to a Spanish spinner to test their possible applications. The material included a bale with 70% wool content and another one with 90% wool content. After a few months, the first spools of wool yarn, with up to 60% recycled post-consumer Fibersorted textiles returned to the company. In this case, the final yarn was blended with virgin polyester. The spinner has found that it is possible to ring spin the fibres into a new yarn. Lastly, a flat-knitting Belgian company created new knitted fabrics and end-products from the recycled yarns including pullovers, scarfs and pillowcases.



Source: Procotex Corporation

5.2 Maximize the quality and consistency of inputs

The lack of traceability of most textiles carries the risk of re-introducing textiles into the system which could pose a threat to product safety due to chemical contamination. In regard to the presence of recycled content, there is a need to ensure and understand the material composition as well as its potential when trying to further develop markets for PCT. Take a closer look at how a collector-sorter group is striving to understand the value of their sorted materials:

Who is TEXAID?

TEXAID[20] is a charity-private partnership founded in 1978. Based in Switzerland, they also operate in Germany, Austria, Bulgaria, Hungary, Morocco and the US. The company collects group-wide around 81,000 tons of used textiles per year, of which slightly less than half is collected in Switzerland. Around 48% of the group-wide collected garments are sorted in their own facilities.

What are they doing?

TEXAID expects that larger amounts of collected volumes will reach their facilities once the Waste Framework Directive mandate to collect textiles separately across the EU by 2025 comes into play. Although their main priority is to maximise the opportunities for reuse, they recognise that there is an increasing amount of garments that cannot be reused either due to low quality or unsuitability with market demand. This is the reason why during the past two years they have co-developed the Texcycle project together with Lucerne University of Applied Sciences and Arts and Coop, funded through Innosuisse – the Swiss Innovation Promotion Agency.[21] The project aimed to assess the availability of non-rewearable textile materials within TEXAID's current sorting process, and understand how they can be transformed into new products through high value recycling.

What have they learnt?

FIND NEW OPPORTUNITIES FOR RECYCLING

It is crucial to understand the composition of the fraction of non-rewearable textiles. In today's market, the purer the material, the easier it is to find recycling opportunities as well as higher market values. Material blends still pose challenges and their handling should be addressed through further R&D.

BUILD INTERNAL CAPABILITIES AND UPSKILL SORTERS

In order to maximise the consistency of inputs for recycling, the sorting process for non-rewearable textiles differs significantly from the sorting focused on reuse. Optimizations have been identified to sort textiles based on a combination of material type. In this regard, sorters will need to be reskilled to sort per material type as well and not only on quality.

ASSESS THE POTENTIAL OF TECHNOLOGIES TO SUPPORT MATERIAL IDENTIFICATION

With manual sorters making an informed decision per garment every six seconds, and around half of the textiles in the recycling fraction with no label or washed out label, technologies such as automated sorting and traceability solutions can further support sorters in material identification.

INVEST AND COLLABORATE WITH EXPERIENCED PARTNERS

TEXAID highlights the importance of sharing successes and challenges throughout the value chain and partnering with stakeholders with complementary areas of expertise. A close relationship with the recycling industry is key to ensure that the textiles are accurately sorted for the different recycling technologies.

ENSURE THE SAFETY OF NEW PRODUCTS DEVELOPED

Prototypes developed during the Texcycle project, belonging to the project partners, included a recycled woolen yarn suitable for carpets, as well as non-woven textiles suitable for insulation and acoustic as well as textile accessories. All products were tested for chemical safety and the substances found were REACH comformative, hence in compliance with current EU legislation.

6. Making recycling a sound business choice: reducing economic barriers

The success of the Fibersort depends on the conditions and context under which the technology is implemented. It is crucial to be aware of the market demands, costing and pricing of sorted PCT.

6.1 Maximize the quality and consistency of inputs

The demand, size and pricing parameters for PCT end-markets still present major uncertainties. While a few technologies for certain materials are already at scale, certainty on the future of recycled textiles remains limited. This is due to the relative immaturity of most recycling technologies, as well as brands and consumers' lack of in-depth understanding of the availability and potential of recycled fibres and fabrics made from PCT. Take a closer look at the journey of Fibersort Interreg project partner as an emerging recycling technology:

Who is Worn Again?

Worn Again Technologies[22] is a technology licensing company that is developing and commercializing proprietary solvent-based processes that will enable end- of- use textiles and polyester packaging resources to remain in constant circulation, driving positive economic, social and environmental impacts. The company has developed valuable relationships with investors including H&M Group, Sulzer Chemtech, Himes Corporation and Directex, as well as having the support of influential brands and partners, such as Kering, ASICS Europe, Sympatex, Dibella and Dhana. After becoming part of the Fashion for Good scaling programme in 2017, Worn Again Technologies has been recognised at multiple circular economy awards over the past three years.

What are they doing?

Worn Again has developed a chemical polymer recycling technology that offers innovative ways of handling blended textiles, which have become very common in the clothing manufacturing over the past decades. The process expects to deal with a significant percentage of non-rewearable PCT as 'feedstock' materials, particularly textiles of pure polyester and polycotton blends. The process is also able to handle up to 10% of other fiber types, e.g. elastane, polyamide and wool. As the chemical recycling partner in the Interreg funded project, Fibersort, Worn Again analysed and tested materials which were sorted with automated technology, Fibersort, to ensure that textiles were separated and prepared in accordance with the recycling process.

What have they learnt?

SORT TEXTILES BY MATERIAL TYPE

Chemical textiles recycling technologies are in need of accurate sorting by material composition to avoid contamination within the recycling process (e.g. in this case >10% of other fibres). The sorting criteria differs significantly from sorting for reuse and therefore automated sorting technologies can provide reliable materials at scalable volumes.

SET CLEAR FEEDSTOCK SPECIFICATIONS

The journey throughout the Fibersort project has shown that it is essential to build clear specifications for sorted PCT that are suitable for the recycling process. Making this information available to collectors and sorters enables the assessment of available volumes per material type. For Worn Again, their polyester-rich feedstock specifications allow for five fractions of the Fibersort to be incorporated into their process: pure polyester, 65/35 poly cotton, 50/50 poly cotton, 35/65 poly cotton and pure cotton. A large percentage of the materials that are currently sorted with Fibersort technology correspond to these categories.

SET THE RIGHT ENVIRONMENT FOR SCALING

In order to scale, the investments for sorting and recycling technologies need to be financially feasible, and there needs to be a business case for increased collection of PCT. Facilitation of scaling funds, innovation grants, tax incentives or other financial instruments need to be available and accessible to the end-of-use textile supply chain. Further, policy instruments such as the implementation of reuse and recycling targets at European level could encourage the scaling of these solutions.

KEY SPECIFICATIONS FOR WORN AGAIN

- Pure polyester, polycotton blends and polycellulose
- All colours
- Mono or multi-layered
- De-metalised: zippers, studs and other metal hardware removed
- De-buttoned: buttons, fasteners and other non-textile hardware removed

6.2 Ensure price parity of recycled and virgin

To date, recycled fibre and fabrics made from PCT are priced higher than virgin sources. This is intimately related to the higher costs required to process PCT, as well as the low demand for them. The upfront investment-costs are still high for many collectors and sorters, and therefore the increase in the end-markets is necessary to justify the investment. The financial feasibility of the Fibersort technology is dependent upon the sale of its outputs: sorted PCT. The market for sorted PCT is contingent on textile-to-textile recycling technologies, or potentially other high-value recycling open-loops. Take a look at how Fibersort Interreg project partners are working towards closing the business case on automated sorting:

Who is Leger des Heils ReShare?

The Salvation Army was founded in 1878 in England and was one of the first organisations to collect second-hand clothing for relief projects. Since 2006, Leger des Heils Reshare,[23] the Dutch branch of the organisation, has been collecting and sorting textiles in several municipalities of the Netherlands.

Reshare has been working together with Smart Fibersorting,[24] the initiative of the Dutch textile sorting company Wieland Textiles B.V., and all Interreg Fibersort partners, to assess and close the business case on automated sorting.

What are they doing?

The business case for textile collectors and sorters is plummeting. Automated sorting technologies present an opportunity for a growing volume of non-rewearable textiles to find a high-value textile-to-textile recycling solution when sorted by material type, colour, and potentially structure. In order to assess the business case for the Fibersort, the main parameters evaluated were the production capacity, the costs and revenue streams and finally the type of materials being sorted. Major lessons have been learnt throughout the project; however, many questions still remain to be further explored.

What have they learnt?

CREATE THE RIGHT INCENTIVES TO COLLECT

There needs to be a business case to collect PCT in order for collectors to be able to establish viable contracts with the municipalities. On one hand, textile collectors cannot bear the full risk of the market value of textiles. On the other hand, implementation of policy instruments such as EPR or Innovation grants are key to ensure the affordability of the collection and sorting infrastructure.

UNDERSTAND THE MARKET

The sorting fractions that an automated sorting technology should integrate depend on market demand and value. Currently the Fibersort is sorting on 45 different fractions including 6 material types and 15 colours. As many of the value chain stages after the sorting process still remain at small scale, the uncertainty on market demand remains.

OPTIMISE COLLECTION & PRE-PROCESSING METHODS

Collection methods affect the quality of the collected textiles and hence, their potential value. Reshare has reported that above ground containers function better to preserve the cleanliness of textiles due to less leakage of containers and better disposal practices from citizens. Pre-processing activities, such as hardware removal to recycle textiles also influence the business case significantly. Mechanical removal of hardware remains to be tested and the implications to the business case further assessed.

ESTABLISH STRONG RELATIONSHIPS ACROSS THE VALUE CHAIN

Close collaboration with recyclers is key to validate the quality and performance of sorted textiles for specific product applications. Further, increased understanding of the materials found within non-rewearable PCT from several sorting facilities across NWE is needed to further adjust the current business case to a regional context.

7. Conclusions

The case studies portrayed throughout this report dive into the opportunities to successfully integrate automated sorting technologies and recycled post-consumer textiles across the value chain. Over the past years, innovation has spurred across this sector of the industry with many more cases that could be explored. However, several challenges remain to ensure the long-term implementation of these technologies in relation to financial and technical feasibility as well as the opportunities to scale.

This report also provides key recommendations for collectors, sorters, recyclers, manufacturers, brands and policymakers gathered throughout the project, in order to successfully implement the use of recycled post-consumer textiles and automated sorting technologies within the textiles and apparel industry. These recommendations are shown in the overview below, where every stakeholder has an opportunity and a responsibility to address socio-cultural, physical and economic barriers. Although the Interreg NWE Fibersort reaches its ending date in March 2020, the partners in the Fibersort consortium expect to continue working towards this circular ambition, as well as encouraging others to join the journey.

To access the content developed throughout the project, go to www.fibersort.eu

	COLLECTORS & SORTERS	RECYCLERS
MAKING RECYCLED THE NEW NORM: EXPLORING SOCIO-CULTURAL BARRIERS	• Optimise collection methods to ensure higher quality of textiles, for instance through above-the-ground containers. • Assess the availability in local context as well as the material type and quality of the textiles collected to ensure suitability with recycling processes. • Partner with recyclers to pilot potential applications for collected non-rewearable textiles. • Communicate sorting challenges to recyclers, brands and manufacturers to encourage design for recyclability. • Communicate challenges and (im)possibilities of current end-of-use infrastructure to governments pursuing circularity ambitions. • Set targets and align with a regional strategy towards a circular economy for textiles.	• Assess the availability of collected sorted post-consumer textiles in your local context. • Partner with collectors/sorters to test their materials and assess their potential uses and applications. • Communicate recycling challenges to brands and manufacturers to foster design for recyclability. • Set clear specifications on material grades suitable for your recycling process and make this available to collectors/sorters, manufacturers and brands. • Set your own or align with industry-wide targets and commitments to close the textiles loop.
CREATING NEW MATERIALS FROM POST-CONSUMER TEXTILES: OVERCOMING PHYSICAL BARRIERS	• Assess infrastructure needs to process collected post-consumer textiles, in collaboration with regional and national governments. • Facilitate non-sensitive knowledge-sharing as much as possible, to leverage the expertise in the collection field and communicate with sorters, recyclers, manufacturers and brands on the potential value of the collected textiles. • Build trusted relationships with partners and clients, while establishing clear agreements and expectations on the material supplied. • Ensure transparency on origin and future destination of sorted textiles. • Sort non-rewearable textiles by material composition, and, if relevant, by colour. • Assess investment in automated sorting technologies for post-consumer textiles. • Collaborate with value chain partners to test non-rewearable textiles to ensure safety in accordance with regulations on chemical content (e.g. REACH)	• Source automated sorted textiles per material type to ensure reliable and accurate input to your processes. • For mechanical recycling, source colour sorted PCT as homogeneous as possible to avoid extra dyeing. • Assess the potential of blending post-consumer with post-industrial textile waste. • Facilitate non-sensitive knowledge sharing as much as possible, to leverage the expertise in the recycling field and widespread the materials' potential and value. • Assess benefits and costs of certifying your recycled material with a (voluntary) certification and/or standard. • Build trusted relationships with partners and suppliers, while establishing clear agreements and expectations on the material supplied.
MAKING RECYCLING A SOUND BUSINESS CHOICE: REDUCING ECONOMIC BARRIERS	• Assess funding opportunities to innovate or implement existing cleaning, hardware and non-compatible label removal solutions • Explore potential automation of activities where it is relevant to minimise handling and processing costs for collected textiles • Collaborate with value chain partners to understand the market value and potential of collected textiles.	• Invest in and/or lead the development and scaling of recycling technologies for pure or blended materials by partnering with brands, manufacturers or other relevant organisations. • Assess funding opportunities to innovate or implement existing hardware and non-compatible label removal solutions • Validate quality and performance of recycled products for determined product applications

	POLICYMAKERS	MANUFACTURERS & BRANDS
MAKING RECYCLED THE NEW NORM: EXPLORING SOCIO-CULTURAL BARRIERS	• Optimise collection methods and inform citizens on how to dispose of textiles (Regional) • Assess current textiles strategies to ensure the right incentives are created (Regional) • Set targets for textiles reuse and recycling (National) • Procure recycled content in own materials and disseminate lessons learnt. (Regional, National, European) • Inform consumers on the advantages of recycled content through campaigns. (National, European) • Define terminologies and methodologies for the assessment of used textiles flows. (European) • Assess the flows and impact of used textiles within own territory. (Regional, National, European) • Define a regional strategy towards a circular economy for textiles. (Regional, National, European)	• Increase customer engagement by implementing take-back and/or repair schemes. • Take-back garments once consumers no longer want to use them and partner with collectors, recyclers and mills to high-value recycle these garments. • Partner with or consult experienced players in textile collection to develop and implement these schemes. • Communicate relevant information on environmental, social and ethical performance of materials, products and processes to inform consumers' purchasing intentions. • Avoid financial incentives in take-back schemes that incentivise increased consumption. • Uptake recycled content firstly focused on quantity of products, to later focus on increasing the quantity of recycled content per product. • Set your own or align to industry-wide targets and commitments to close the textiles loop. • Retrain internal teams on circularity, its potential and current limitations. • Communicate your targets and goals to consumers and engage them in personal goal setting to translate purchasing intentions into changed purchasing behaviour.
CREATING NEW MATERIALS FROM POST-CONSUMER TEXTILES: OVERCOMING PHYSICAL BARRIERS	• Implement Design Guidelines. (European) • Map infrastructure requirements to process PCT. (National) • Establish end-of-waste criteria for sorted textiles. (European) • Enforce REACH Directive. (National) • Assess the implications of REACH for recycled content. (European) • Define testing procedures for recycled content. (European) • Assess use and limitations of standards for recycled content. (European) • Invest in the development of traceability solutions. (National, European) • Lead the adoption of traceability solutions in the industry. (European)	• Design garments that are durable (according to material health guidelines) and can be recycled (today or in the near future). • Avoid the presence of materials that cannot currently be handled appropriately at their end-of-use. • Facilitate and/or lead value chain collaboration, partner with collectors, recyclers and mills. • Assess the necessary requirements of the recycled PCT in your products and communicate to recyclers which certifications and/or standards cover these requirements. • Invest in further research into the actual impacts of recycled textiles including but not limited to chemical composition, environmental footprint, labour conditions. • Build trusted relationships with partners and suppliers, while establishing clear agreements and expectations on the material supplied.
MAKING RECYCLING A SOUND BUSINESS CHOICE: REDUCING ECONOMIC BARRIERS	• Invest in the development and scalability of recycling technologies. (National, European) • Invest in the development and scalability of hardware removal technologies. (National, European) • Assess the potential of sheltered workshops for hardware removal. (Regional) • Support the establishment of the required infrastructure through innovation grants. (National, European) • Source materials with recycled content through Green Public Procurement. (Regional, National, European) • Establish EPR to ensure affordability of infrastructure. (National) • Investigate potential VAT changes to allow for price parity of recycled content with virgin alternatives. (National, European)	• Invest and/or participate in development and scaling of recycling technologies by partnering with recyclers. • Assess the potential to use your own textile waste from production together with PCT to reduce costs and manage resources more efficiently. • Conduct a long-term assessment of material pricing that takes into consideration the valuation of natural capital, resource scarcity and price fluctuations. • Increase market offer of recycled content in final products, to reduce pricing due to scale.

8. Endnotes

1. Interreg NWE, Fibersort, 2018. Industry Reference Sheet (https://www.circle-economy.com/fibersort-industry-reference-sheet)
2. Interreg NWE, Fibersort, 2018. Manual Sort of Post-Consumer Textiles in North-West Europe (https://www.nweurope.eu/media/3453/fibersort_manual-sort-pct_jan2018.pdf)
3. Ellen MacArthur Foundation, 2017. A new textiles economy: Redesigning fashion's future (http://www.ellenmacarthurfoundation.org/publications).
4. Interreg NWE, Fibersort, 2019. Potential barriers for the long-term implementation of the Fibersort (https://www.nweurope.eu/media/6811/fibersort-barriers-report-final.pdf)
5. Douchy, N., 2019. Interview with Nicolas Douchy from Procotex, 3 December. / Floor-van Randwijk, H., 2019. Interview with Henriette Floor-van Randwijk from Leger des Heils Reshare, 13 December. / Akerboom, M., 2020. Interview with Marieke Akerboom from Worn Again, 15 January / Westerhoff, M. & Mann, M., 2019. Interview with Marjolein Mann and Michiel Westerhoff from Cirkel Waarde, 6 November. / Pehrsson, A. & Emmenegger, M., 2019. Interview with Anna Pehrsson and Michael Emmenegger from TEXAID, 14 November. / Bright, L., 2019. Interview with Lauren Bright from Gap Inc., 10 December. / Mensink, E. & Berentzen, I, 2019. Interview with Ellen Mensink and Isabel Berentzen from Loop.a life, 6 December.
6. Interreg NWE, Fibersort, 2019. Fibersort Fact Sheet. (https://www.nweurope.eu/media/9160/wp-t1-extra-fibersort-fact-sheet-accuracy-final-copy.pdf)
7. Circulus-Berkel, 2020. Home (https://www.circulus-berkel.nl/)
8. ROVA, 2020. Werken aan een mooie leefomgeving (https://www.rova.nl/) 9. AVU, 2020. Afval Verwijdering Utrecht (http://www.avu.nl/cms/)
9. AVU, 2020. Afval Verwijdering Utrecht (http://www.avu.nl/cms/)
10. Circulus-Berkel, 2020. Cirkel Waarde. (https://www.circulus-berkeljaarverslag.nl/thema-s/grondstoffen/cirkelwaarde/)
11. Loop.a.life, 2020. Duurzame Kleding van Loop.a life | 100% circulair (https://loopalife.com/)
12. Gap Inc., 2020. Home (https://www.gapinc.com)
13. Ellen MacArthur Foundation, 2019. Make Fashion Circular launches the Jeans Redesign. (https://www.ellenmacarthurfoundation.org/news/make-fashion-circular-launches-the-jeans-redesign)
14. Ellen MacArthur Foundation, 2020. New York City. (https://www.ellenmacarthurfoundation.org/assets/downloads/WEARNEXT-CASESTUDY3.pdf)
15. Fashionpositive.org, 2020. Fashion Positive. (https://www.fashionpositive.org/)
16. Alliance for Responsible Denim, 2019. Home | Denim Alliance (https://www.denimalliance.org/)
17. Global Fashion Agenda, 2019. 2020 Commitment. (https://globalfashionagenda.com/commitment/)
18. Procotex Corporation, 2020. Procotex. (https://en.procotex.com/)
19. Interreg NWE, Fibersort, 2019. Fibersort Fact Sheet. (https://www.nweurope.eu/media/9160/wp-t1-extra-fibersort-fact-sheet-accuracy-final-copy.pdf)
20. Texaid, 2020. TEXAID: WELCOME (https://www.texaid.ch/en/)
21. Texaid, 2019. Texaid and Lucerne University of Applied Sciences and Arts research better ways of recycling collected clothing. (https://www.texaid.ch/files/texaid/inhalte/schweiz/Presse%20Schweiz/2019/MM_Texcycle_6.11.2019_EN.pdf)
22. Worn Again Technologies (2020). A waste-free, circular resource is within reach. (http://wornagain.co.uk/)
23. Reshare.nl, 2020. Leger des Heils Reshare. (http://www.reshare.nl)
24. Smart Fibersorting, 2020. History. (https://smartfibersorting.com/history

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