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Lifestyle & Design Cluster

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Research and identification of textile plants globally - focusing on fibre-to-fibre recycling for the fashion & textile industry

Titel: Research and identification of textile plants globally - focusing on fiber-to-fiber recycling for the fashion & textile industry
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Lifestyle & Design Cluster works to promote innovation and sustainable growth primarily in the small and medium-sized housing and clothing companies as well as in the creative industries. We have a broad dialogue-based interface with the business community and, through our many different projects and activities, generate new knowledge which is communicated via events and here on the website via cases and news updates.

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PREFACE: RESEARCH METHODOLOGY

The first version, "Research and identification of textile plants in the Nordic countries & Europe – focusing on fibre-to-fibre recycling for the fashion & textile industry", was published in January 2020 and included 17 textile plants and 7 cases.

The second version of "Mapping textile plants fibre-to-fibre recycling globally" aims to enhance the knowledge of fashion and textile brands to which recycling plants exist globally and the current status of the recycling technologies. More specifically, the research conducted has evolved around recycling technology, business model, input and output materials, capacity, and scalability.

In the report, there are three stages of technology categorised in: 1) Pilot stage, meaning that they have found a solution as to how to recycle on a laboratory scale and can produce and test on a very small scale. 2) Operational stage making it possible to process larger amounts of textile waste, but only to a limited commercial scale for selected customers, as they are still working on solving challenges at this point. 3) Commercial stage which are fully functional processing of high amounts of waste, being sold on as raw material, fibre, yarn, fabric or/and finished articles.

The methodology used behind this paper is a questionnaire sent to all 33 companies regarding the following themes: Types of recycling technologies, input, output, capacity, partnerships, certifications, technical limitations, quantities now and in the future. Twenty companies replied to the questionnaire, while for the remaining 13 described in the paper the information has been collected through company websites and other reliable sources for updated information.

It is worth noticing, that most chemical recycling plants included in the first publication have moved from pilot stage to semi-commercial stage and are working hard towards commercial stage in the coming years. For example Södra, Infinited Fiber and Re:newcell are now able to recycle higher quantities. Other chemical recycling plants such as Worn Again and SaXcell have moved from laboratory to pilot/operational scale. Some recycling plants such as Pure Waste and Refibra® by Lenzing, have since 2020 also worked with post-consumer textile waste and are not limited to using pre-consumer waste. To name a few plants newly added to the updated mapping are e.g. U.S. based chemical recycling plants Evrnu and Ambercycle that has received big investments from fashion giants, making it possible to accelerate the process, but are still not considered commercial.

Five new company cases are part of the 2nd version: Wolkat, Södra, Textile Change, New Retex and Dear Denier. The idea behind these is to showcase how automated sorting, mechanical and/or chemical recycling companies work, as well as how a tight-and-sock-brand tackles nylon recycling. The case studies were conducted by interviewing the five companies and asking multiple questions regarding their business model, how to secure feedstock of textile waste, partnerships, challenges and future visions.

INTRODUCTION

Redesign, remaking and recycling fibre-to-fibre have been a part of our life for centuries. In the eighteenth century, the Napoleonic Wars caused shortages of virgin wool, requiring that wool fibres be spun into new yarns. However, recycling became less attractive and unnecessary in the late nineteenth century and the beginning of the 20th when man-made fibres were born. Suddenly the technical progress and the abundance of raw materials created no need for recycling anymore.

Just a few examples; today, cotton/polyester blends, nylon PA6 and 100% polyester can be chemically recycled due to years of laboratory research and experimentation. In addition, fibres such as wool, cotton, camel, and cashmere can be mechanically recycled with or without adding virgin fibres.

Using recycled materials is generally considered better environmentally, but the processes are generally demanding; and the challenges many. Many steps are needed during both the mechanical and chemical processes, e.g., characterisation of materials especially blends, dyes, pigments, chemicals and separation of non-wanted components (zippers, buttons etc.). Blends of, e.g. cotton/polyester and/or elastane, can be highly time-consuming to recycle due to the several separation steps. In addition, mechanically processed fibres are challenged in achieving an equal quality to virgin material without adding any virgin fibres. For these and other reasons, recycled textiles are today more expensive than virgin raw materials, which continues to challenge the development of a circular textile industry.

RECYCLING PROCESSES

MECHANICAL RECYCLING

Mechanical recycling of textile fibres is a well-established method, especially in the southern part of the EU, e.g. Prato region in Italy, where wool recycling has been part of the textile industry for decades. The focus within mechanical recycling is to increase the feedstock quantity of recycled fibres and improve the quality of yarn – the latter being accomplished by skilled machinery adjustments.

The methodology has the advantage of recycling a wide variety of fibres and blends and handling small quantities, which is positive for smaller brands with modest supplies of textile waste. It does not demand high levels of investments, production space or highly skilled employees – it can, in many cases, be handled with few additions of equipment to existing production lines. In general, the quality of recycled yarn is lower than that of virgin-fibre yarn (lower strength and, i.e. tendency to pilling). Still, it is in many cases sufficient for fashion but insufficient for workwear.

Some chemicals used in wet treatment of textiles, such as dyes and other additives, become contaminants as waste which cannot be removed in the mechanical process but must be treated, e.g. bleached and over-dyed with considerably use of water resources. This is partly avoided by some companies by colour-sorting the waste before shredding. A further disadvantage of mechanical recycling can be the addition of virgin fibres to maintain a certain quality level of the yarn. Depending on the skills of the spinners, some need to add 20%, others 50% or more. Overall, the technologies are constantly optimising the quality of recycled fibre and yarn as output.

A third of the companies in the survey replied that the utilised spinning method for recycled fibres to yarn is a combination of ring- and rotor-spinning, while the 2/3rd use either ring- or rotor-spinning.

THERMAL RECYCLING

The technology of thermal recycling can only be used on thermoplastic polymers like polyester, nylon etc. which can be melted. However, it's already commercial and produces rPET- (for PES-fibre) or PA-pellets which are sold on to fibre spinners. The rPET-pellets can, of course, also derive from recycled plastic bottles, a uniform and clean source of material. But the new EU strategy for Sustainable and Circular textiles to be implemented by 2024 states that "bottles should be used for bottles only (and not for new textiles), and so this source will soon be eliminated. The quality of recycled fibres manufactured with this method is almost as high as virgin materials. This process is characterised as cost-effective, efficient and easy to implement in existing production lines. It is, however, a delicate process - any impurities, motif prints, pigments, flame retardants, coating etc., can cause problems and decrease the output quality.

CHEMICAL RECYCLING

Chemical recycling companies use various methods of chemical recycling depending on their technology and which fibre is targeted. Different chemicals are used for depolymerisation, dissolution or hydrolysis, with water, alcohols, glycols, ionic liquids, carbamate or enzymes to divide the textile fibre into monomer-stage. Some solvents like ionic liquids are right now expensive and so add to the price of the final fibre product, making it more expensive.

Chemical recycling of cotton/viscose/linen/hemp produces cellulosic pulp - later dissolved and used for regenerated cellulosic fibres. The waste must preferably contain 50% cellulosic material or more. High-quality sorting is important in chemical recycling, as the high purity of the input material will make the process more efficient. Most technologies include a decolouring step. The requirements

needed to achieve scalability are faster processing, feedback from clients on the quality of recycled content and a continuous feedstock of the right textile waste to make it available at the right price. The pulp can be blended with wood pulp and then processed and spun as viscose, lyocell or new variations of cellulosic fibres.

Chemical recycling of polyamide/nylon (PA6 or 6.6) or polyester is generally a depolymerisation process where polymers are dissolved/broken down into monomers (the basic building block of any polymer). Solvents used for this method are water (hydrolysis), alcohols (metanalysis) or glycols. In fact, recycling nylon has been commercial for the past decade, while polyester recycling is still relatively new commercially. However, chemical monomer recycling is energy demanding due to the high temperatures needed.

There are three ways of chemical recycling polyester and polyester/cotton blends: 1. solvent-based dissolution, 2. hydrothermal and 3. enzymatic, also known as biochemical recycling. The technologies are still not fully developed, and only a few companies work with chemical recycling. However, the quality (e.g. strength and durability) of polymer fibres made from recycled monomers is generally higher than the same type of fibre (mainly polyester) from thermal recycling (melting).

SUSTAINABILITY

Sustainability in its true meaning does not exist in textile production. OK, if you have a flock of sheep grazing in your back yard, cut the wool, spin the yarn, knit a sweater and use it until it falls apart, then yes. But that is how the textile and fashion world works. Therefore, our full focus should be on constantly taking steps towards choosing the least environmentally harmful materials produced with the best available technology while aiming for the highest quality and the proper use. Recycling textiles chemically, mechanically or by means of melting is one giant step. Do not forget, however, that unless textiles are colour-sorted (like before mechanical recycling) or spun-dyed, wet treatment like decolouring/bleaching, dyeing, printing and finishing of yarn/fabric uses a considerable amount of dyes, chemicals, water and energy, so use best available technology in this step too!

Mechanical recycling is less complicated and uses fewer resources than chemically recycled fibres (even though a not insignificant amount of electric power is unavoidable). This is because the fibres are commercially available and so easier accessible now for fashion and textile brands. But mechanically recycling textiles over and over is not an option without the loss of fibre length and strength – it is down-cycling-spiral where the fibres end up in technical textiles and composites where the fibres lend strength to the material. Here chemical recycling especially takes advantage because they make it possible to break down fibres into tiny monomer-building blocks that then, through different processes, can polymerise and make new polymer fibres. Thermal recycling is also an option but requires relatively pure fibre materials to work. That might be a challenge as many mechanically recycled fibres also contain traces of other fibres.

TECHNICAL LIMITATIONS

From the questionnaire conducted, half of the companies (10) replied that they indeed could recycle textiles with prints on, while the other half answered that it is not possible; depending on which fibre type and which kind of printing method is used, prints on textiles can be challenging to some recycling technologies either mechanical or chemical.

Generally, all-over-print on cellulosic fibres (CO, CV, LYO), wool or silk is done with reactive dyes or pigments. The first should cause no problems, but pigments are glued onto the fabric with a binder acting as a coating that causes problems by mechanical, thermal and chemical recycling. Likewise,

if polyester is AOprinted with disperse dyes, either by means of sublimation or direct printing, there should be no problem with mechanically recycling it. However, chemical recycling of such fabrics may require a decolouring. The biggest recycling problem is motif prints on T-shirts and workwear because the coloured pigments are embedded in binders based on acylate, polyurethane, silicone and similar, which cause problems with thermal, mechanical and chemical recycling alike, with a few exceptions.

OUTPUT MATERIALS & PRODUCTS

The output varies depending on where in the value chain the recycling company is; if it, for example, is exclusively a recycling technology providing cellulosic pulp (Textile Change + Södra) or if they also have in-house textile production skills and equipment for spinning yarns or even create fabric which is the fewest manufacturers (Rester + Wolkat).

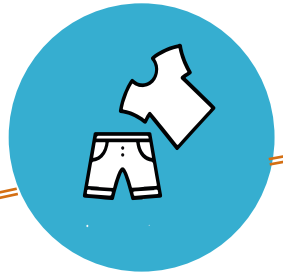
Most of the recycling plants included in this report collaborate with spinners (fibre to yarn), weavers and knitters (manufacturing fabrics), their output being pulp, synthetic monomers, flakes, fluff/short fibres or recycled fibres suitable for spinning. One factor to be aware of is that it is not a 1:1 process, meaning that the amount of input materials is higher than the amount of output due to the loss of material in the process.

PRICING

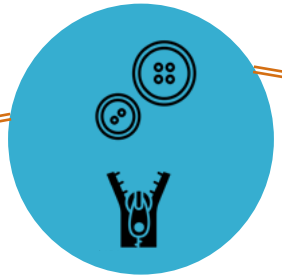
The provisional conclusion is that the current price level of recycled materials is higher than similar materials made with virgin fibres, making them less attractive from a price perspective. But that will change with the increasing amount of recycled textiles – the more textile is recycled, the more recycled textiles are used, and the lower the price.

Big fashion companies like H&M and Bestseller seem to have a great advantage when it comes to chemical recycling, as they can meet the amounts needed for chemical recycling and have the systems for collection - chemical recycling requires large investments and big amounts of continuous feedstock. Also, industrial laundries have an advantage because they have a lot of very desirable textile blend polyester/cotton in big amounts.

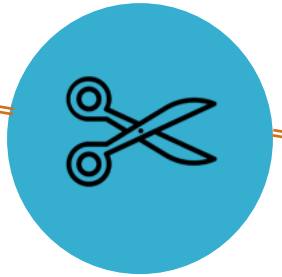
PREPARATION STEPS FOR RECYCLING



WASTE COLLECTED & SORTED



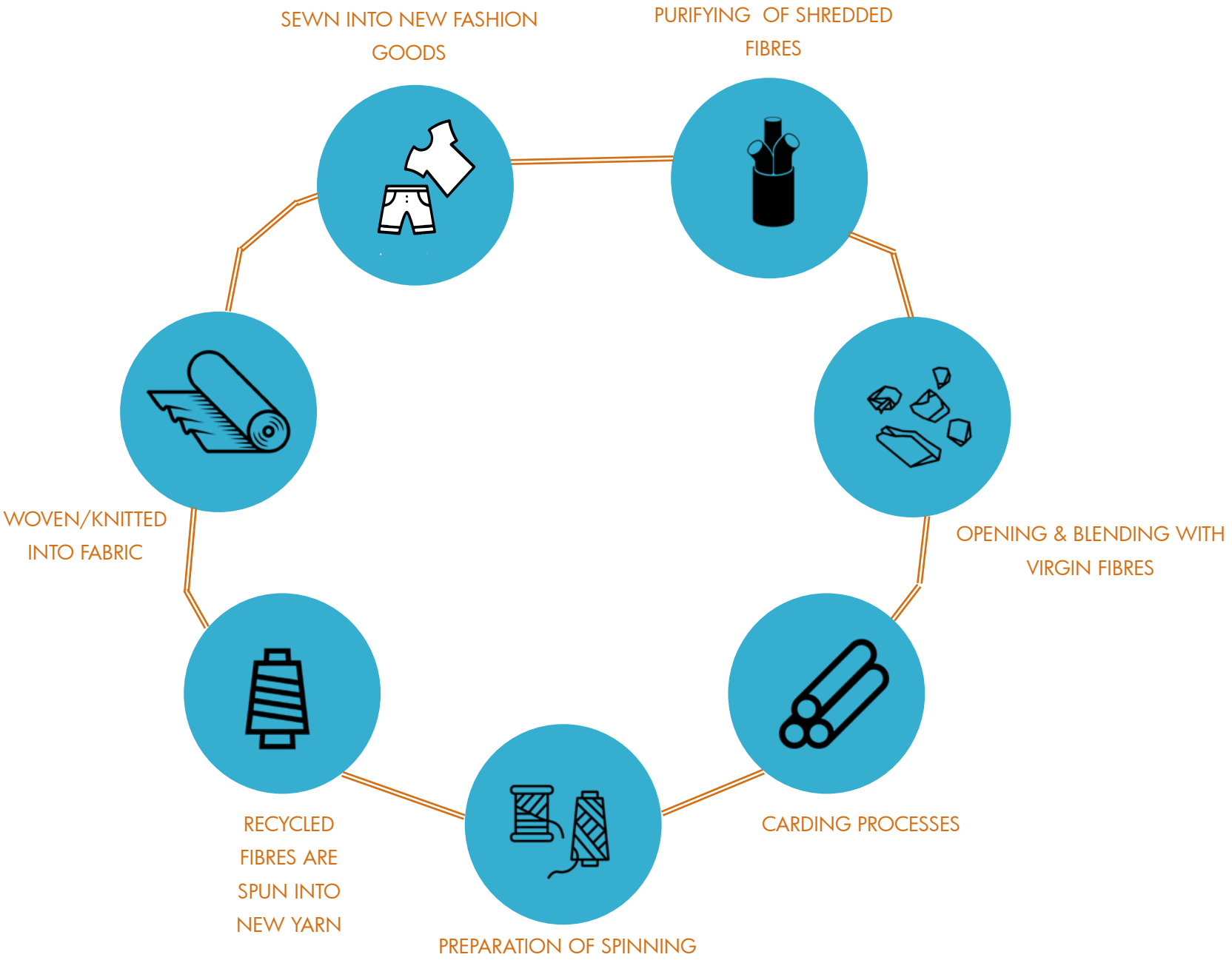
REMOVAL OF TRIMS & OTHER NON TEXTILE COMPONENTS



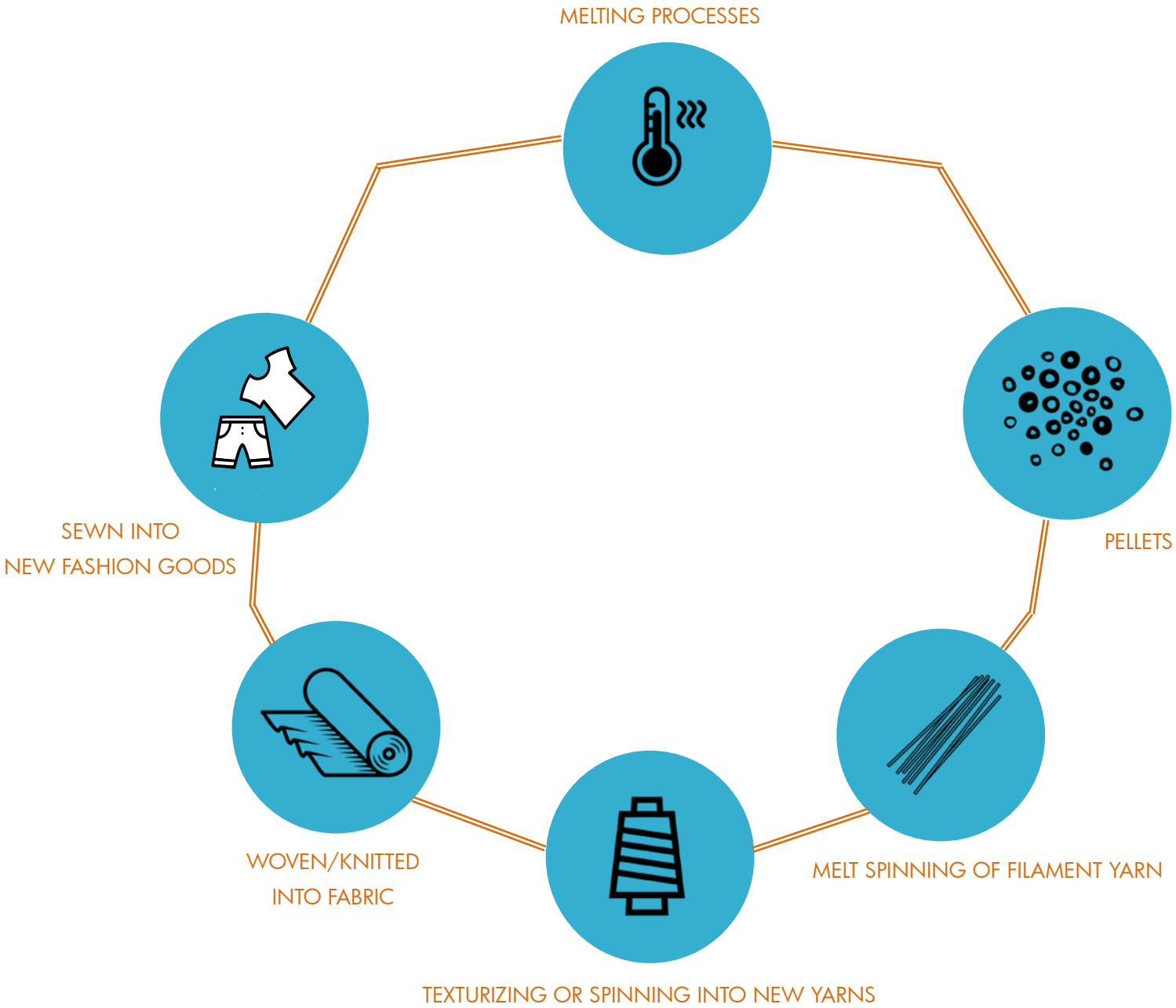
CUTTING, SHREDDING & DEFIBRATING

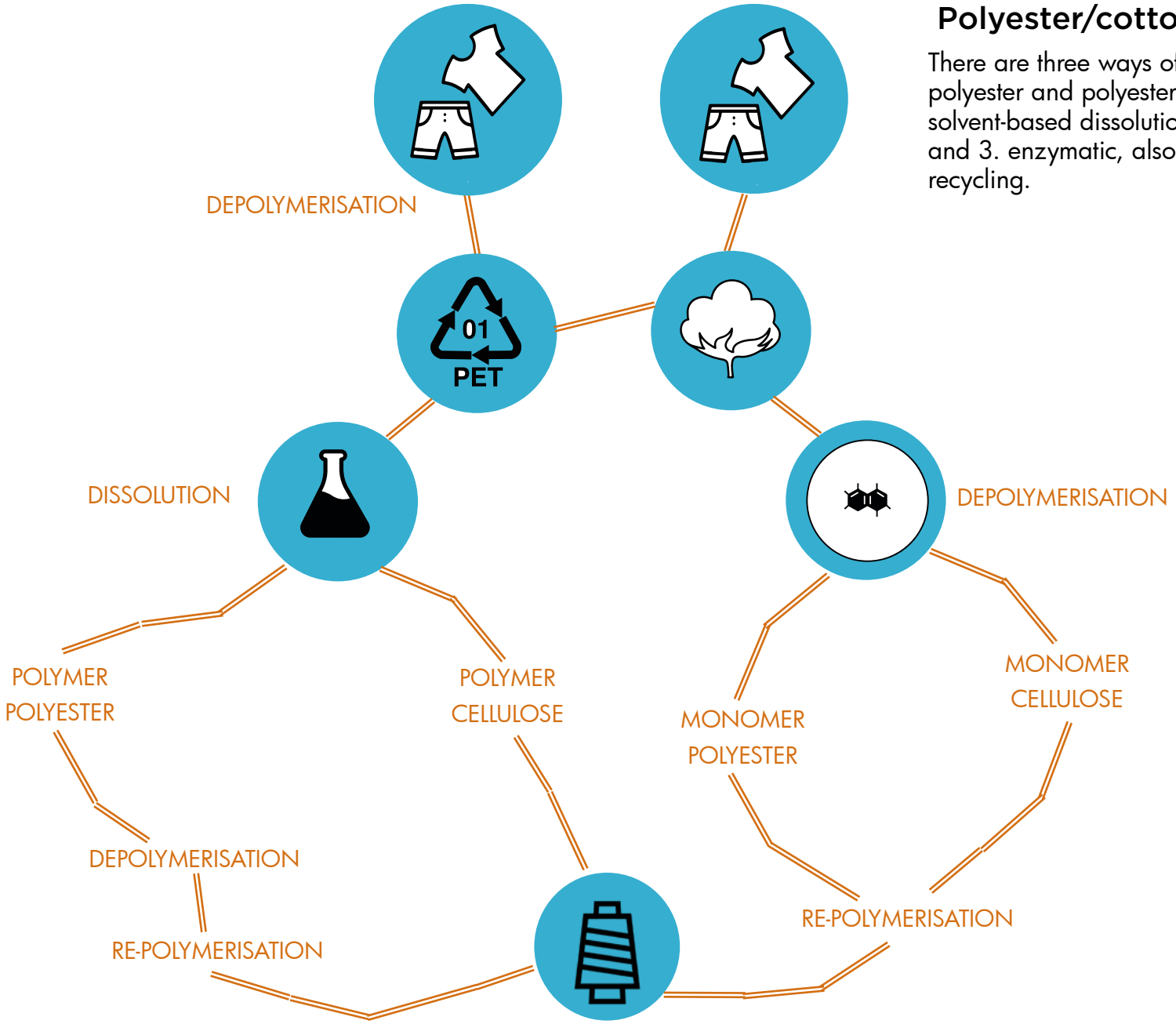
PURIFYING OF SHREDDED FIBRES

MECHANICAL PROCESS



THERMAL PROCESS

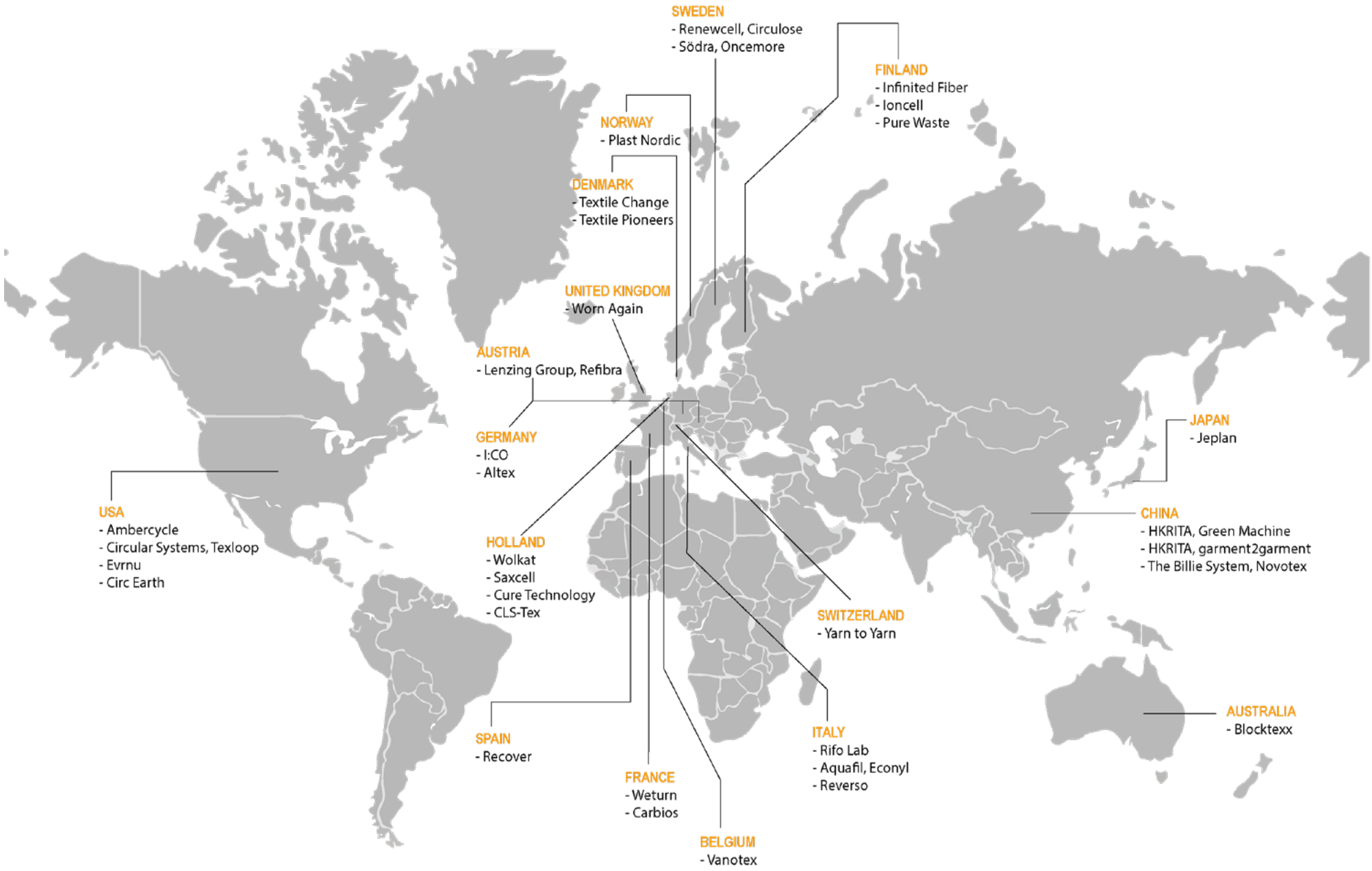




Polyester/cotton blends

There are three ways of chemical recycling polyester and polyester/cotton blends: 1. solvent-based dissolution, 2. hydrothermal and 3. enzymatic, also known as biochemical recycling.

33 GLOBAL RECYCLING PLANTS



STAGES OF TECHNOLOGY

P Pilot

- Ioncell
- Infinited Fiber
- Plast Nordic
- Textile Change
- Yarn to Yarn
- Saxcell
- Cure Technology
- Weturn
- Worn Again
- Circ
- Carbios

O Operational

- Renewcell
- Södra
- Evrnu
- Ambercycle
- Blocktexx
- The Billie System
- Jeplan

C Commercial

- Pure Waste
- Rester
- Textile Pioneers
- I:CO
- Altex
- Vanotex
- Wolkat
- CLS-Tex
- Lenzing, Refibra
- Rifo Lab
- Reverso
- Aquafil, Econyl
- Recover
- Circular Systems, Texloop
- Green Machine

SYMBOL DICTIONARY

Able to process cotton fibres as feedstock

Able to process wool fibres as feedstock

Able to process cashmere fibres as feedstock

Able to process camel fibres as feedstock

Able to process polyester materials as feedstock

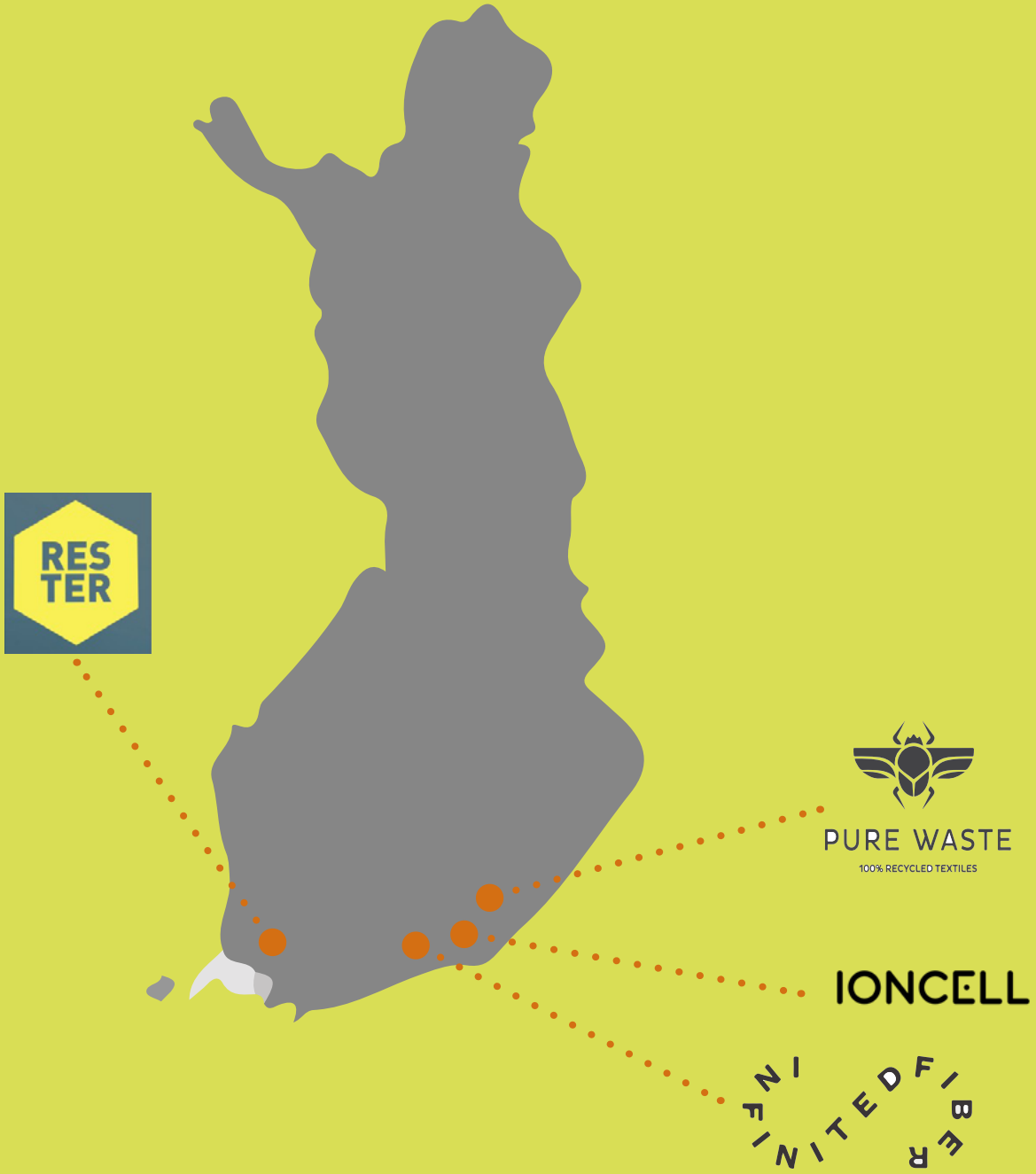
Able to process nylon materials as feedstock

Production of recycled textiles suitable for apparel

Production of recycled textiles suitable for upholstery

Mechanical recycling process

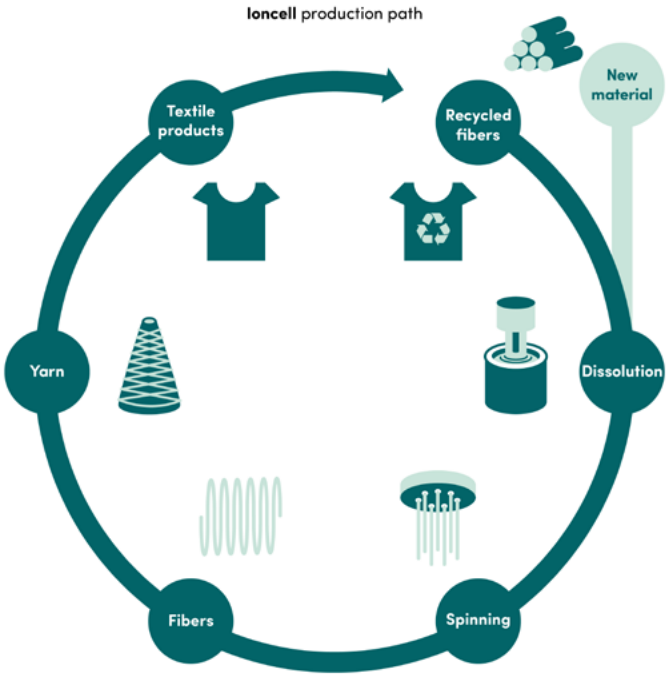
Chemical recycling process


RES
TER
PURE WASTE
100% RECYCLED TEXTILES
IONCELL
FINNFIBER

FINLAND

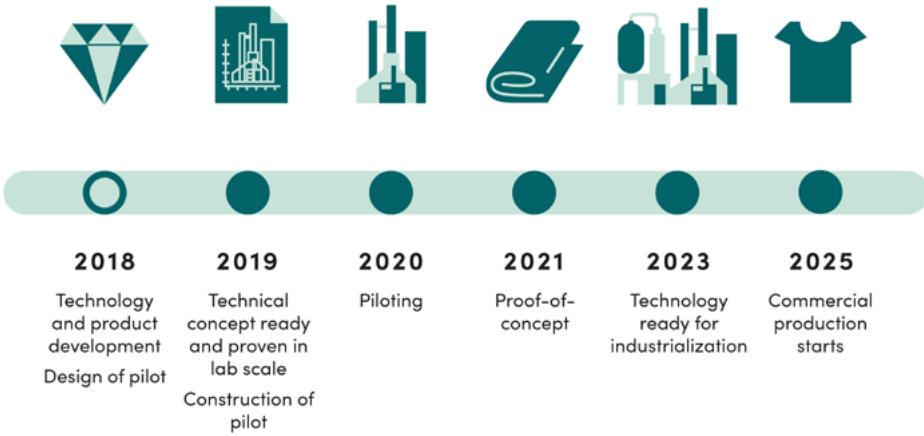
IONCELL

Technology: Lyocell spinning technology using ionic liquid
Business model: Supplier of Regenerated Cellulose Fibers
Input: Wood pulp and/or pretreated pre- and post-consumer cellulosic textile waste
Output: Regenerated Cellulose Fibers
Capacity: not published
Scalability: exact plan not known
Founded: IONCELL OY founded 2022 for commercialization of the Ioncell® fiber process
Contact: www.ioncell.fi



what

The Ioncell® technology converts wood pulp or pre-treated cellulosic waste as raw material into new regenerated cellulosic fibres. The technology can be applied to worn-out garments made from cotton, viscose, lyocell, other cellulosic waste, and even old newspapers. Both pre- and post-consumer cotton waste can be used as a raw material resource, provided that non-cellulosic components are removed by suitable pre-treatments and the average length of cellulose molecules is adjusted to a predetermined value. The Ioncell® technology is still under development and can currently only be used on a laboratory scale. During the pandemic period, a small pilot plant was built and installed, which is now at our disposal to develop the Ioncell® technology into a continuous and closed process over the next two years. This is a prerequisite for planning a demonstration plant from around 2025. The commercial development of the Ioncell® process is being carried out by a new start-up company, IONCELL OY, which was founded in April and will begin operations in August.



process & result

A solvent belonging to the category of ionic liquids (=liquid salt) dissolves the wood pulp or pre-treated cellulosic (textile) waste to create a spinning solution that is spun into new high-quality fibres in a dry jet wet-spinning process. The Ioncell® process belongs to the Lyocell fiber category according to the BISFA definition. The chemicals used consist of a non-toxic ionic liquid (liquid salt) and water, recycled in a closed-loop process. In the laboratory, Ioncell® is able to separate polyester/cotton textile blends through the chemical process of dissolution. However, the separated polyester must be broken down into polyester monomers and then re-polymerised to produce new polyester yarn.

Fibres made by the Ioncell® technology have properties such as strength, softness and subtle lustre comparable to or even better than commercially available viscose and lyocell fibres. Loncell® fibres/fabrics can be dyed like any other cellulose fibre. The Finnish brand Marimekko has produced prototypes of Ioncell® knitwear using digital printing for home and fashion textiles.

PURE WASTE

100% RECYCLED TEXTILES

Technology: Mechanical recycling
Business model: Integrated value chain from fiber to final garment
Input: Cotton industrial waste and pre- and post-consumer waste
Output: Yarns, fabrics and garments
Capacity: Production scale capacity unknown
Scalability: High, but plan not known
Founded: 2013, Finland
Contact: www.purewaste.com

what

Pure waste uses cotton pre-consumer textile waste from the fashion industry in India. Raw material derives from two main sources: yarn waste from spinning, knitting and weaving processes and fabric cut-offs from garment manufacturing.

In 2019 recycling of 100% post-consumer garments was achieved, composed of 20% post-consumer cotton, 40% pre-consumer cotton waste and 40% recycled polyester. In 2020 a 2nd production line was installed. PW currently handles 4.000 tonnes, and they're aiming for a capacity of 10.000 tonnes/an.

process & result

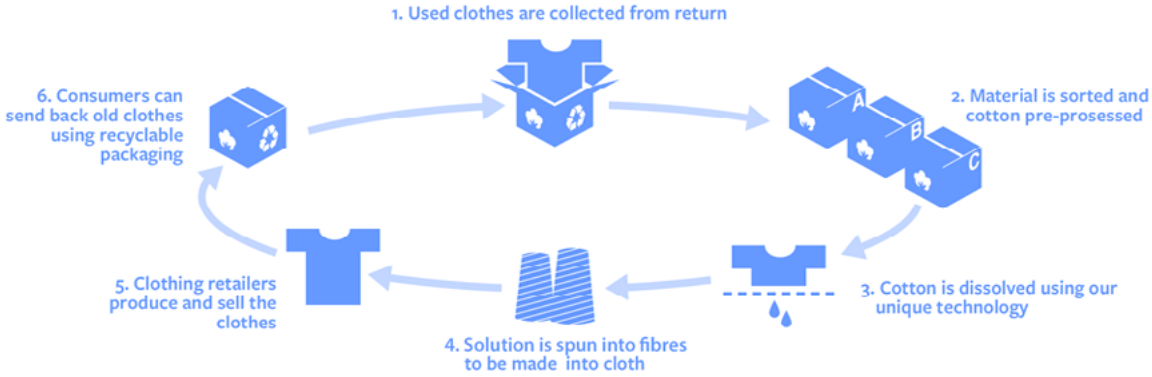
The production takes place at a textile mill in India. The recycling process is mechanical and occurs after collection and sorting by colour, meaning that the dyeing process can be eliminated.

1st step is shredding the pieces, focused on keeping the length of the cotton fibres as long as possible. 2nd step is blending the cotton fibres. During this step, it is possible to add chemically or mechanically recycled polyester from PET bottles or viscose fibres to create a textile blend. The last steps are spinning the recycled fibres into yarn, knitting/weaving fabric, finishing, and the fabric is ready for making up garments. Pure waste calculates that the production of a t-shirt reduces CO_2 by 50% and freshwater consumption by 99% compared to a t-shirt made of 100% virgin materials.

Technology: Chemical recycling based on carbamate technology
Business model: Fibre supplier
Input: Cotton or cotton-rich pre- and post-consumer waste
Output: Infinna™ fibers
Capacity: Pilot scale 150 metric tonnes/an
Scalability: Plans for 30.000 metric tonnes/an, full capacity expected by 2025. Technology licensing to scale up the availability further.
Founded: 2016, VTT Technical Research Center of Finland
Contact: www.infinitedfiber.com

what

Infinited Fiber Company technology chemically processes pre- and post-consumer waste collected from brands such as H&M. The textiles can be blends of cellulose and synthetic fibres, but the feedstock must be min. 80% cellulosic content. Moreover, it's possible to use decomposed cardboard and agricultural waste as cellulose sources.

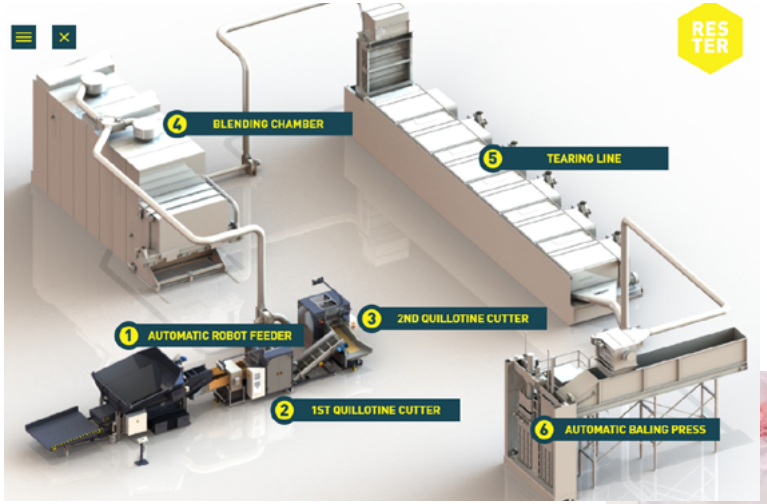


process & result

The chemical process involves three steps: 1st step - the cellulose in the sorted and shredded textile waste is extracted and cleaned of contaminants like dye, finishing chemicals and synthetic fibres. 2nd step – the cellulose goes through the carbamation-phase of the process to form a stable cellulose carbamate powder. 3rd phase - the carbamate powder is dissolved to create a honey-like liquid that is wet-spun to new cellulosic fibres; these can be continuous or cut to staple length, washed, dried and baled for delivery to the next step in the manufacturing chain, yarn spinning.

The Infinna™ fibers are suitable for spinning into yarn using various methods and existing yarn manufacturing equipment. They can be used as single fiber for 100% regenerated yarns or blended with conventional fibers like cotton. The feedstock for Infinna™ fibers is not limited to cellulosic textile waste; other cellulose-rich waste streams like cardboard, paper or agricultural residues like rice and wheat straw, can be used. The technology uses less chemicals and no virgin fibers are added, while the fabric absorbs and fixates up to 30-40% more dye in the dyeing process. Infinna™ fiber has a cottonlike feel and is highly suitable for clothing, therefore brands like Bestseller, Ganni, Patagonia, Tommy Hilfiger and others have secured supplies of fibers in the coming years.

Technology: Mechanical recycling
Business model: Material recover company/Fibre supplier
Input: Pre- and post-consumer waste: cotton, PES or PES/CO blends & polyamide
Output: Recycled Fibres
Capacity: Production scale 6.000 metric tonnes/an
Scalability: High, but exact plan not known
Founded: 2019
Contact: www.rester.fi



what, process & result

Rester Oy is Scandinavia's largest recycling plant with 3,000 m2 and is mainly owned by workwear supplier Touchpoint. It's an automated mechanical recycling line that can process 6,000 tonnes of end-of-life textiles yearly (1 tonnes/h). Together with LSJH line (municipal waste management company) line, we can handle about 10% of Finland's textile waste. About 100 million kilos of textile waste are generated annually in Finland alone.

Rester collects textile waste from laundries, used workwear, retail leftovers and industrial side streams. Rester can handle various material compositions such as cotton, polyester, and polyester/cotton in light and colour tones and can also work with blends containing up to 5-10% (elastane/PU). After mechanical opening/shredding pre- and post-consumer waste, the output is recycled fibres of different qualities, which can be used as a raw material in fluff/short fibres, filling materials/ loose fibres and fibres suitable for yarn spinning. The recycled fibres can be used for various end-use applications: non-wovens, technical, automotive & geo-textiles, insulation, yarn, fabric for apparel etc.

SWEDEN

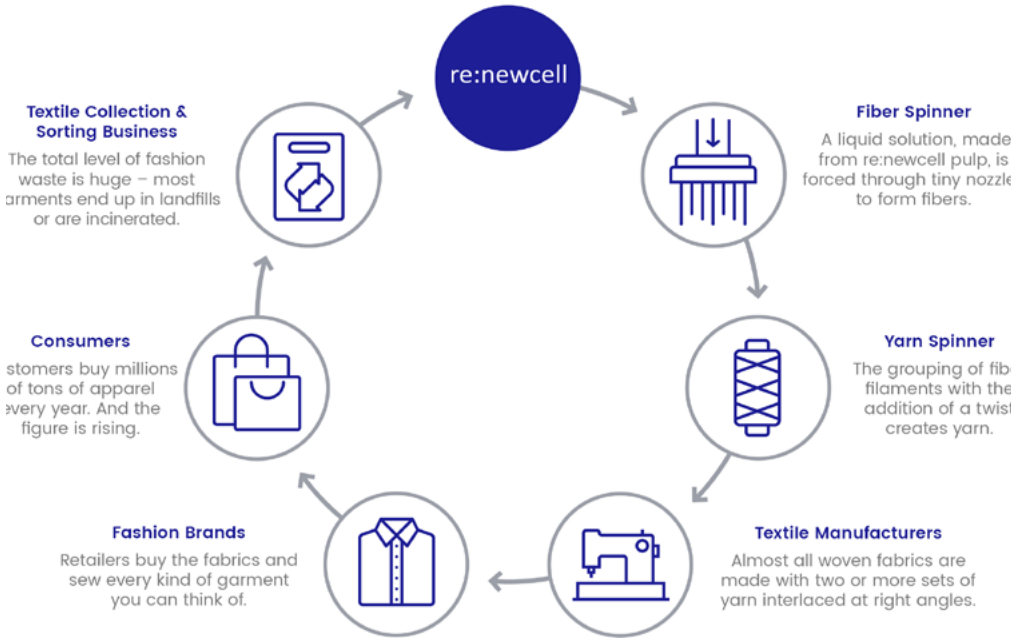
re:newcell

CIRCULOSE

Technology: Chemical recycling based on dissolution
Business model: Raw material supplier
Input: Pre- and post-consumer waste cotton and polyester/cotton with high cellulose content
Output: Pulp
Capacity: Production capacity 60.000 metric tonnes/an
Scalability: Expected 250.000 metric tonnes/an by 2025, 360.000 metric tonnes/an by 2030
Founded: 2012, KTH Royal Institute of Technology Stockholm
Contact: www.renewcell.com & www.circulo.se

what

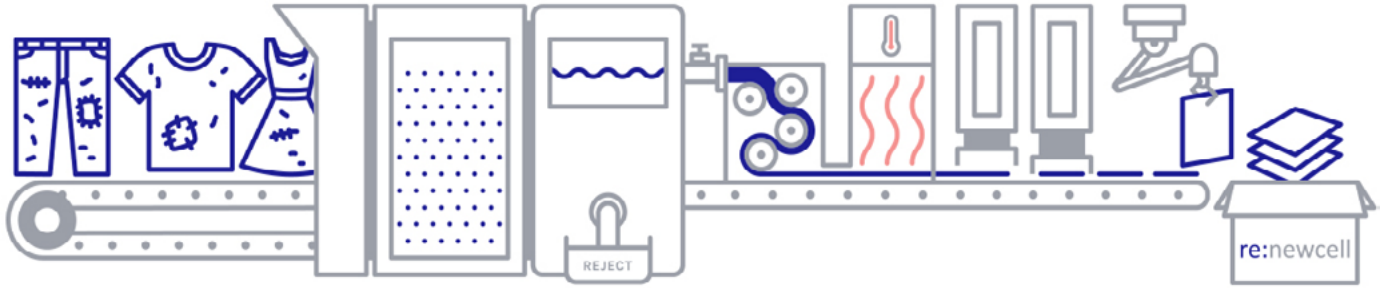
Renewcell technology turns textile waste with preferably > 95% cellulosic content, like cotton, into Circulose®, a natural dissolving pulp that closes the loop in fashion. Worn-out garments are shredded, metallic and plastic accessories are removed mechanically, and dye and non-cellulosic fibres, e.g., elastane and polyester, are removed chemically before the cellulose is dissolved and the pulp Circulose® is formed and dried into sheets. The sheets are dissolved into a viscose fluid, and fibres are extruded by Renewcell's customers, global textile fibre producers. Of the fibres, yarns are spun, and fabrics are knitted or woven.



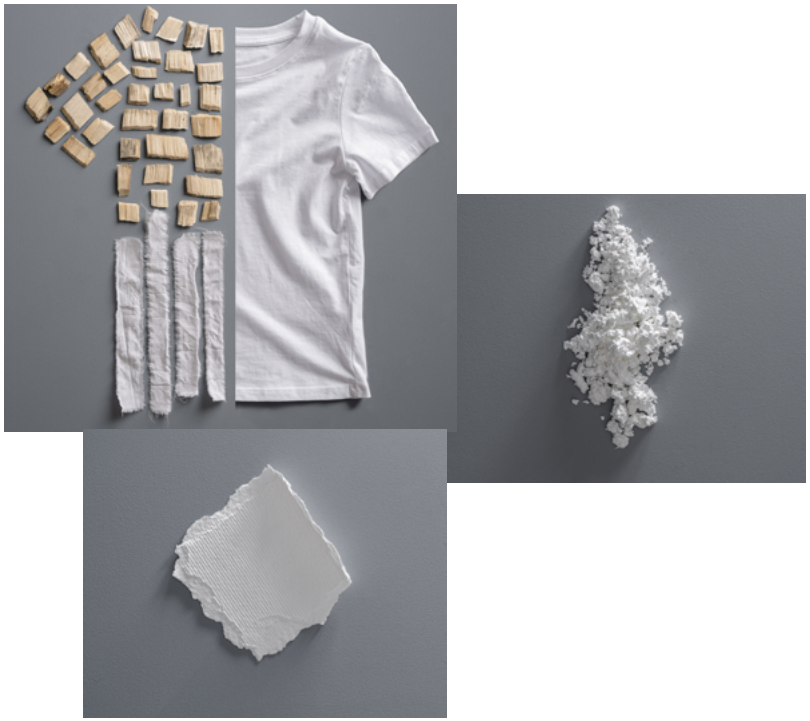
process & result

Circulose® can replace raw materials like cotton, oil (f. PES, PA) and wood to reduce the consumption of virgin materials. The chemical process is non-toxic and runs on 100% renewable energy. Renewcell collaborates with collectors and textile manufacturers and receives its pre-consumer and post-consumer waste from sorters worldwide. The production capacity of Circulose® pulp is now at 4,500 tonnes in the demo-plant in Kristinehamn and 60.000 tonnes/an in Renewcell 1 in Sundsvall. By 2024, the capacity will increase to 120.000 tonnes/an at the new plant in Sundsvall.

Renewcell has signed LOIs with, amongst others, Indian viscose giant Birla Cellulose and the Japanese company Daiwabo for long-term collaboration. In addition, they have done brand launches of finished garments with GANNI, H&M, Levi's®, Bestseller and Gina Tricot and are working on projects with, among others, Inditex, PVH and Kering.



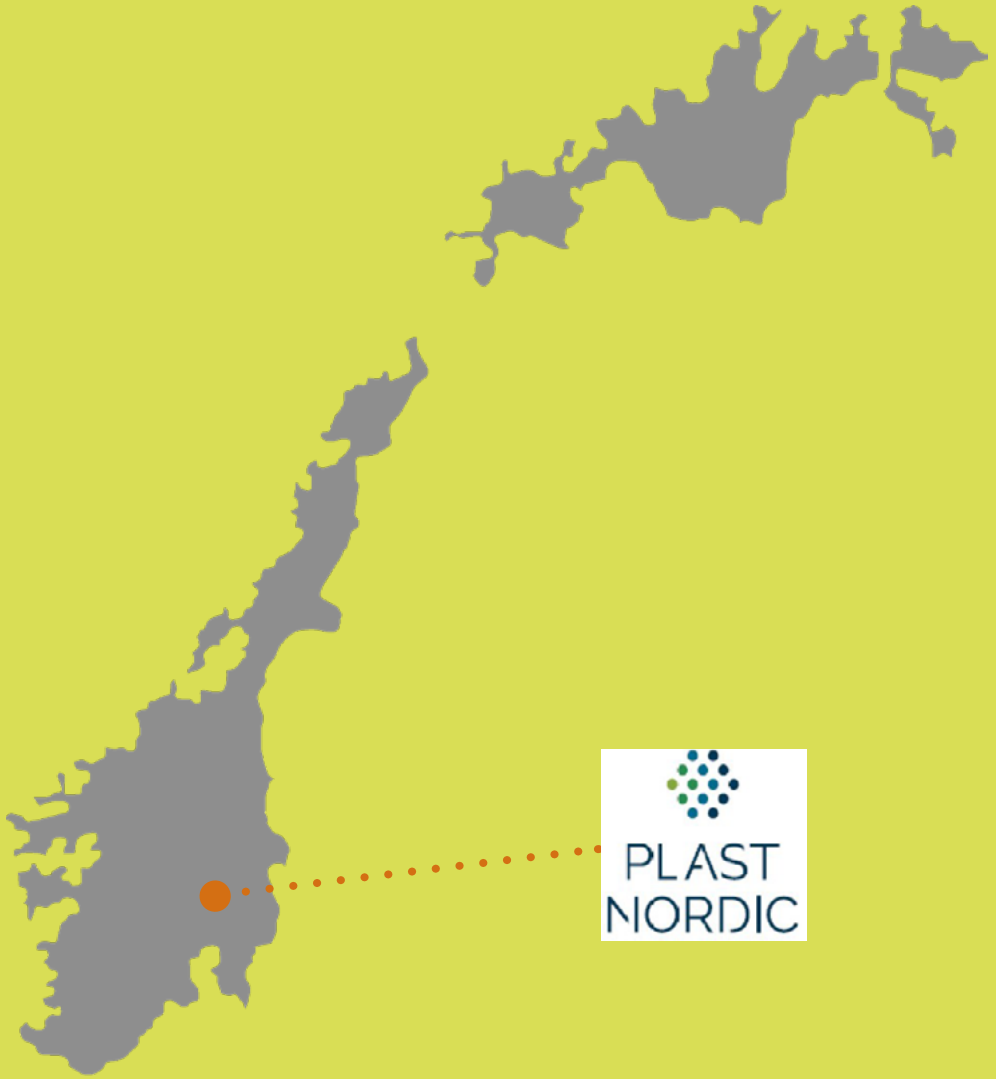
Technology: Chemical recycling based on dissolution
Business model: Raw material supplier
Input: Pre- and post-consumer waste, Cotton and Polyester/ Cotton with high cellulosic content
Output: Cellulosic pulp 50% recycled content
Capacity: Production scale 2.000 metric tonnes/an
Scalability: Expected 25.000 metric tonnes/an by 2025
Founded: 2019, Södra, Sweden
Contact: www.sodra.com



what, process & result

Södra is a Swedish forest industry group wood pulp manufacturer whose main products are paper pulp, textile pulp and sawn timber. In 2019 Södra expanded to a circular approach and created OnceMore®, a textile pulp blend made of wood pulp and 3% pulp from recycled post-consumer waste. Today the recycled content has increased to 20%, and ambitions are to increase it by 2025 to 50%. Södra focuses on white textiles, so the type of textiles used are, e.g., towels, bathrobes, bed sheets, napkins etc., from laundries/hospitals. In the future, Södra would like to be able to handle colored textiles as well. This will be possible when a decolouring method is final developed and progress has already been achieved through trials with a Swedish supermarket company recycling coloured workwear. Polyester is removed through a chemical process, and cotton is dissolved into cellulose pulp at their plants in Sweden.

The output is either viscose or lyocell fibres (e.g. at Lenzing AU), spun into yarns and knitted/woven into fabrics by Södra's customer further in the value chain. Currently, the capacity is at 6.000 tonnes/an. While the aim for 2025 is 25.000 tonnes of textile waste and offering OnceMore® pulp based on 50% Södra's forest raw material and 50% recycled pulp. If a company has white/unbleached cotton or polyester/cotton blends with a minimum cotton content of 50%, it could be relevant for Södra. But traces of other fibres such as viscose and lyocell can be handled too.



NORWAY

PLAST NORDIC

Technology: Depolymerisation/Alkaline hydrolysis + microwave technology
Business model: Provide recycled PTA and MEG equal to virgin oil-based monomers
Input: PET-based waste like polyester, PES/CO, plastic bottles, food containers
Output: Recycled monomers (PTA and MEG), building blocks f. synthetic fibres
Capacity: 30.000 metric tonnes/an/plant
Scalability: Plans to cover the Nordic market within 8-10 years
Founded: 2018, Plast Nordic Norway
Contact: www.plastnordic.no
www.gr3n-recycling.com

what, process & result

Plast Nordic has partnered up with the Swiss company gr3n, the inventor and patent holder behind the unique chemical recycling technology. The demonstration plant is in Italy. Plast Nordic has the commercial rights for the Nordic region, and the plan is to open several plants over the next decade. One plant can process 30.000 tonnes/an. The first plant in the Nordic is planned for 2025.

The gr3n technology depolymerises PET-based materials such as polyester textiles, food packaging and drinking bottles. The output is recycled monomers equal to virgin oil-based monomers. The output monomers are PTA and MEG, which are the key materials for making new PET again. Without any loss of quality.

The process is an Alkaline hydrolysis enhanced by a patent microwave technology. The process can be presented in the following steps: pre-processing/grinding, depolymerisation, purification, and crystallisation.

DENMARK

Technology: Chemical recycling based on depolymerising into monomers
Business model: Raw material supplier
Input: Pre- and post-consumer waste polyester and PES/CO
Output: Cellulosic pulp and rPET pellets (f. PES fibers)
Capacity: Lab scale
Scalability: Expected 15.000 metric tonnes/an by 2023
Founded: 2020, Denmark
Contact: www.textilechange.com

what, process & result

The Textile Change (DK) technology can process post-consumer textile waste collected directly from households (by 2025) and other sources like recycling stations. Mechanical and chemical dissolution technology for all pure cellulosic and -blends, e.g. cotton, viscose, linen, polyester and elastane. The output is cellulose pulp and polyester pellets for extrusion/spinning of fibres.

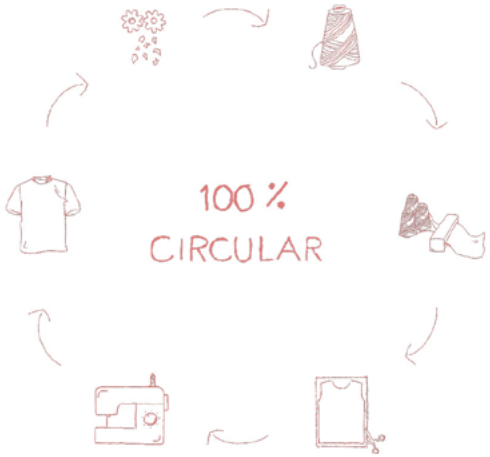
The business model of Textile Change is as follows; a recycling company will sort the textile waste and pay Textile Change to process the waste into PET pellets and cellulose pulp. The pulp will be sold on to companies that spin fibres, such as Lenzing Group and Kelheim Fibres. It will feed into the existing value chain where fibre becomes yarns, fabrics and finally, clothing.

Textile Change is in 2022 working with a pilot production plant, and by 2023 full scale plant 15.000 tonnes/an.

Future plans are to establish facilities in Germany and license their patented technology.

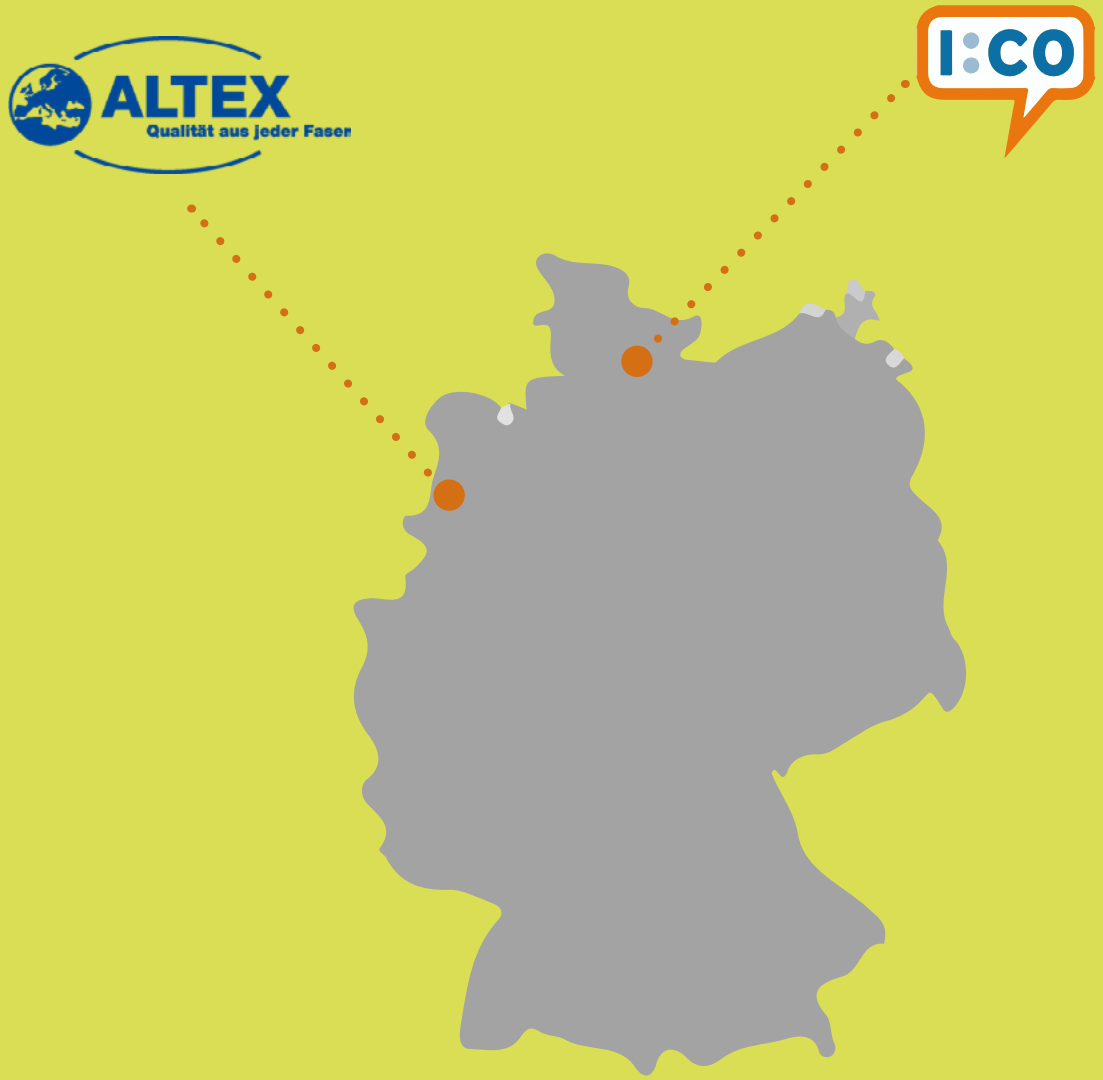
TEXTILE PIONEERS™

Technology: Mechanical and Thermal mechanical recycling in subcontracting
Business model: Service provider
Input: Pre- and post-consumer waste cotton and pure polyester
Output: Yarns, fabrics or finished garments
Capacity: Subcontracting
Scalability: Yes, but not specified
Founded: 2015, Denmark
Contact: www.textilepioneers.com



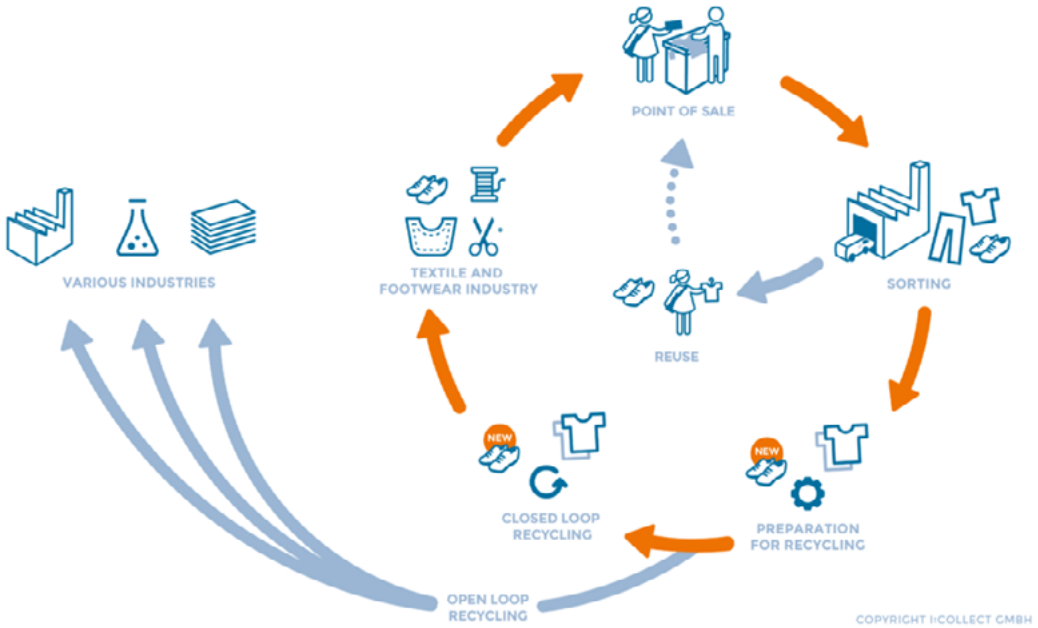
what, process & result

Textile Pioneers (DK) provides the service of recycling your company's textile waste into yarns, fabrics or finished garments. It can be pre-and post-consumer waste too. It can be mechanically processed if it contains more than 51% natural plant-based cellulosic fibres. If the main component is polyester (preferably > 98% PES), a thermal process is applied. No chemicals are used in the process. The recycling plants are in India.



GERMANY

Technology: Mechanical recycling
Business model: Service provider w. integrated value-chain collection, sorting, resale and recycling
Input: Pre- and post-consumer waste
Output: Fibres
Capacity: Production scale 11.000 tonnes/an
Scalability: Yes, but no info provided
Founded: 2009, Germany
Contact: www.ico-spirit.com



what, process & result

I:CO (I:Collect) (DE) is a company with expertise in global solutions within three main areas; collection, reuse and recycling of textile waste. Through 51 global partners, e.g. a brand can either set up a collection point of post-consumer textile waste in a store or online. When consumers are ready to give their used clothing and shoes a 2nd life, a reward is given to the customer for bringing back their used items. I:CO collects clothing and shoes in more than 60 countries.

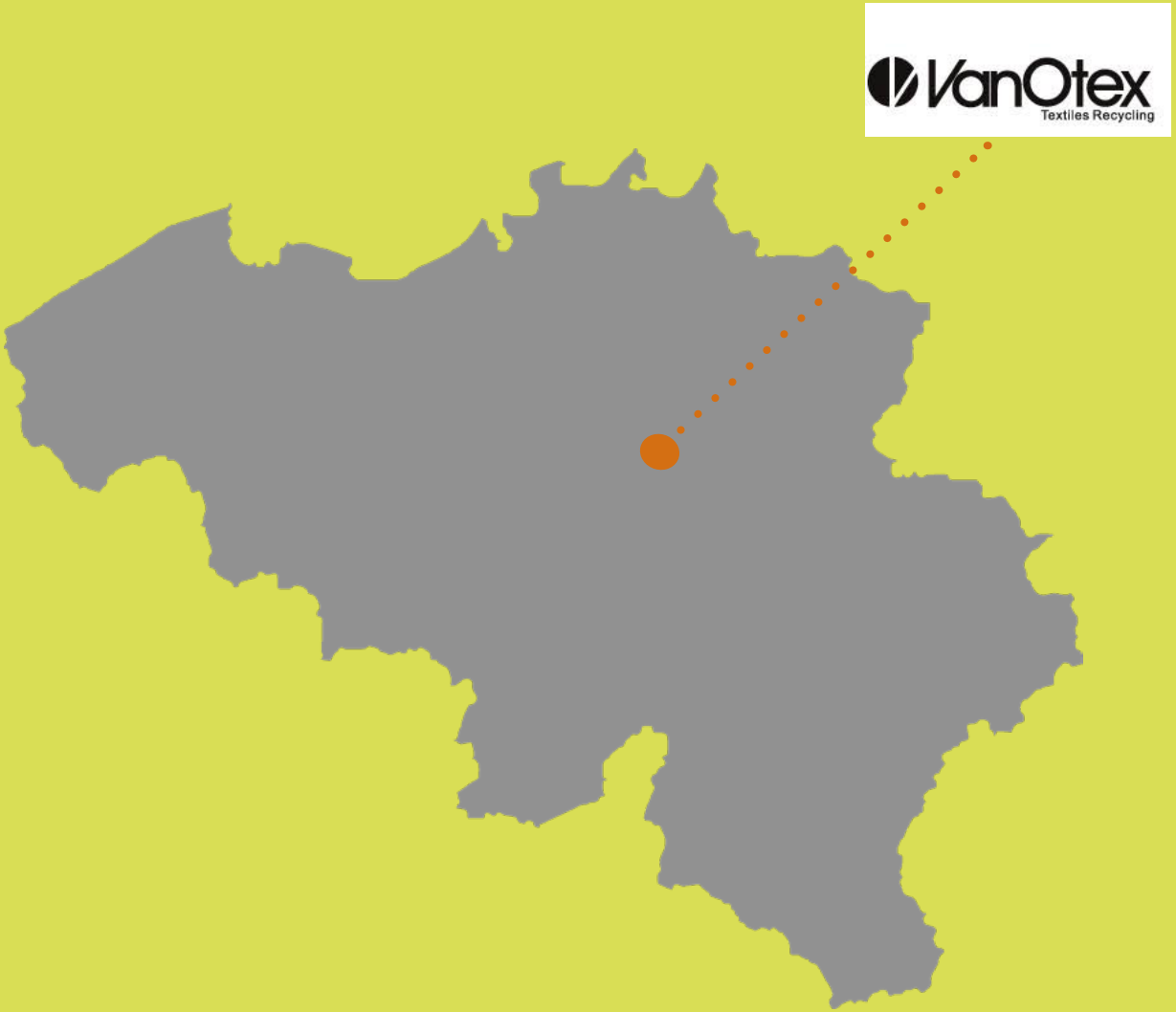
Sorting is done manually by evaluating 350 factors depending on the condition of the used items. Material identification and separation are automated. Some sorted items are given a 2nd life at the shops I:CO collaborates with. App. 60% is recycled in an open-loop system involving various industries such as automotive and construction, serving as insulation materials; The rest, 40%, is processed mechanically in closed-loop recycling. The recovered fibres are spun into new yarns and thereby re-entering the supply chain of partners.

Technology: Mechanical recycling after collection and sorting
Business model: Fibre, yarn and non-woven supplier
Input: Industrial, pre- and post-consumer waste
Output: Fibers, mostly thicker yarns for e.g. carpet and fibers for non-woven
Capacity: Production scale 36.000 metrics tonnes/an
Scalability: High
Founded: 1989, Germany
Contact: www.altex.de

what, process & result

ALTEX (DE) offers all kinds of recycled fibres with different fineness, length and opening. In addition to shredding textiles, ALTEX can make blends with various compositions for yarns or non-woven. Based on their years of experience, the company can meet special requirements from customers. They have six pulling lines with two - six tambours and make various fibre lengths, colours, thicknesses, qualities and blends of various fibres, even as commission work.

Recycling innovators such as Re:newcell, Valerius and Altex have contributed to the Closed Loop Project in order to aid their operations in the future.



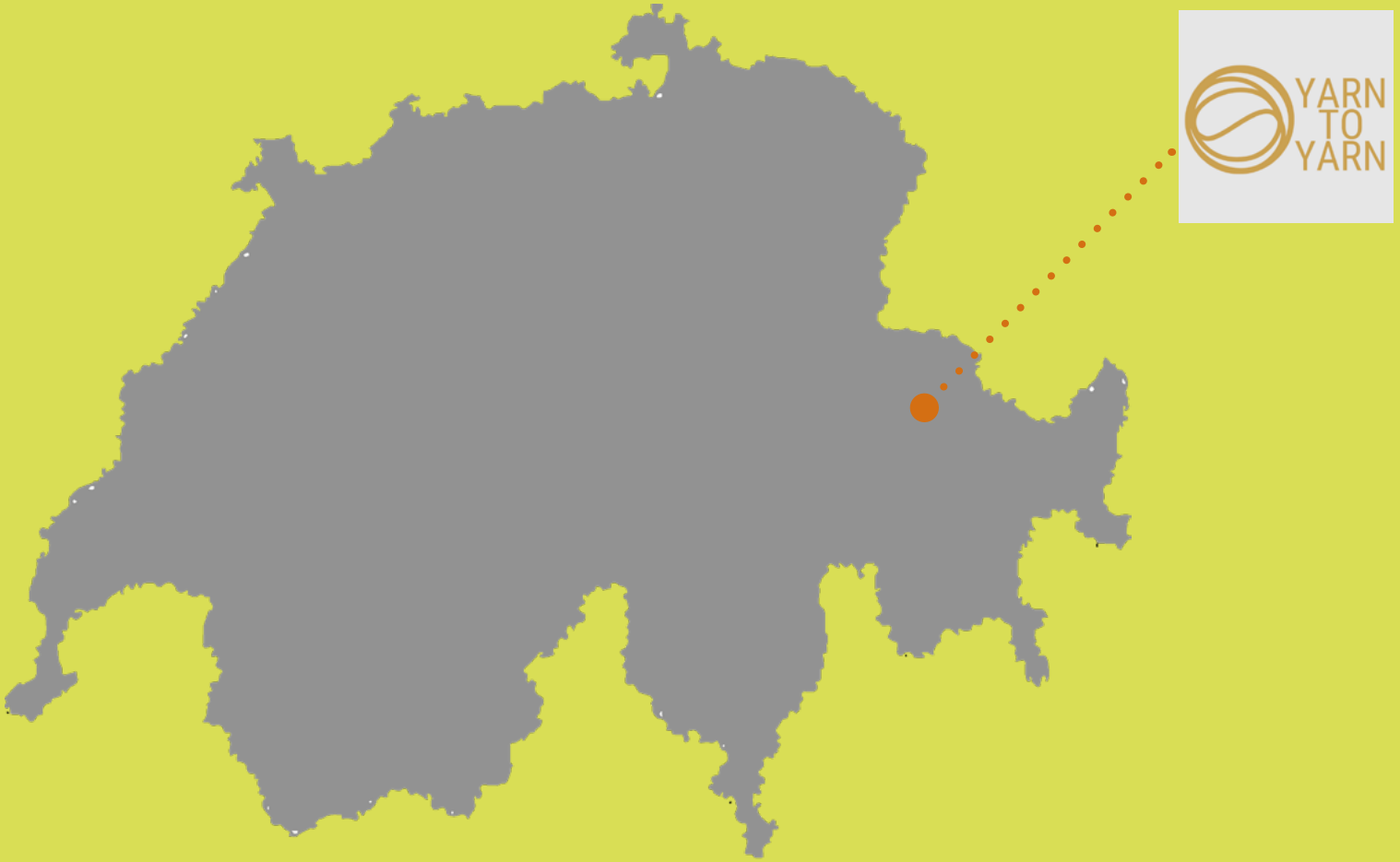
BELGIUM

VanOtex
Textiles Recycling

Technology: Mechanical recycling
Business model: Fibre supplier
Input: Industrial synthetic waste
Output: Fibres, mainly synthetic
Capacity: Production scale, capacity unknown
Scalability: High, but no info provided
Founded: 1975, Belgium
Contact: www.vanotex.be

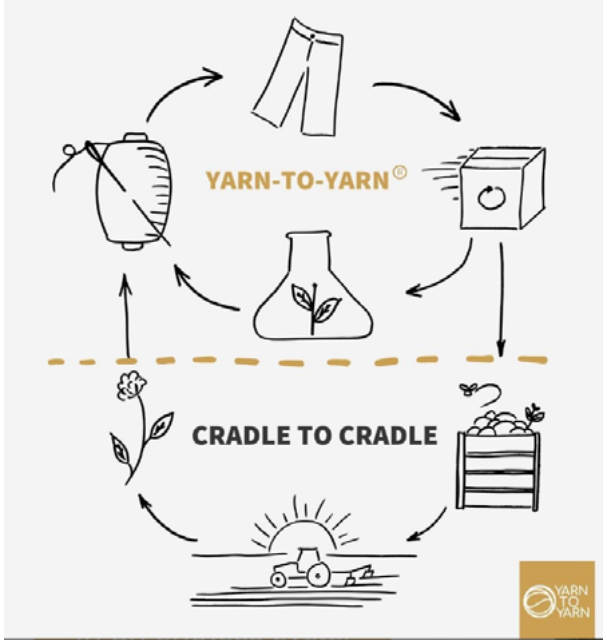
what, process & result

VanOtex (BE) is an expert within shredding/defibering. After sorting, the waste is cut and forwarded to large blending chambers. The cutting machines are equipped with metal detectors to identify metal trims. The blending chambers have a capacity of up to six tonnes to ensure a constant blending quality. The material is then taken to the pulling machine to be shredded to fibres.
The process can be tailored in various ways to offer a precise pulling grade for every type of fibre. Thanks to modern defibering machines, the production loss is kept at a minimum, and dust development during pulling remains within the norms. The product is immediately pressed into uniform, packaged bales and sold to yarn or non-woven manufacturers.



SWITZERLAND

Technology: Biochemical, enzymatic recycling
Business model: Raw material supplier
Input: Pre- and post-consumer waste
Output: Raw materials for yarns
Capacity: Lab scale
Scalability: Unknown
Founded: 2021, Switzerland
Contact: www.yarn-to-yarn.org



what, process & result

YARN-TO-YARN® is a newly started bio company that has developed a technology making it feasible to recycle man-made blended textiles, even with elastane and nylon, back into their original components. The textile waste is treated with enzymes that cleanly separate textiles into viscose(cellulose), elastane and nylon. The final product will in the near future, be high-quality yarns for creating new clothing.

The company already collaborates with the Swiss brand Seefeld, the first brand to use Yarn-to-Yarn in clothes. An example is "Circular pants" designed for textile bio-cycling, made of cutting floor waste and post-consumer pants.

(Current collaboration activity with the company is low due to being newly established, therefore the authors can't guarantee that contact to this particular company will be successful)


CURe
Polyester
Rejuvenation
SAXCELL
CLS | Tex
INTERNATIONAL
closed loop solutions
Wolkat

HOLLAND

Technology: Chemical recycling based on lyocell technology
Business model: Fibre supplier
Input: Pre- and post-consumer cotton waste
Output: Lyocell fibres
Capacity: Pilot scale 25 metrics tonnes/an
Scalability: Planned for 10.000 metrics tonnes/an by 2022
Founded: 2015, Saxion Univeristy of Applied Sciences Holland
Contact: www.saxcell.com

what, process & result

SaXcell (ND) is a spin-off from research work at Saxion University of Applied Sciences. The technology developed uses a chemical process to recycle post-consumer, sorted and shredded cotton waste with the highest possible cellulosic content.

The process begins with manually sorting textiles, removing trims, grinding and chemical decolouring. For the time being, the process cannot handle prints and PU. The fluff is then dissolved (a change in decolouring/dissolution is prepared), and wet spinning of fibres is done using a similar technique to the Lyocell method. The advantage is that the production of Saxcell fibres can easily be implemented in existing production lines globally with no or only a few adjustments, resulting in regenerated lyocell fibres ideal for garments and home textiles. The resulting yarns will then be woven or knitted into fabrics. It is possible to dye at the fibre, yarn or fabric stage. By 2024 yarns and fabrics is likely available for sale.

Wolkat

Technology: Mechanical recycling
Business model: Fabric supplier
Input: Pre- and post-consumer waste
Output: Fabrics
Capacity: Production scale 250 metric tonnes/an
Scalability: Plans to increase capacity to 500 metrics tonnes/an
Founded: 2004 (1948), Holland
Contact: www.wolkat.com

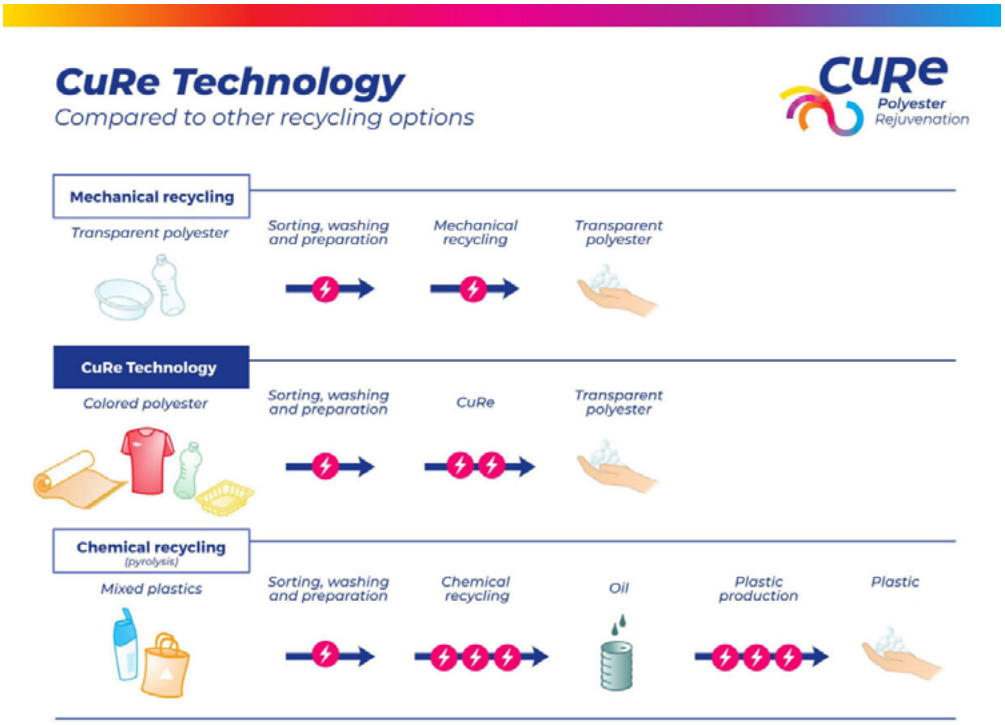
what, process & result

Wolkat (ND) consists of seven international, innovative recycling companies and has, therefore the capability to control the various steps of developing new recycled materials. Wolkat collaborates with local municipalities, government agencies and private companies in collecting textile waste which at Wolkat is sorted, shredded, blended, spun and woven/knitted from recycled content. In addition, Wolkat has the facilities in-house for new products for fashion, furniture and automotive purposes. In 2014 the company was able to spin their first recycled yarns, and in 2016 it established its own weaving mill.

Wolkat has collaborated with brands such as Nike to develop a recycled gift bag made of PET bottles. In addition, the brand Filippa K has worked with Wolkat on rPES fabric made of PET bottles for a coat design.

The ReYarn project partnership consisted of the City of Copenhagen, Trasborg, Salvation Army Denmark, Bacher Work Wear and ReValuate with the scope of collecting household waste, sorting, recycling and creating new products. Wolkat has the role of recycling, weaving/knitting fabrics, and making non-wovens from the collected post-consumers textiles.

Technology: Chemical recycling based on depolymerisation into polymers
Business model: Raw materials supplier
Input: Industrial, pre- and post-consumer polyester waste
Output: rPET pellets
Capacity: Pilot scale 320 kg/h
Scalability: Yes, planning 25.000 metric tonnes/an and the technology will be licensed
Founded: 2018, Holland
Contact: www.curetechnology.com



what, process & result

CuRe Technology (ND) has developed ground-breaking technology for polyester rejuvenation. The CuRe technology offers low energy recycling of polyester, as it doesn't decompose the polyester back to monomer level, but only to polymer level. The technology is modular and flexible in choosing the best route depending on the type of polyester used. It can handle any type of pure polyester, remove dye/colour, and convert the polyester into clear PET pellets that can be polymerised with the same properties as virgin polyester. For example, Coca-Cola has invested in PET bottle-to-bottle recycling technology.

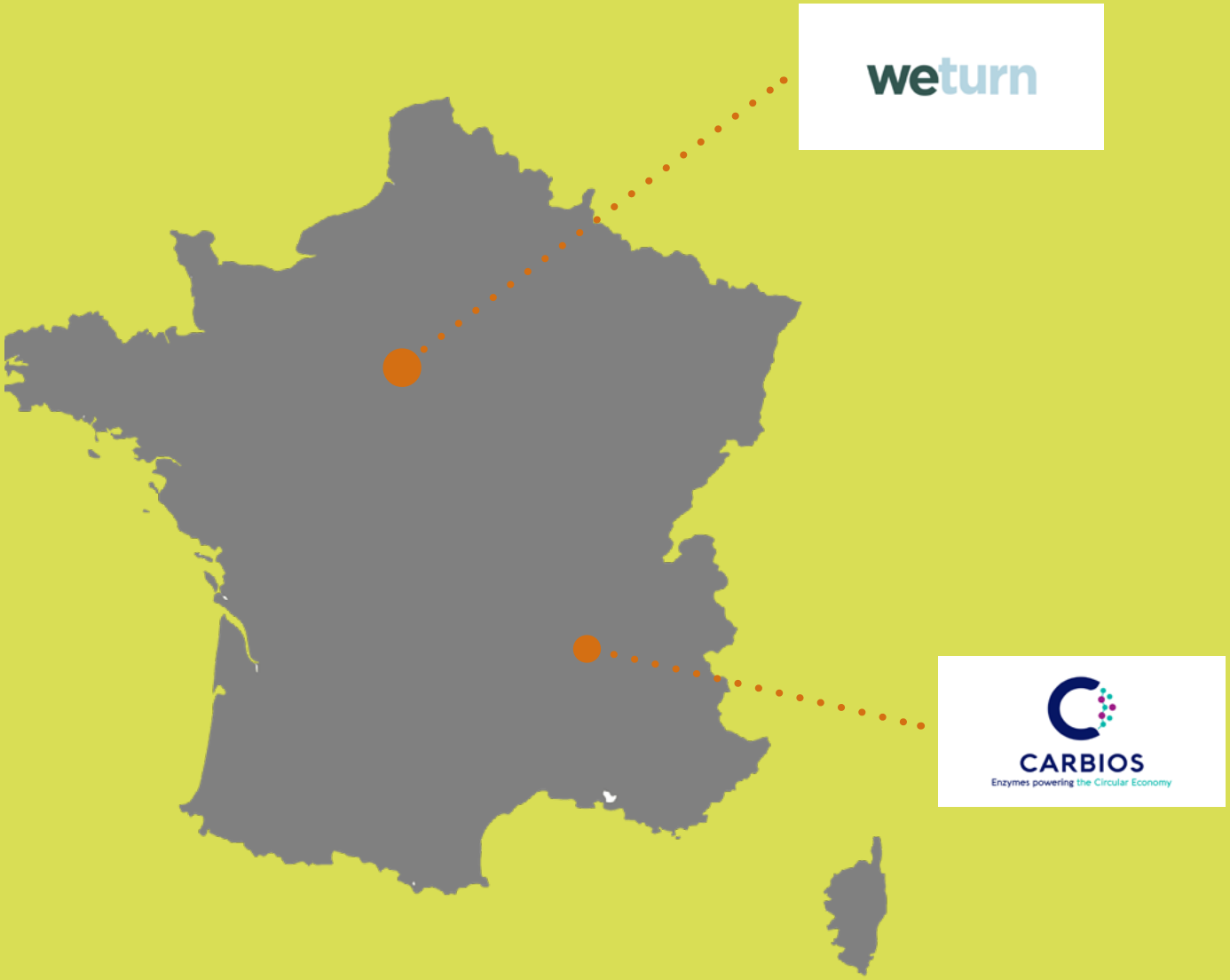
Technology: Mechanical and chemical recycling (with HTEX)
Business model: Yarn, fabric and garments
Input: Post-consumer work wear and uniforms
Output: Monomer building blocks (for new polyester)
Capacity: Not known
Scalability: High
Founded: Not known, Holland
Contact: www.cls-tex.com

what, process & result

CLS-Tex stands for Closed Loop Solution Textile (ND) and has, together with company HTEX, developed a technology that transforms workwear made of polyester (and polyester/cotton) into monomer building blocks as raw material for new polyester fibres. The raw material is made from the granulate produced through recycling old workwear in combination with shredded plastic waste.

The HTEX team and CLS-Tex in corporation form a closed loop solution for textile reuse for their partners. Products made with this material can e.g. be used for outdoor furniture and workwear. CLS-Tex is in charge of taking back workwear through their return logistic P4T®, recycling to raw material and supplying its partners with new raw materials so fibres, yarns and textiles can be manufactured.

CLS-Tex and Pure Waste has partnered for creating the label "Pure Waste CLS Inside" supplying recycled yarns, fabric and garments.



FRANCE

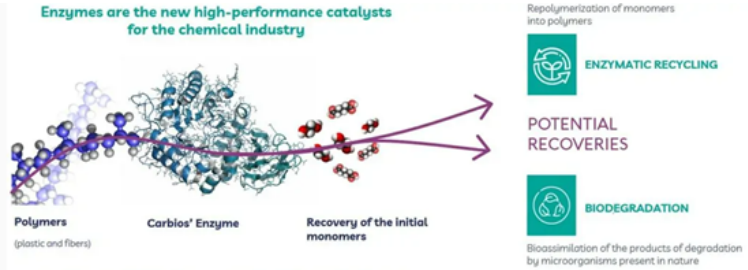
CARBIOS
Enzymes powering the Circular Economy

Technology: Biological recycling based on enzymes
Business model: Technology licensing and selling of enzymes
Input: Pre- and post-consumer PET waste (packaging & textile)
Output: Monomers (PTA and MEG) to produce 100% recycled PET (f. PES-fibre)
Capacity: Demo plant, 100 metric tonnes/an
Scalability: 50.000 metric tonnes/an by 2025
Founded: 2011, France
Contact: www.carbios.com

what, process & result

The Carbios (F) innovation makes it possible to recycle all types of PET waste - plastics and textile- without losing quality. Carbios has developed a biological recycling process using enzymes capable of depolymerising the PET (polyethylene terephthalate) contained in various plastics or polyester textiles. Trims/accessories on garments must be removed before enzymatic treatment, but the process can handle printed textile waste. The monomers from the depolymerisation process are purified to be re-polymerised into new polyester of a quality identical to virgin polyester obtained from the petrochemical industry. The unique process allows infinite recycling of these materials, whether clear, opaque, complex plastic or of textile origin (polyester), to produce new materials.

It is the intention that customers can buy the end products, PET resin and PES-fibre, through partnership with companies with the right competencies. Carbios is collaborating with partners such as L'Oréal, Nestlé Waters, PepsiCo, Suntory Beverage & Food Europe.



weturn

Technology: Mechanical recycling
Business model: Fabric supplier
Input: Pre-consumer waste
Output: Yarns and fabrics
Capacity: Start up capacity unknown
Scalability: Not known
Founded: 2020, France
Contact: www.weturn.eco

what, process & result

WETURN (F) is a newly started company that has identified a gap in the market for recycling services targeting fashion and textile brands. There are three primary textile waste sources: unsold goods that would otherwise be burned, production scraps and deadstock fabrics.

WETURN started as a pilot project with the LVMH Group for testing the concept and now collaborates with recycling companies in Spain, Italy and Portugal since France (red. apparently) lacks upcycling companies. Their service includes the removal of trims as well as recycling textiles with prints. The end products are yarn and finished fabrics, knitted and woven, in natural cellulosic fibres (cotton, linen, hemp, pinà, sisal), natural protein fibre (wool, silk) and synthetics fibres (polyester, polyamide, polypropylene and elastane).

WETURN's vision of a relevant circular economy is the creation of a virtuous recycling chain with collection, shredding and spinning of yarn for new fabrics. A complete chain is a guarantee of moving towards greater transparency, information and impact. This is why we position ourselves at the beginning, middle and end of the chain, to guarantee total respect for products, suppliers, manufacturers and consumers.

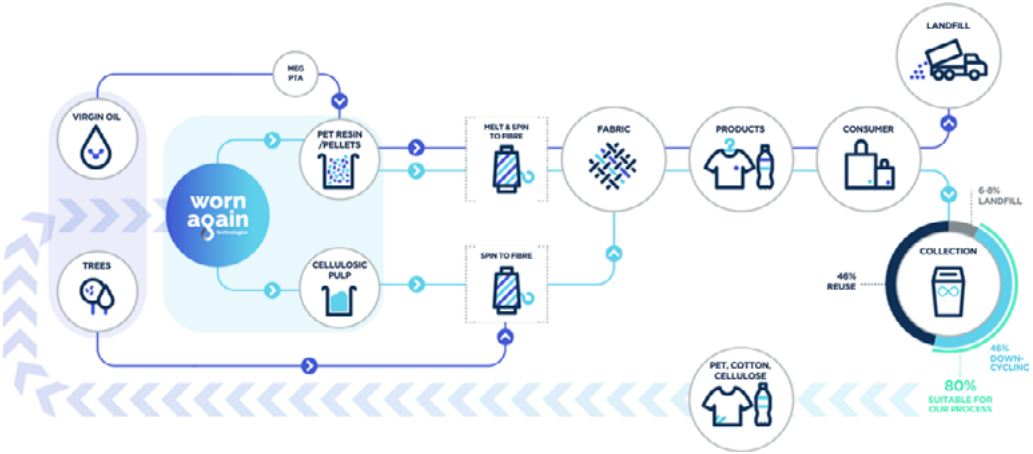
(Current collaboration activity with the company is low due to being newly established, therefore the authors can't guarantee that contact to this particular company will be successful)

UNITED KINGDOM

Technology: Chemical recycling
Business model: PET-resin (for PES fibers) and cellulosic pulp (for viscose/lyocell)
Input: Post-consumer textile waste PES/CO, PET bottles, plastic waste
Output: PET resin and cellulosic pulp
Capacity: 1.000 metric tonnes/an textile waste
Scalability: Yes
Founded: 2005, United Kingdom
Contact: www.wornagain.co.uk

what

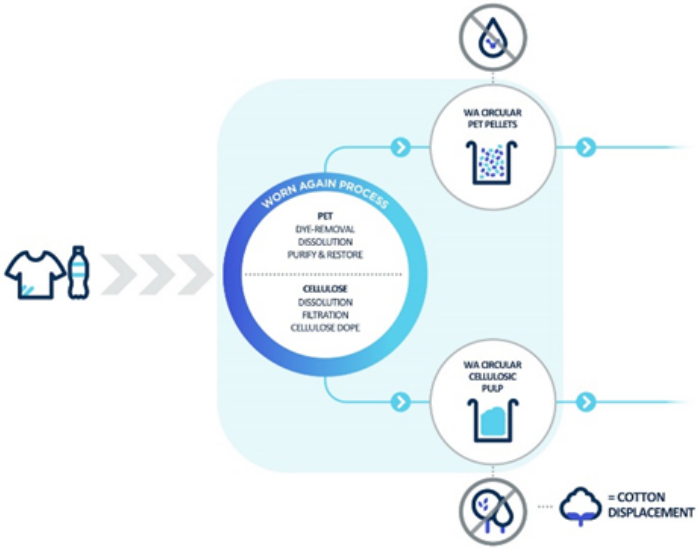
The Worn Again Technologies (UK) rely on two main sources of waste: post-consumer textile waste blends of cotton/polyester in various percentages and PET-bottles and -packaging. The technology separates polyester/cotton fabric blends by dissolution in a close loop system, followed by polymer separation and restoring polymers (for PET) and cellulosic polymers - the resulting PET-resin for spinning of new PES-fibres and cellulosic pulp for spinning of viscose/lyocell fibres (which are then used to spin yarn and weave/knit fabric for garments). 80% of post-consumer waste is suitable for Worn Again's technology and can therefore be used in the closed loop system. The new plant is being constructed in Winterthur, Switzerland, near one of the start-up's technology partners, Sulzer Chemtech.



process & result

In 2017 Worn Again Technologies was invited to become part of the Fashion for Good scaling program and received in 2019 the ANDAM Innovation Prize, the PCIAW Outstanding Contribution to the Textile Industry and the 'One to Watch' at the Global Good Awards. In 2019, the company's Founder, Cyndi Rhoades, was also a finalist for The Circular Economy Awards Leadership award.

Worn Again holds a `Cradle to cradle´ certificate since 2018 and is part of the Ellen MacArthur Foundation and Fashion for good. H&M, Sulzer Chemtech, Himes and Directex (textiles producer) have invested in Worn Again Technologies. Influential brands and partners such as Kering, ASICS Europe, Sympatex, Dibella and Dhana also support the companies.



Refibra™

AUSTRIA

Refibra™

Technology: Chemical recycling based on Lyocell technology
Business model: Fibre supplier
Input: Industrial, pre- and post-consumer waste
Output: Cellulosic Fibres
Capacity: Present production capacity not known
Scalability: High, 25.000 metric tonnes/an by 2025
Founded: 2017, TENCEL™ and REFIBRA™ are trademarks of Lenzing AG Austria
Contact: www.tencel.com

what, process & result

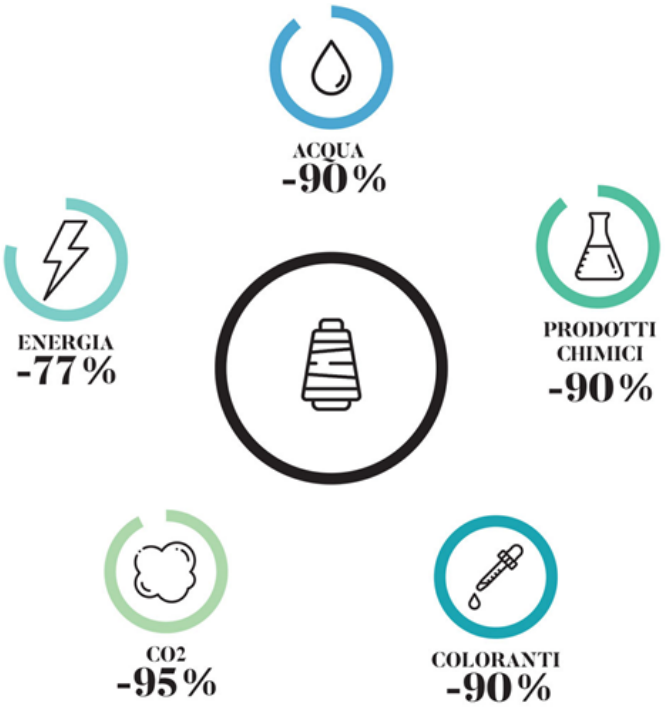
TENCEL™ Lyocell fibres with REFIBRA™ technology (2017) started with 20% cotton pre-consumer textile waste combined with cellulosic pulp from wood. In 2019 REFIBRA™ technology succeeded with the first production of TENCEL™ x REFIBRA™ Lyocell consisting of 30% post- and pre-consumer CO-textile waste, using t-shirts and bed linen not suitable for resale. In addition, Lenzing started collaborating with the Swedish company Södra, which produces cellulosic pulp.

The closed-loop lyocell process consists of six steps, the main being: pulp from cotton textile scraps is combined with wood pulp and then dissolved in a solvent (99.8% recyclable in a closed loop); a fibre ID is added to the mix for transparency at any stage of the process; the fibres are spun. The final product is biodegradable fibre suitable for knitting or weaving fabrics for the fashion and home textiles industries.

TENCEL™ Lyocell fibres with REFIBRA™ technology are available in commercial volumes for design brands globally. The future goal is to increase the content of post-consumer cotton waste up to 50%, 25.000 tonnes/an by 2025.

ITALY

Technology: Mechanical recycling
Business model: Garment and home textiles supplier
Input: Pre- and post-consumer waste (primarily denim and wool)
Output: Garments and home textiles
Capacity: Production capacity unknown
Scalability: High, but plan not known
Founded: 2017, Italy
Contact: www.rifo-lab.com



what

Rifó (I) Circular Fashion has several local and global collaborators collecting post-consumer waste. For example, worn-out jeans derive mainly from Southern Europe, while used cashmere garments are collected in US and Italy.

The process needs no re-dyeing since collected items are colour-sorted before shredding. For example, worn-out jeans and old cashmere garments are shredded separately, and the resulting yarns made of jeans waste come in three shades of blue, while cashmere yarns come in many different colours. The addition of virgin fibres is not highly needed since the fibres are still long after shredding and strong enough for yarn spinning. The recycled yarns are perfect for knitting new apparel and accessories and weaving fabric for tablecloths etc.

process & result

The newest Rifo products are sportswear of sweatshirt fabric from recycled denim yarns.

Rifo Lab has also launched a Zero Waste Line with products such as scrunchies, clutch bags, T-shirts, and gloves made of yarn and fabric leftovers. In 2021 the company partnered up with the online platform Zalando. Brands and private customers can buy directly from Rifó-Lab's e-commerce platform.

ReVerSo™

Technology: Mechanical recycling
Business model: Service provider & yarns/fabric
Input: Industrial waste and post-consumer 100% wool & cashmere
Output: Recycled yarn and fabric
Capacity: Not known
Scalability: High, but plan not known
Founded: 2014, Italy
Contact: www.re-verso.com

what

Re-VerSo™ (I) manufactures high-quality recycled wool materials with a well-established textile system involving several partners; Green Line, Nuova Fratelli Boretti, Filpucci, A.Stelloni Collection and Antica Valserchio. The processes applied are mechanical and result in re-engineered wool, cashmere and camel fibres. The textile waste by colour and thereby avoiding re-dyeing and significant use of water.

process & result

Green Line sources pre-consumer cut-offs and collects post-consumer wool-articles from EU, sorting and sanitising them. Nuova Fratelli Boretti takes care of the mechanical process of transforming the various collected wool waste into fibres by shredding and blending. Lanificio Stelloni manufactures knitted and woven fabrics for fashion and home textiles and Antica Valserchio make-up garments & accessories.

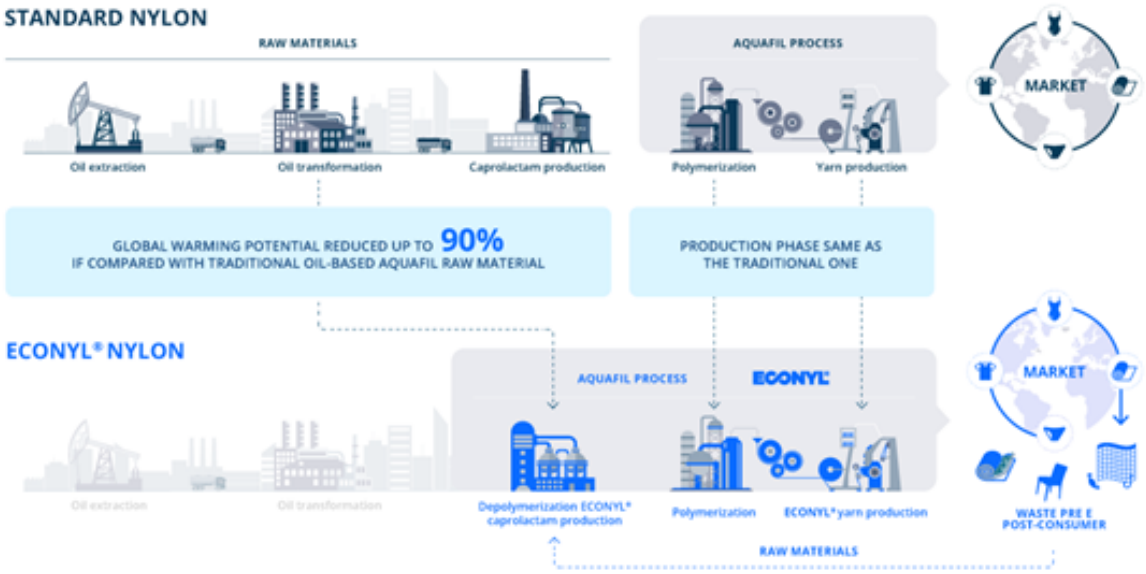
Re-VerSo™ holds certifications such as Global Recycling Standard, ISO 9001 and SA8000.

The Swedish brand Filippa K collaborates with Re-VerSo™ by sending wool fabric cut-offs to Italy for this to be recycled and reused, as any brand can do.

Technology: Chemical recycling based on depolymerisation into monomers
Business model: Yarn and polymer supplier
Input: Pre- and post-consumer waste
Output: Polyamide yarns and raw material polymer
Capacity: Production scale capacity not known
Scalability: High
Founded: 2011, Italy
Contact: www.aquafil.com
www.econyl.com

what

Aquafil S.P.A. (I) is the company behind ECONYL® Regenerated Nylon, recycled nylon using two primary sources: pre-consumer and post-consumer waste such as used fishing nets and carpets. Both waste streams are shredded, and contaminants are removed. Depolymerisation then takes place (at their plant in Slovenia), breaking down the nylon waste to the monomer stage (caprolactam, the building block of nylon) followed by a polymerising process back to the PA-polymer.



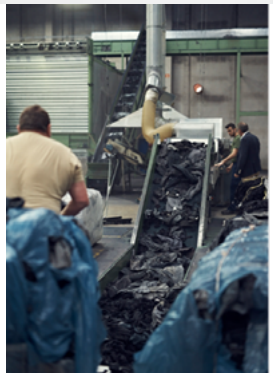
process & result

It's possible to regenerate the ECONYL® nylon repeatedly. ECONYL®'s process results in a variety of yarns for the fashion and textile sector; swimsuits, sportswear and carpets. ECONYL® yarns are used by more than 2.000 brands worldwide, such as Burberry, Gucci, Prada, Adidas, Swedish Stockings and Ege Carpets. A partnership with the world's largest dealer of CPL (caprolactam) and nylon chips, Itochu in Japan, will help Aquafil to expand and sell ECONYL® for even more applications within fashion carpeting, automobiles and packaging.

Aquafil has several certifications on yarns and production incl. Standard 100 by OEKO-TEX®, SA 8000, ISO 9001 and 45001.

SPAIN

Technology: Mechanical recycling
Business model: Recycled fibre supplier
Input: Post-industrial to pre-and post-consumer waste
Output: Recycled RCotton and RColorBlend fibres
Capacity: High/not known
Scalability: High. By 2026 350.000 metric tonnes/an
Founded: 2015, Hilaturas Ferre Valencia, Spain
Contact: www.recoverfiber.com

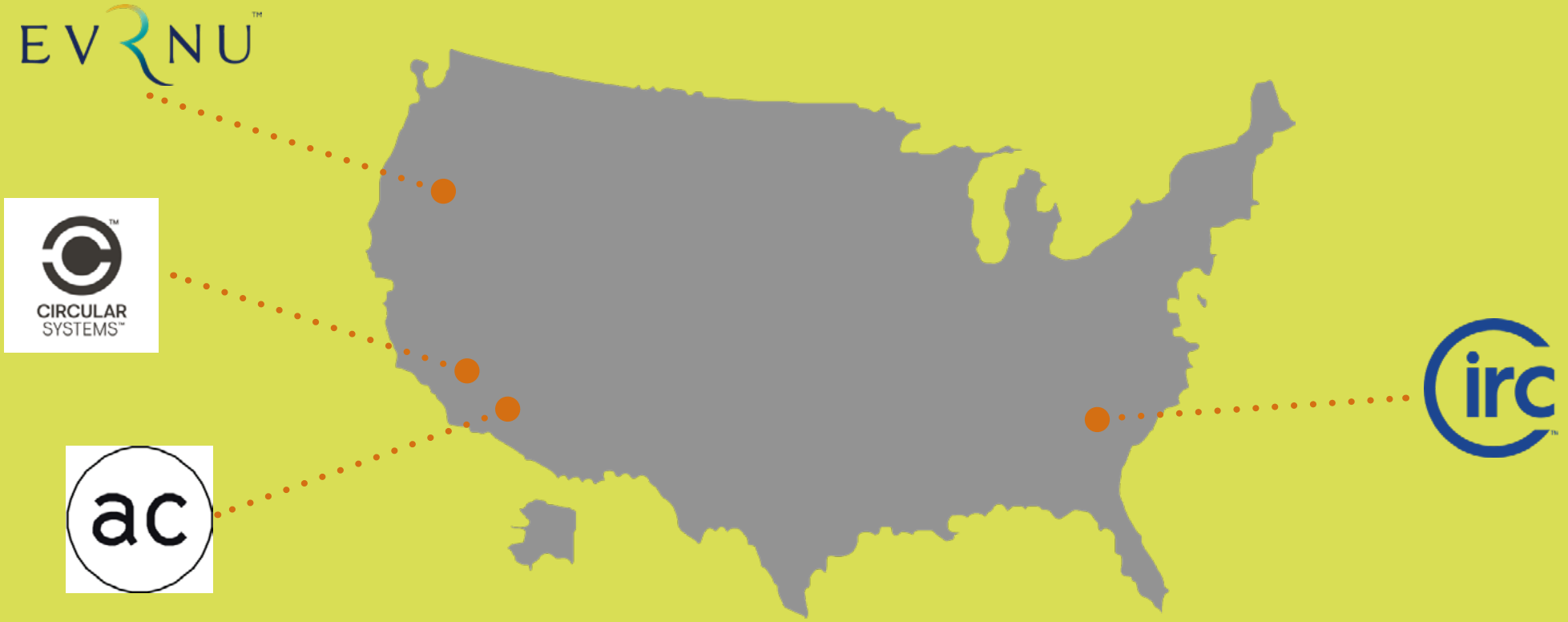


what, process & result

Recover™ (ES) is an experienced mechanical cotton recycling company; the collected and sorted textile waste is cut into smaller pieces, shredded, blended and further processed into RCotton fibre (100% recycled CO), RColorBlend cotton w. 30-70% recycled PES-fibres or REarth 50% recycled CO/50% organic CO - which are then sold on to yarn spinners. Further down the line, the yarns become fabrics for the fashion and interior design industry.

Recover™ has a recycling capacity in Pakistan and Bangladesh and plans to expand further. They partnered with Swedish waste recycling company Sysav, and today the automated sorting plant is known as Siptex. This partnership will contribute to consistent supplies of post-consumer waste for Recover. Additional partnerships include Textile Exchange, ReHubs, Sustainable Apparel Coalition, Circular Fashion Partnerships and Denim Deal.

By 2025 the company targets 40 % of its feedstock to be derived from post-consumer sources.



USA

Technology: Chemical recycling
Business model: Future pulp and fibre supplier
Input: Industrial, pre- and post-consumer cotton textile waste
Output: Regenerated fibre
Capacity: Not known
Scalability: Medium/high – expected 2023
Founded: Recent/not known, USA
Contact: www.evrnu.com
info@evrnu.com

	100% Conventional Cotton T	100% Polyester T	100% NuCycl Lyocell T
Climate* (CO2e)	0.3 to 2.4	2.0 to 4.1	-2.5 to -6.4
Water use	substantial	water efficient	water efficient
Fertilizers and pesticides	substantial	no	no
Plastic pollution	no	major	no
Recycled raw material	no	no	yes
Biodegradable	yes	no	yes

* Cotton includes an embodied biogenic carbon credit. NuCycl instead is given a waste omissons avoidance credit

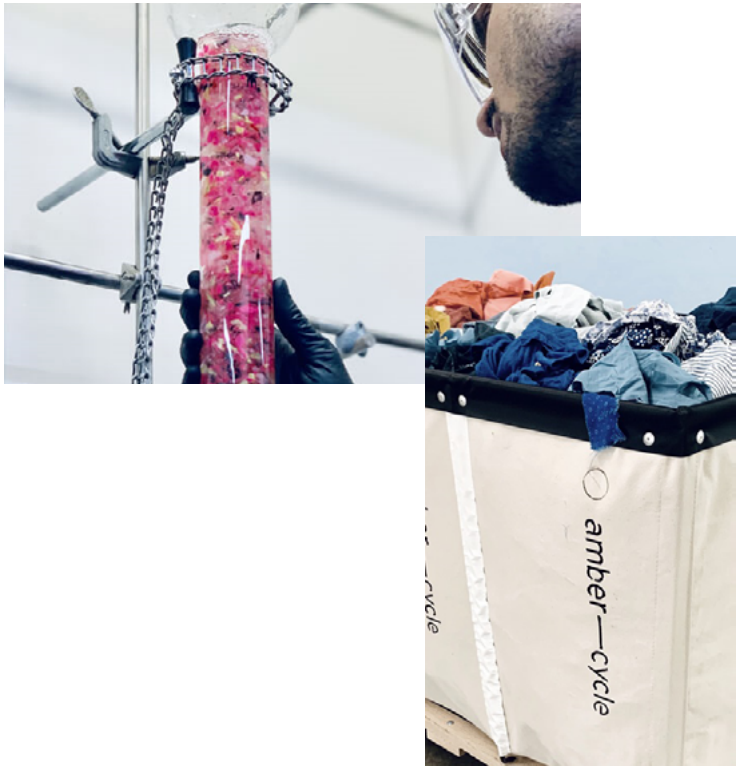
what, process & result

Evrnu® (US) engineers regenerated fibres from post-consumer cotton textile waste through depolymerisation into monomers, which are then used as building blocks for new, virgin-grade fibre. The method is patented. The textile innovator has launched NuCycl™ Lyocell, a high-performance fibre that outperforms virgin nylon and polyester in material properties such as tenacity and strength. The material can be recycled up to 10 times using Evrnu's chemical recycling solution, although it loses around 10% of its tenacity each time.

Production of recycled cellulose pulp will be ready by mid-2023 and NuCycl r-lyocell fibre by late 2023. Evrnu has more than 40 clients in the pipeline and is, at this stage, searching for supply chain partners interested in securing exclusive rights to distribute NuCycl to the market.

The first collaboration with designer Carlos Campos whose collection of t-shirts was made with NuCycl r-lyocell fabric, has been presented, and further collaboration progresses with Adidas, Stella McCartney and Bestseller, who are some of their major investors.

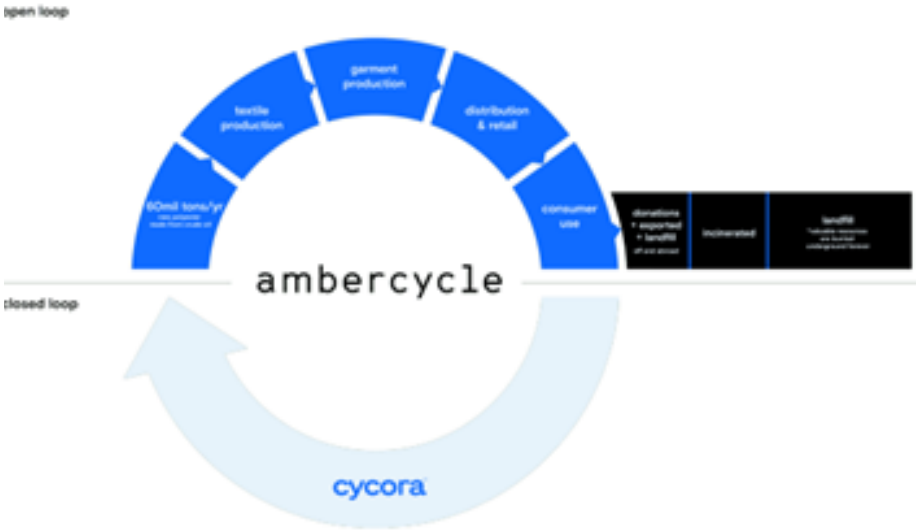
Technology: Chemical recycling
Business model: rPET pellets and recycled PES-fibres
Input: Polyester textile waste – industrial, pre- and postconsumer
Output: Cycora polyester fibres
Capacity: Not known
Scalability: Medium/high
Founded: Recent/not known, USA
Contact: www.ambercycle.com



what, process & result

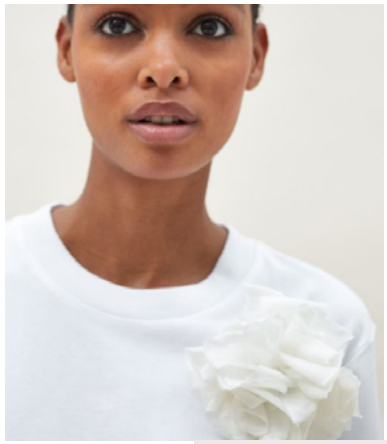
Ambercycle (US) is an innovation company within chemical recycling that uses textile waste, mainly polyester and polyester blends that goes through a chemical separation process where the synthetic fibre is dissolved and made to rPET-pellets and then spun into virgin-grade PES-fibre/yarn Cycora® which will then be made into new fabrics for clothing.

Ambercycle won the H&M Global Change Award in 2016 and has received US$21.6 million in funding from companies such as Zalando, Bestseller and H&M.



CIRCULAR SYSTEMS™

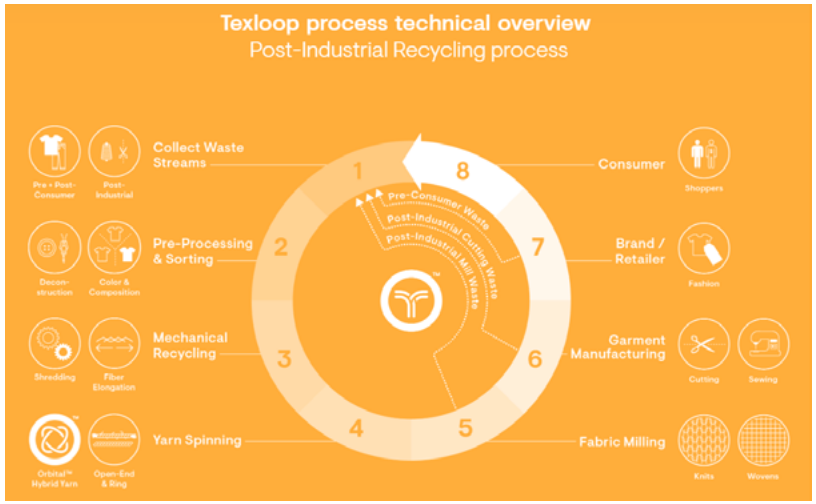
Technology: Chemical recycling
Business model: Yarn and fabric supplier
Input: Industrial, pre-, post-consumer & agricultural waste
Output: Yarn and fabric for fashion
Capacity: Not known
Scalability: High
Founded: 2017, USA
Contact: www.circularsystems.com



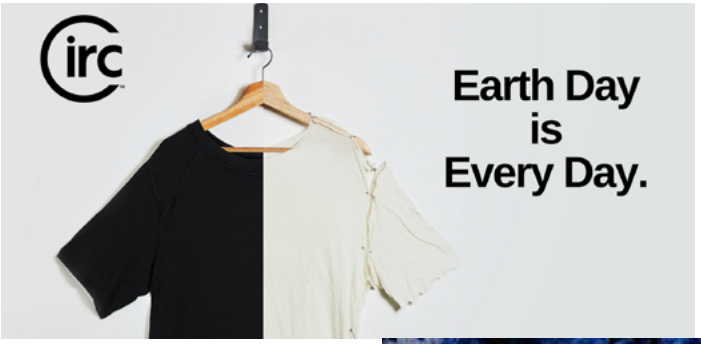
what, process & result

Circular Systems (US) has developed three lines of products; Texloop™ made from pre-consumer/industrial waste, Orbital™ Hybrid Yarn and Agraloop™ biofiber derived from agriculture waste. Texloop™ is created from post-consumer waste of natural and synthetic fibres such as cotton, viscose, polyester/cotton and polyester with the addition of virgin organic cotton. The final output is fabric primarily for fashion items.

A partnership with the company Nishat Mills Ltd. (70 years of experience in yarn, fabric, home furnishing, towels and garments) has enabled Circular Systems to have broad access to the textile market with sustainable materials in Pakistan and expand its customer portfolio, but also give them a more competitive advantage when it comes to prices. As a result, circular Systems won H&M Global Change Award in 2018 and have among others Bestseller as an investor.



Technology: Chemical recycling based on hydrothermal depolymerisation into monomers
Business model: Raw-material supplier
Input: Pre- and post-consumer waste
Output: Recycled cellulosic pulp and rPET (powder/pellets)
Capacity: Pilot scale 4 tonnes/day
Scalability: Planned increase of capacity to 60.000 metric tonnes/an
Founded: 2011, USA
Contact: circ.earth



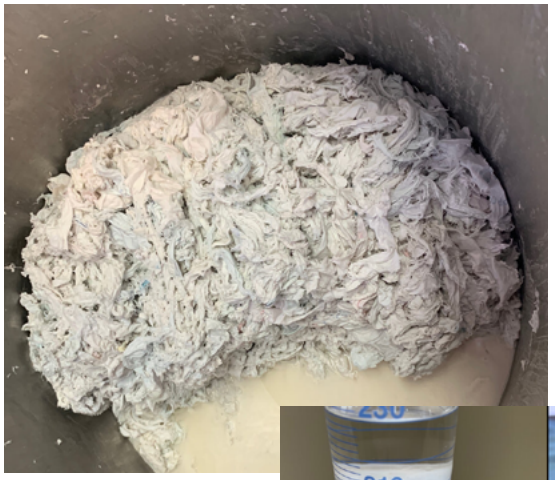
what, process & result

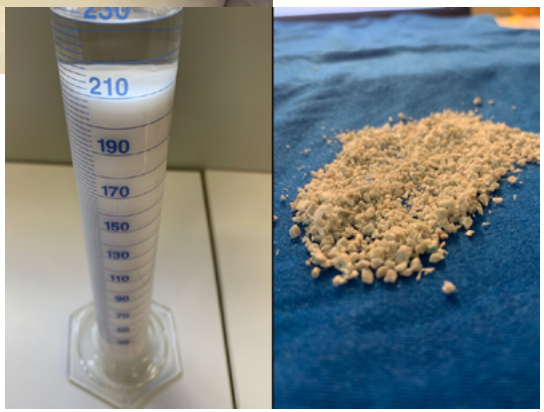
CIRC™ Technology (US) can recycle textiles of cotton, polyester and their blends. The recycling process is hydrothermal with addition of (responsible) chemicals and depolymerises polyester into monomers and recover the cellulose from cotton. Both can then be used as raw materials for new polyester and for viscose and lyocell. The recycling technology is patented. Due to the flexible process, it can meet the needs of its customers within product specifications and pricing.

Circ™ havs in 2021 formalised a partnership with Andritz (A) to commercialise the technology. Andritz has the role of engineering and manufacturing continuous equipment for CIRC™ facilities that are planned around the world.

AUSTRALIA

Technology: Chemical recycling based on hydrothermal depolymerization into monomers
Business model: Raw-material supplier to partners
Input: Pre- and post-consumer and industry textile waste
Output: S.O.F.T. rPET pellets (f. PES) & cellulose powder (f. viscose/lyocell)
Capacity: 2022 4.000 metric tonnes/an
Scalability: High, but status unknown
Founded: 2018, Australia
Contact: www.blocktexx.com





what, process & result

BlockTexx (AU) textile recovery technology is a clean-tech company that recovers polyester and cellulose from textiles and clothing - pre- or post-consumer – collected from consumers, industry or commercial spots. They have developed their own chemical recycling process named Separation Of Fibre Technology (SOFT), resulting in rPET pellets and cellulose powder, suitable for further processing of textile fibres and packaging. It is not known which solvents are used.

The first plant will be finalised in 2022 and is in Queensland, Australia. It is intended to handle 4.000 tonnes of textiles in its first year, increasing the amount to 50.000 tonnes/an. BlockTexx works with Australian as well as international brands.

CHINA

Technology: Chemical recycling based on hydrothermal treatment
Business model: License and sale of the technology
Input: Pre- and post-consumer waste
Output: PET fibres and cellulosic powder
Capacity: Pilot
Scalability: High
Founded: 2016, Hong Kong Research Institute
Contact: www.hkrita.com

what, process & result

The Green Machine is a project led from The Hong Kong Research Institute of Textiles and Apparel Ltd. (HKRITA) in collaboration with H&M Foundation under the program Recycling Revolution. The process only uses heat, water and less than 5% biodegradable green chemical to achieve a recovery rate of > 98% for polyester fibres in 0.5-2 hours. One Green Machine can process up to 1.5 tonnes of textile waste per day. The output is polyester fibres equal to the input quality, and the cotton is extracted as cellulose powder, which can be used in multiple ways, e.g., for new viscose/lyocell fibres -> yarn -> fabric -> garments.

Kahatex, one of the largest textile manufacturers in Indonesia, made the first commercial order of the technology in 2020. In 2021 one of the world's biggest denim producers ISKO, through licensing agreement, applied the technology to build their own system in Turkey.

HKRITA is a research institute, not a recycle manufacturer and are therefore not in charge of collecting waste or recycling but is working on knowledge transfer of the Green Machine to textile recyclers and manufacturers interested in the business of recycling. Finally, the Green Machine is ready for commercialisation and will be licensed by HKRITA.

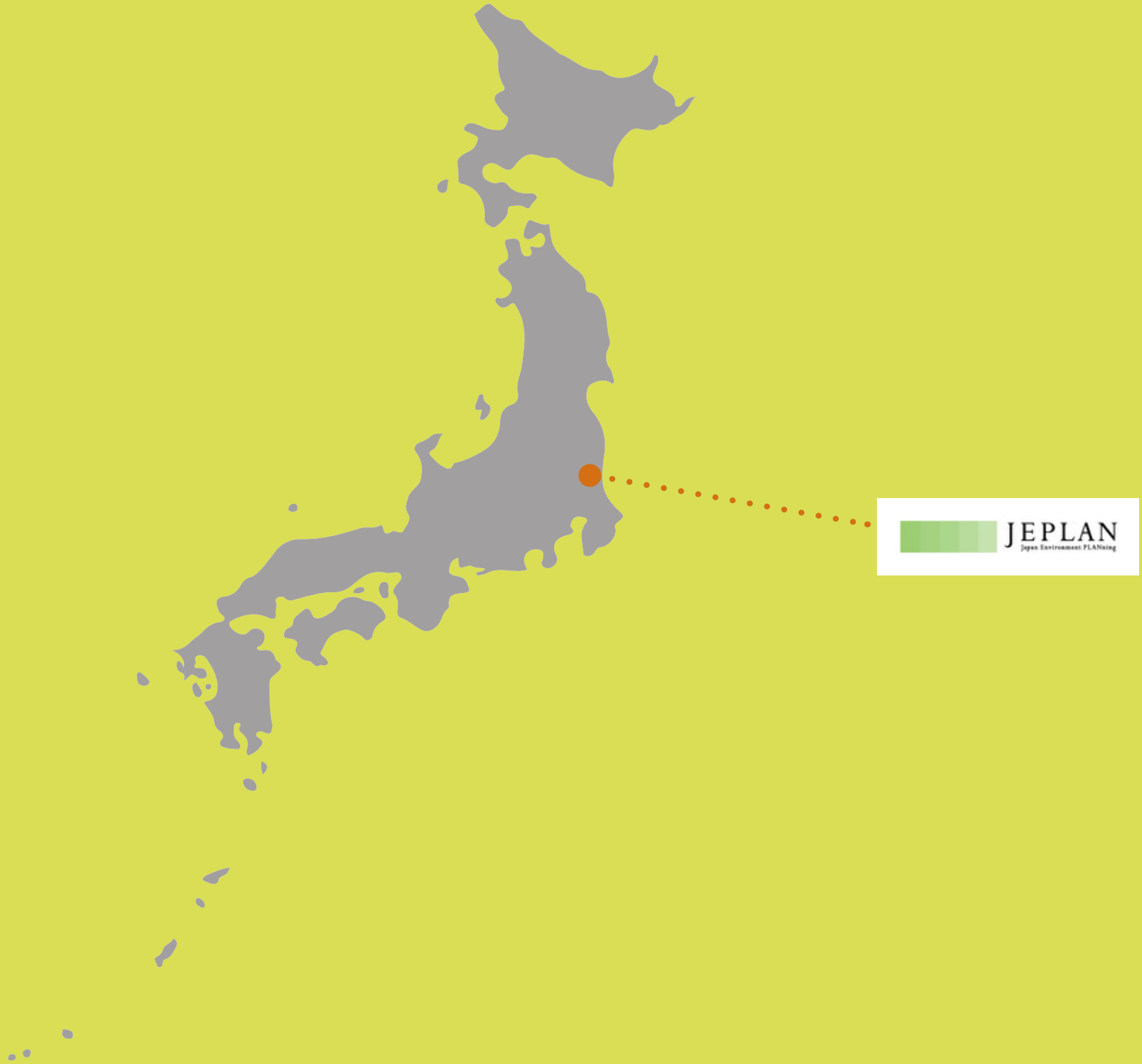
Technology: Sorting and mechanical recycling
Business model: Fibre and yarn supplier
Input: Industrial, pre- and post-consumer textile waste
Output: Fibres and yarns
Capacity: Production scale capacity 240 metric tonnes/an
Scalability: Yes, not known but indicated 260 metric tonnes/an
Founded: 2018, Novotex China
Contact: www.thebillieupcycling.com




what, process & result

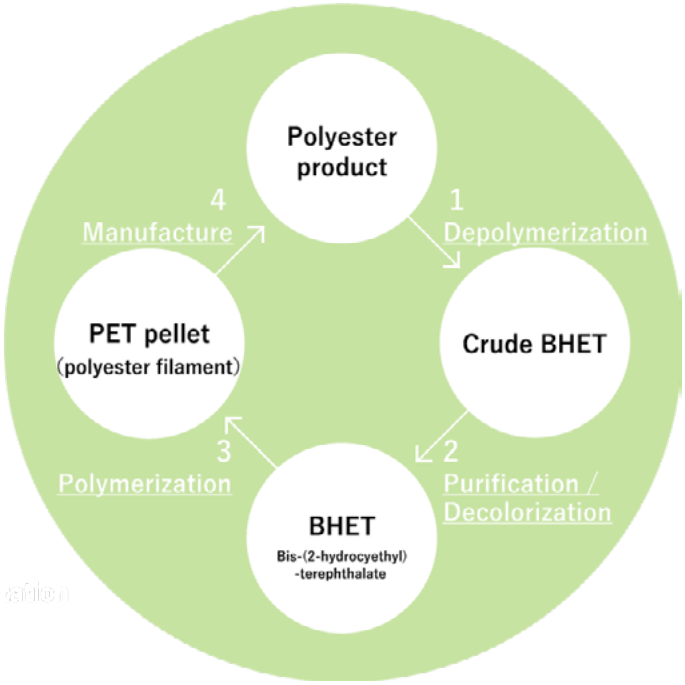
The Billie Upcycling System (HK) has been developed in a collaboration between Novetex Textiles Ltd. and the Hong Kong Research Institute of Textile and Apparel (HKRITA). It is a fully automated patented system, thereby reducing the labour costs associated with textile recycling in their Zhuhai facilities. The feedstock derives from both industrial, pre-consumer & post-consumer waste and deadstock based on natural fibres.

The almost fully automated Billie System has six steps: 1. Sanitisation with ozone 2. Removal of accessories 3. Colour sorting (up to nine colours) 4. Fibre processing/shredding 5. UV-sanitization 6. Twisting of fibres into slivers (pre-yarn spinning) - a certain addition of virgin materials is necessary to spin a strong, high-quality yarn. Each machine can process up to 3 tonnes/day. The final output is yarns for fashion fabrics, and these are used by some of the big brands in the fashion industry.



JAPAN

Technology: Collection, sorting and chemical recycling
Business model: Selling licensed technology to PET-manufacturers
Input: Post-consumer textile waste and PET-bottles
Output: rPET-pellets (for spinning of PES-yarn)
Capacity: 22.000 metric tonnes/an rPET based on bottles
Scalability: High but extend not known
Founded: 2007, Japan
Contact: www.jeplan.co.jp



what

Jeplan (JP) produces recycled polyester yarn from post-consumer waste. Jeplan's patented chemical process starts with the manual sorting of textile waste at one of their plants in Japan.

Since 2010 a collecting and recycling system named Bring™ has been established by JEPLAN in Japan. It started with 50 spots in physical stores and has now grown to app. 2.800 collection spots in Japan - the future goal is 10.000 spots. More than 100 million tonnes of clothing are discarded each year in Japan and 90% of these have been incinerated until now.

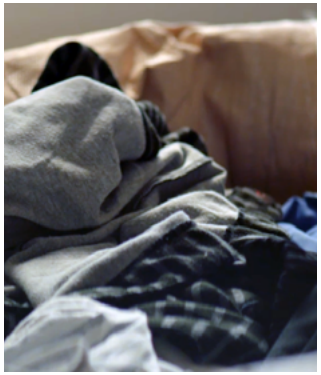
BRING

process & result

The post-consumer waste is mechanically shredded, then a depolymerisation process follows resulting in polyester monomers (BHET). Finally, a purification phase is needed to remove irrelevant materials such as cotton and other components. Buttons and zippers are also being recycled after their removal. This chemical process's end product is PET-pellets spun into PES-yarn (extruded) at Jeplan's Japanese textile partners.

The pilot plant was set up in 2017, separating polyester/cotton to create an output of PET pellets. The pilot plant capacity was 2.000 tonnes/an PET/PES fibre-to-fibre recycling, the present capacity is not known.

A new facility in Dubai was in 2019 aided by an estimated US$30 million investment facilitated by a public-private partnership. H&M has already used JEPLAN as a supplier.



CASES 2.0.

Five new cases have been created with the following companies:

1. Kimberley Van der Wal, Director of Business Development at Wolkat
2. Rikke Bech, CEO at New Retex
3. Johannes Bogren, Vice President of Cell Bioproducts at Södra
4. Ditte Højland, CEO at Textile Change
5. Frederik Lewinsky CEO at Dear Denier

The companies represent both mechanical and chemical recycling as well as sorting. The case studies were conducted by interviewing each company asking multiple questions regarding their business model, how to secure feedstock of textile waste, partnerships, challenges and future visions. The way these cases are structured give an insight into:

- Business model
- Securing feedstock
- Partnerships
- Challenges
- The future

Wolkat

New Retex

SÖDRA

TEXTILECHANGE

DEAR DENIER
SUSTAINABLE AND INNOVATIVE HOSIERY

BUSINESS MODEL

Wolkat is a 70-year-old Dutch company with a broad business model covering collection, sorting, recycling as well as creating end products: recycled yarns and fabrics. Wolkat already saw potential when it started its journey in recycling, though the revenue back then was primarily in secondhand clothing. Then 10 -15 years ago, they revisited the idea and slowly began to realise their visions within recycling. Today their core business evolves around sorting for recycling and end products made from recycled fibres.

Wolkat was able to accelerate quickly because of the in-house competencies they now possess. In total, 800 people are employed by Wolkat, 500 of them sort, 25 are situated in Holland while the rest are in Morocco. Kimberley Van der Wal tells us that creating the business of spinning recycled fibres was created due to the lack of interest of other spinning companies 15 years ago exploring this field.

SORTING & RECYCLING

The company works with two types of collection 1) in stores where end consumers can hand in used clothing & textiles in special boxes and 2,) through municipalities curb sides collection focused on volume. The sorting process consists of five main steps: 1) manually pre-sorted in Holland into reusable and non-reusable in multiple categories of products, e.g., shoes, woven, knitted, accessories etc., 2) then it's sent to Morocco where it is sorted again into more categories, 3) reusable textile is sold globally as a product 4) From the non-reusable textile the trims are removed, 5) separated in fibre type & colour for recycling. Sorters have recently begun using hand scanners in the pre-sorting phase to identify material types more efficiently.

Wolkat is mainly interested in five fibre types for recycling at their facilities: cotton, low wool, polyester, acrylic, and cotton in a variety of 20-40 colours. Moreover, another very valuable fibre type, either 100% or 50%, is sold to manufacturers recycling in Prato, Italy. In general, adding 10-25 % of virgin fibres is needed depending on the fibres' quality.

END PRODUCTS

Wolkat produces a wide variety of end products such as accessories, home textiles, and fashion textiles, and they wish in the future to manufacture garments as well. Yarns can be thin or thick depending on the client's needs, and they don't operate with having yarns stocked up exclusively made to order. If a client is requesting a specific colour, it can take up to six months depending on which colours are trending in fashion at the moment or which ones used to be in fashion since some of the used clothing can be years old so to say this can be difficult from time to time to accommodate.

FUTURE AMBITIONS

Wolkat plans to increase capacity soon with a new factory being built in Morocco, and by 2026 double or triple the size.

Wolkat's future vision is to be part of a well-established ecosystem that provides high-quality clean feedstock of textile waste to companies such as Re:newcell, Worn Again and many more companies doing chemical recycling.

REYARN PROJECT COLLAB

Wolkat participated recently in a Danish project called Reyarn, a collaboration with the City of Copenhagen, Trasborg, Salvation Army Denmark, Bacher Work Wear and ReValuate with a scope of collecting household waste, sorting, recycling and creating new products as local and sustainable as possible. Wolkat had the role of recycling, spinning yarns, and weaving/knitting fabrics, as well as producing non-wovens. A project like this also proved that investments are highly needed at the beginning of such a journey to gain revenue.

ADVICE

Kimberley Van der Wal, Director of Business Development, advises fashion & textile companies to think out of the box and that all stakeholders involved need to give a little and mainly step away from virgin fibres.

There are three ways a fashion company can collaborate with Wolkat: 1) buy recycled products from Wolkat because there is a high need to increase the demand for recycled fibres, 2) create in-store collection points for used clothing, 3) develop R&D projects.

Wolkat

BUSINESS MODEL

New Retex's core business model is automated sorting of textile waste. The company currently sorts in six colours and 21 material types, although the market does not yet demand it. Therefore, New Retex focuses on ten categories for now, e.g., 100% CO or PES/CO blend. By August 2022 New Retex will sort 10t per week; from Autumn 2022 this will increase rapidly. The future capacity goal is 40,000 tonnes/an.

New Retex has, since the beginning, worked on establishing a strong ecosystem of various important stakeholders; Danish municipalities such as Herning, Århus, and Solrød and waste companies such as Vestforbrænding, Affaldplus and more. Such partnerships are very vital for the future of circular textiles. Furthermore, the sorting company also seeks partnerships with other types of stakeholders in the textile value chain, such as yarn spinners, fabric manufacturers and other suppliers.

FEEDSTOCK

New Retex is currently experimenting and evaluating what could be recycled (fibre-to- fibre or non-wovens) from the upcoming household textile waste or needs to be incinerated due to it being wet or contaminated. The goal is to recycle 50% of the household waste, resulting in yarns, fabrics, or non-wovens. Several stakeholders are also interested in creating furniture or even paper qualities from textile waste; this will need high development activity to succeed.

PARTNERSHIPS

A new partnership has been established between New Retex and Blue Cross. Blue Cross will be in charge of pre-sorting textile waste, including pillows, jackets etc., containing feathers to be recycled. Additionally, hand scanners could be used in the future pre-sorting phase. Still, Rikke Bech CEO at New Retex believes that the human eyes cannot be replaced with robots when evaluating the potential of secondhand clothing for sale.

CHALLENGES

Rikke Bech says there are several challenges when you are semi-newly started company in a country like Denmark where textile and garment production was outsourced three decades ago. This has had a negative impact on the local skills and material knowledge. Also, the lack of expertise within technology combined with the textile industry is a concern. Therefore, there is now more than ever high need of educating material engineers in Denmark.

FUTURE AMBITIONS

New Retex envisions a future where they are not only able to automatic sort but do much more. They have the ambition of shredding, spinning, and producing fabric from the textile waste they collect locally. This is to control the process better and to keep the high quality of fibres their priority. Even more, New Retex wishes to become the biggest sorting plant in Europe and lead several of the production steps in the circular value chain.

ADVICE

Rikke Bech advises fashion & textile brands to establish a take-back system by collaborating with existing resale logistic platforms or creating their own take-back scheme. Moreover, she advises to get very well familiar with design for circularity and implement circular principles. Not only designers should be involved in such but also buyers and other employees in a fashion company. The fashion industry is used to a high pace, and Rikke Bech says that fashion brands should get used to a slower pace that is significantly needed in order to develop high-quality circular materials.


KUKA

SÖDRA

BUSINESS MODEL

Södra is a Swedish forest industry group, and one of its main activities is pulp production from sustainable wood forests and selling it to the market.

PROCESS & MATERIALS

The recycling process of Södra focuses on recycling the cotton content that needs to be at least 50% content in blend material while removing the polyester. In the future, though, polyester will presumably be recycled, and elastane can also be present but not in very high percentages.

FEEDSTOCK

Securing feedstock can be challenging, not due to lack of textile waste (either pre-/post-consumer) but due to it not being easily available today because the system is not yet set up for recycling. Therefore, Södra focuses on receiving its feedstock from laundries with the advantage of big amounts of used textiles, specifically blends of polyester/cotton. Another advantage is that regularly used textiles from laundries are white, making it easier for Södra to recycle. Moreover, laundries remove various trims before sending it to Södra, while thread and labels are kept because that's not problematic.

Furthermore, a recent collaboration with the Swedish ICA supermarket chain was an opportunity for Södra to explore new territory. The partnership allowed Södra to investigate how recycling could work with coloured feedstock since it is challenging with dyes because there is a need to know exactly which chemicals have been used, hence it always requires testing before processing. Additionally, Södra is looking to expand its partnerships within feedstock stakeholders.

PARTNERSHIPS

Partnerships are essential when succeeding in the circular value chain, specifically when working with recycling. As a pulp producer Södra does not possess competencies in spinning fibres or making fabric since that is not their core business. This means that a company such as Södra as raw material suppliers, are seeking partnerships with expert companies in the next steps of the value chain and that have the ability to spin fibres out of the pulp and create fabrics as end products. A recent example of such a collaboration is Södra partnering up with Lenzing Group in Austria.

FUTURE AMBITIONS

A future Södra envisions is to be visible in fashion stores. Collaborations with fashion brands, such as a very recent one with Bestseller, Jack & Jones should in the future showcase Södra as the company behind the recycled raw material. The label should not only inform the end consumer of where the garment is sewn but, most importantly, tell where raw materials, yarns and fabrics are produced and by who. (covering the multiple production steps the textile value chain entails)

Considering the household textile waste, it is currently possible for Södra to recycle because it's the most complicated input material. According to Johannes Borgren, there is a price competition between virgin and recycled fibres. The cost of textile waste handling is currently high, which slows down the process as it doesn't make recycled materials attractive from a price perspective.

Södra finds that recycling plants should be established in countries with high textile production activity, such as Asia and not in countries like Sweden where textile production is very low. At the moment, it seems like a big challenge to envision a future where recycling plants can recycle enormous amounts of textile waste, such as 500,000 tonnes/an.

ADVICE

Sorting is key! A fashion/textile brand or even municipality must first partner up with a good sorter company. This will be crucial for ensuring high-quality textile waste is recycled.

Johannes Bogren, Vice President of Cell Bioproducts at Södra, advises fashion brands to explore possibilities within recycling to establish a take-back system for reselling clothing, while Södra could receive what is not suitable for resale.

BUSINESS MODEL

Textile Change is a recycled raw material supplier that soon will recycle collected and sorted textile waste from sorting companies and fashion brands that eventually will have a take-back system.

Currently, Textile Change is in a test phase period experiencing easy access to textile waste, while a big concern is the missing data. Sorting companies have no data on collected, used garments generating an unsure feedstock for chemical recycling companies. It is necessary to have information on chemicals used in the production and the use phase of textiles.

In 2024/2025, the company will be ready with its first commercial plant in Denmark. Moreover, Germany is a very appealing market to scale up due to the country's knowledge of recycling plastic while lacking in recycling companies within chemical processes of textiles.

FEEDSTOCK

Materials need to be polyester or cotton or a blend of polyester/cotton. The company experiences a relatively easy access to feedstock, especially from the sorting companies. For a company like Textile Change it is crucial to have a steady, preferably big supply of feedstock. It is important, that brands develop smaller take-back systems, and are willing to put the collected items back into a larger recycling system that doesn't necessarily separate the items of the specific brand from others, according to Ditte Højland, CEO of Textile Change. Small quantities of too many different materials will slow down the recycling process as the machines would need to be paused too often. It would create an unnecessarily complicated logistic setup trickling down through the remaining value chain.

PARTNERSHIPS

Regarding collaboration possibilities for companies with Textile Change, there are different scenarios. For example, it could be a collaboration with a sorting company, NGOs or fashion and textile brands. Fees might differ depending on the accessibility of the valuable materials and the amount of actual waste (e.g., diapers, rubber boots, etc.) that needs to be removed.

According to Ditte Højland the mindset of some fashion brands nowadays challenges chemical recycling companies. When brands are interested in a closed loop, meaning that the textile waste a brand delivers as input, it expects as an output. This challenges the recycling process slowing it down because textile waste from a particular brand should not be blended with another brand's even though it might be of the same fibres etc. This will most likely change in the future when recycled fibres are as standard as virgin fibres, but time will tell.

FUTURE AMBITIONS

Ditte Højland, CEO of Textile Change, is looking forward to seeing even more chemical recycling technology companies work with the separation of blends since it's highly needed for the textiles engineered nowadays. This needs to be supported by fabrics and clothing designed much differently than nowadays with a focus on design for circularity, for example, easy disassembly or recycling requiring the use of mono materials.

Ditte Højland explains how the company will incorporate recycled raw materials in fabrics (cellulose dissolving pulp or polyester powder). To achieve this, it is necessary to establish strong partnerships with existing manufacturers that spin fibres into yarns, then produce fabric and sell it to the market. Furthermore, the idea of a trademark such as Re:newcell has with Circulose is an interesting way of bringing recycled fibres to the market, says Ditte Højland.

Textile Change's ambition over the next five to ten years is for the company to recycle large amounts of post-consumer waste and not only them but also other recycling companies to help accelerate recycling. Additionally, Ditte Højland is looking forward to the arise of new innovative business models within this agenda.

ADVICE

Ditte Højland advises fashions and textile brands to 1) start collecting data and demanding more on content from suppliers, especially on chemicals, e.g., dyes, and 2) do not create material blends with several synthetics such as nylon and polyester because it is hard to separate from each other. Instead, they should use max two types of different materials, for example, a blend with one natural and one synthetic fibre is better.

BUSINESS MODEL

Dear Denier is a Danish socks and tights brand striving to create long-lasting products with a clear vision of making the industry more circular by closing the loop at the end of the use stage.

Every year, more than two billion pairs of tights are produced, used, and discarded. All conventional pairs are made with petroleum, chemicals and a large waste and energy consumption. Moreover, when thrown away, they dissolve into microplastics, which pollute the groundwater and the world's oceans.

RECYCLING LANDSCAPE OF NYLON & ELASTANE BLENDS

There is currently no sustainable solution for recycling tights, and Dear Denier's unique "Recycling Initiative" is the first of its kind worldwide with a promising recycling technology. The brand launched the initiative in 2020 and regularly receives tights from retail partners and end consumers. Just one pair of nylon tights saved from incineration saves the climate 0.8 kilos of CO2, which is equivalent to about 10 kilometres in a car. Dear Denier is currently the only brand in the world using recycling nylon and elastane.

The brand works with design for circularity, especially focusing on design for longevity. Their products have been ISO tested, scoring higher than lower class tights or even same price level tights showcasing that their products can last 2,5 times longer. The brand's motto is The less Dear Denier products their customers buy, the better.

INNOVATIVE RECYCLING PROJECT

If Dear Denier collects 8000 nylon socks for recycling, it is equivalent to the emission of driving twice around the globe. The calculations come from an innovation project carried out together with the Danish Technological Institute, where fibre-to-fibre recycling of nylon and elastane blends is in focus. The overall goal is to close the loop and the usage of any virgin fibres at all. Nylon and elastane blends are difficult to recycle at present, making tights, especially unwanted waste steam; for example, NGOs can't resell secondhand tights. So, the only way to recycle tights is the chemical process by separating nylon and elastane and recycling the nylon part for now.

Frederik Lewinsky says that tights are an overseen textile waste product, and they wish to change that. The recycling technology is in the final steps of finetuning and will soon be ready. Partnerships are essential, says Frederik Lewinsky CEO at Dear Denier therefore, it is crucial to cultivate those in order to accelerate the development process of this recycling technology and make it available to the market as soon as possible. The vision is to expand the technology as much as possible and have other companies buy a license to use it.

Frederik Lewinsky experiences an explosion of interest in recycled yarns, especially from yarn suppliers. The currently recycled nylon derives from pre-consumer waste from their manufacturers and nylon waste from other industries. Production is zero-waste with efficient management of waste and energy consumption, and renewable energy is a natural part of the production.

ADVICE

Advice to brands that wish to embark recycling journey that Frederik Lewinsky wishes he knew back when they started:

• It's a good idea to start screening recycling technologies before developing your own. (You can use this mapping as a starting point). Then, if the technology for the materials does not exist in the format you need, you could use the existing knowledge to develop further.

• Reach out! Reach out to other companies and experts and ask questions - lots of questions.

• You shall figure out the outreach of which activities your brand can handle in-house and which need to be outsourced—for example, take-back system or shredding textile waste etc.

• Look for funding to help your innovation recycling project grow and accelerate.

• Start your own take-back system. Begin with customers you have a good relationship with or end consumers directly and test it out in a pilot project to evaluate what works for your brand and what does not.


RECYCLE
TIGHTS
DEAR DENIER
DEAR DENIER
RECYCLE YOUR TIGHTS HERE
WE RECYCLE TIGHTS FROM ANY BRAND
BE PART OF THE SOLUTION
SMALL ACTIONS WITH BIG IMPACT


DEAR DENIER
DEAR DENIER


DEAR DENIER
RECYCLE YOUR TIGHTS HERE

CONCLUSION

WHAT NEEDS TO CHANGE?

• High-quality sorting is generally essential to achieve high-quality recycled fibres.

• Proper coordination, systems for waste streams and exchange of knowledge across the value chain are of extremely high value.

• The different stakeholders in the value chain brands, collectors, recyclers, spinners and fabric suppliers need to collaborate on a much higher level for a future recycling landscape to succeed.

• More knowledge about the possibilities and limitations of recycling is required.

• Investment in recycling companies.

• Products of high(er) quality are needed in the future market.

• Products designed and made to be easily recyclable at end-of-life.

• Alternatives to elastane as elastic fibre for flexibility in fabric.

• Fibre and product traceability providing information for easier sorting and recycling (products lifecycle).

• Proper information for consumers about the environmental advantages of recycled clothing and textiles.

FUTURE TEXTILE WASTE LANDSCAPE

When all EU countries by 2025 will have established collection systems for household textile waste, the quantities of waste will be enormous, and the existing recycling plants' capacities are not sufficient.

Therefore, it will be necessary to increase the number of recycling plants in Europe and establish more plants in countries where the major part of the world textile production is situated so that also pre-consumer textile waste is included in the recycled circle.

According a new McKinsey & Company report „Scaling textile recycling in Europe - turning waste into value" 15,000 new jobs can be created and approx. 4 million tons of CO_2 equvilant could be saved if the industry unlocks its full potential. McKinsey & Company has also evaluated the textile recycling sector becoming worth 1.5 - 2.2 million euros by 2030.

IDEAS ON HOW TO START RECYCLING AS A SMALLER FASHION BRAND

Ideas to start:

1. Contact a mechanical recycling company, especially one that has in-house services. In this case, your brand will be able to purchase recycled yarns, fabrics or even garments without having to invest in in-house services (Wolkat, Rifó, Textile Pioneers, Weturn)

2. Few recycling companies currently sell or will in the near future start selling their recycled products through fabric companies; this will be one way for your brand to buy (knitters, weavers and whole sellers).

3. If you wish to incorporate your own waste from your take-back system, you should contact a recycling company that has the possibility of using textile waste from smaller companies (Reverso, Textile Pioneers, Wolkat, Jeplan). However, recycling companies cannot guarantee that the textile waste used is exclusively from your brand.

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VIA University College

If you know about other recycling plants which are not included in the current paper, please let us know by e-mail: gabriella@ldcluster.com

If you have any feedback on the report, please feel free to contact us by email: gabriella@ldcluster.com