# WP C COMMUNICATION –

## ACTIVIT A.C.3 PUBLICATIONS

Deliverable D.C.3.4

Dossier “Knowledge & Tools to implement Resource Efficiency & Circular Economy in Textile Industry.”

**Version 2**
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**Responsible partner:**

LP Centro Tessile Cotoniero e Abbigliamento SpA (CENTROCOT)- (Italy)

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**ENTeR – Expert Network on Textile Recycling**

ENTeR works in five central European countries that are involved in the textile business, to promote innovative solutions for waste management that will result in a circular economy approach to making textiles.
The project will help to accelerate collaboration among the involved textile territories, promoting a joint offer of innovative services by the main local research centres and business associations (“virtual centre”), involving also public stakeholders in defining a strategic agenda and related action plan, in order to link and drive the circular economy consideration and strategic actions.
The approach of the proposal and the cooperation between the partners are oriented to the management and optimization of waste, in a Life Cycle Design (or Ecodesign) perspective.

# 1. Introduction

Innovative services require educated people with versatile skills. To support this, one of the main outputs of the ENTeR project is the development of High Level Training Modules. Within WP3 "Approach & Validation" relevant Training Paths have been identified and training modules have been elaborated using the experience and knowledge of the project partners. The training material can be used either as self-leaning or e-learning courses as well as for real training courses. Target groups are entrepreneurs, technicians, high level students and public authorities.

The training course has a modular structure and can be adapted to the needs of the participating target groups. The pilot training course covered six modules, i.e. Training Paths, developed by project partners, translated into national languages and revised in view of project partner conditions and state of the art.

| Region/Partner | Training Paths |
|---|---|
| Italy/CENTROCOT/UNIVA | **1. Circular Economy & Tools from ENTeR Project** |
| Hungary/PBN | **2. Strategic Agenda & Regional Analysis** |
| Germany/STFI | **3. Main textile recycling technologies and methods to recover, reuse and recycle textile waste** |
| Poland/PIOT/Ł-IW | **4. Projects and networks (national and European) related to textile recycling** |
| Czech Republic/ INOTEX/ČTPT | **5. Technical and economic findings from the pilot cases and professional profiles** |
| Hungary/INNOVATEXT | **6. ECO DESIGN – Applications and challenges for fashion and textile industry** |

A training course for selected target groups was organized in each region during semester 5 and semester 6. The main objective of activity A.T3.1 HIGH LEVEL TRAINING MODULES was to implement training modules with the materials collected during field activities (A.T2.2 and A.T2.3), for supporting the approach to resource efficiency and Circular Economy.

In addition, new professional profiles and related skills needed by companies to face environmental challenge are described.

# 2. Materials prepared for the courses

**Italy**

The webinars are part of the "ENTeR Project - Expert Network on Textile Recycling", an economic development project promoted by Centrocot and the Union of Industrialists of the Province of Varese and funded by the Interreg Central Europe Program.
Objective: to strengthen the innovative capacity of companies in the textile supply chain, proposing the reduction of production waste and the use of renewable resources.

The Italian training module took place in 4 modules in Italian.

- Introduction to the Circular Economy
- Recycling technologies
- Research and trends (EU projects and Pilot Cases)
- Ecodesign and Industrial Symbiosis.

Materials prepared for the courses (Link): All slides are on ENTeR website http://interreg-central.eu/Content.Node/3.html, section: Publications.

**Hungarian**

At the end of the event, a lively debate formed among the participants. Many of them had questions and remarks about recycling opportunities of textile waste, and equiries were made about the registration procedure in the M3P platform.

All presentations can be found on the following link:

https://www.innovatext.hu/en/node/311

https://www.innovatext.hu/hu/hir/enter-online-textil-hul-ladekgazdalkodasi-konferencia-es-trening-letoltheto-eloada-sok-es-program

Furthermore, All slides are on ENTeR website http://interreg-central.eu/Content.Node/3.html, section: Publications.

**Germany**

STFI organized a training section on Circular Economy in the premises of the institute. The training was integrated in a project meeting of STFI's national recycling network "RE4TEX – New

technologies for textile recycling" which has been established in spring 2019. 25 participants from R&D institutions, universities and companies from the textile, recycling and mechanical engineering sectors took part.

The ENTeR project and the results/outputs, such as M3P platform, Strategic Agenda and Regional Analysis have been presented. Main part was dedicated to the recycling topic, recycling technologies and methods how to recover, reuse and recycle textile waste.

Finally, projects and networks (on national and European level) related to textile recycling and possible synergies between them and the national recycling network were discussed.

All slides are on ENTeR website http://interreg-central.eu/Content.Node/3.html, section: Publications.

**Czech Republic**

Czech partners of ENTeR Project (INOTEX and CTPT) organized Training webinar focused on Circular Economy. The webinar was organized as international meeting of Czech and Slovak experts from companies, R&D institutions, public authorities. All presentations were prepared and presented in Czech language.

The agenda of the webinar included:

- Introduction of the Czech ENTeR partners (INOTEX and CTPT)
- Introduction of the ENTeR project
- Textile waste from the point of view of circular economy
- Textile recycling technologies
- M3P Platform
- Pilot Cases

Link: http://www.inotex.cz/e-learning.aspx

Furthermore, all slides are on ENTeR website http://interreg-central.eu/Content.Node/3.html, section: Publications.

**Poland**

Polish partners of ENTeR Project (Ł-IW and PIOT) organized **one-day Training on Circular Economy on the premises of FERAX company** – a leader of hosiery and active wear production in Poland. It should be noted that the initiative of such a meeting is a result of contacts during our Local Conference organized in Zakopane Kościelisko last year.

The training covered all required/planned modules, i.e. Training Paths: CE Tools, Strategic Agenda, Recycling, Pilot cases, Eco-design.

Earlier, all presentations were translated into Polish and revised with reference to Polish conditions and state of the art; some information was added as well.

Link: https://iw.lukasiewicz.gov.pl/dzialalnosc-naukowa/projekty-realizowane/projekty-zakonczone/ (ENTeR +)

Furthermore, all slides are on ENTeR website http://interreg-central.eu/Content.Node/3.html, section: Publications.

# 3. Professional skills/profiles needed by companies to face the business challenges

At the end of the training course, the partnership drew up a map on the training needs for companies. The courses took into consideration the training needs of companies (monitored in the Strategic agenda and in the action plan) and a map was drawn up (next chapter) on professional courses useful for facing the circularity challenge.

# 3.1. Professional skills/profiles map

| Professions in Textiles | Professional skills / Professional Requirements | | |
|---|---|---|---|
| Selection has been done in accordance with the education possible in the Germany | **Specified profile** | **Specified requirements/abilities related to the job** | **General requirements/abilities** |
| **Skilled workers/Technicians** | | | |
| Textile production mechanics (Produktionsmechaniker Textil) | Production mechanics - textile ensure that production facilities function perfectly and that work processes in their areas of work are trouble-free and economical when manufacturing yarns, woven fabrics or composites. Before starting production, they set up fully and partially automated production machines and plants. For this purpose, they install or remove machine components and tools, for example. They analyse sample templates, determine design techniques and product features and create data carriers. They enter the necessary production data, e.g. for machine speed, via control and regulation equipment on machines or at control stations. Finally, they start up machines, monitor process sequences and check textile products. They also maintain production plants. In the event of machine malfunctions, they systematically isolate the fault and rectify it. | **Knowledge in** textiles, technical, mechatronic, electronic issues and materials **Knowledge in:**<br>**Mathematics** (e.g. for calculating pulp quantities, commercial weights, mixing ratios and pulp costs)<br>**Plants/technology** (e.g. when maintaining, caring for, repairing and servicing production machines)<br>**Physics** (e.g. when reading circuit diagrams and block diagrams) | **Technical/professional:** technical insight, technical understanding, multidisciplinary knowledge, technical intuition, cross-sectoral knowledge, implementation of theoretic knowledge into practice, computer skills, basic knowledge in English (e.g. for reading English technical texts and internet searches)<br>**Methodological**: creativity, accuracy, prioritizing of tasks, ability to structure tasks, interdisciplinary work, systematic approach, planning of process and then transfer into practice<br>**Social:** social competence, ability to work in a team, communicative skills, reliability, open-minded, mutual respect **Personal:**<br>flexible, self-organized, ability to work structured, willingness to learn, patience, solution-oriented working |
| Textile product finisher (Produktveredler) | Carry out textile finishing processes in the specialisation directions printing, dyeing, finishing and coating; setting machine parameters, commissioning and monitoring machines and systems; preparation of liquors or pastes for finishing processes according to the given recipes; applying knowledge of the properties of textile materials in finishing processes; carry out quality assurance tests and evaluate and document the results of the finishing process | Knowledge in textiles, chemistry and materials, technical, mechatronic and electronic issues **Technology:** If circuit and machine diagrams have to be prepared, experience in technical drawing is helpful. Skills in technical drawing are relevant for identifying machine faults or repairing minor damage.<br>**Chemistry:** Knowledge of chemistry is advantageous for dosing chemicals for finishing.<br>**Physics:** Physical understanding, especially knowledge of electricity, is important for understanding how to use the machines.<br>**Mathematics:** Arithmetic is part of the tools of the trade of prospective product finishers - textiles. Basic arithmetic and percentage calculations are important for calculating chemical formulations. | |
| Machine and equipment operator - textile technology (Maschinen- und Anlagenführer) | Operation and monitoring of production machines and plants; independently planning, implementing and controlling production processes; compliance with work instructions and production regulations; creating, preparing and documenting production and quality data;<br>implementation of defined safety and quality criteria; application of rules of occupational safety, health and environmental protection | Knowledge in textiles and materials , technical, mechatronic and electronic issues **Physics:**<br>Good knowledge of physics, helps to understand how machines and plants work and are basis for their operation as well as for the application of different test methods.<br>**Plants/Technology:**<br>If machines and equipment have to be inspected and maintained during the training, knowledge in technical works would be advantageous. Technical drawing is helpful when dealing with crack drawings. | |
| Machine and equipment operator - textile finishing (Maschinen- und Anlagenführer) | Planning and preparation of work processes; allocating and handling materials, operating and auxiliary materials; operating and monitoring finishing machines and plants;selecting and applying sector-specific finishing processes; knowing the effects of processes on different materials; identifying and eliminating quality defects and irregularities | Knowledge in textiles and materials , technical, mechatronic and electronic issues<br>**Physics:**<br>Good knowledge of physics, helps to understand how machines and plants work and are basis for their operation as well as for the application of different test methods.<br>**Plants/Technology:**<br>If machines and equipment have to be inspected and maintained during the training, knowledge in technical works would be advantageous. Technical drawing is helpful when dealing with crack drawings. | |
| Product tester for textiles | Search for and elimination of defects in the production of textile surfaces; removing knots and impurities; repair of defects, damages; compensating for colour deviations by levelling and spotting; eliminating the sources of error | **Knowledge in** textiles and materials, skilled with fingers and in manual work | |
| Rope maker (Seiler) | Rope makers process natural and artificial fibres or wire by machine into ropes of all kinds. They make finished ropes ready for sale or process them further, e.g. they manually provide them with loops or eyelets or braid nets.Tasks: setting up, operating and maintaining tools, devices, machines and technical equipment; manufacture of ropes; manufacture and assembly of netting; making and inserting rope connections and slings; completion and installation of ropes and nets; performing measurements and tests; storage, packaging and preparation for dispatch of products | **Knowledge in** textiles and materials, skilled with fingers and in manual work | |
| Textile and apparel sewer (Textil- und Modenäher) | Textile and fashion sewers produce in particular small series, samples or prototypes of textile products, e.g. clothing, home textiles, backpacks, technical textiles and compression stockings. They select suitable materials and auxiliary materials, plan - often on the computer - the individual production steps for partial products, cut the pieces with machines and automates and sew them together or weld them. They also manufacture textile products with model-related features, e.g. pleats or flounces. | **Knowledge in** textiles and materials, interested in fashion and design, feeling for colours and fabrics, skilled with fingers and in manual work, a sense of aesthetics | |
| Chemical lab assistant (Chemielaborant) | Chemical laboratory technicians plan test procedures and series, which they then carry out, record and evaluate. They operate laboratory equipment and computers, clean and identify substances and produce organic and inorganic preparations. | **Knowledge in** textiles, natural sciences (biology, chemistry, physics) and materials **Chemistry** (e.g. for the analysis and production of substances)<br>**Biology** (e.g. for the creation of cell cultures)<br>**Physics** (e.g. for the experimental setup)<br>**Mathematics** (e.g. for the determination of substance concentrations) | |
| Textile lab assistant (Textillaborant) | Understanding the physical properties of fibres, yarns and a wide variety of textiles to be tested, such as clothing, automotive textiles geotextiles or fibre composites. The tasks include the preparation of samples, the performance of tests and the documentation of the results. Taking into account the functions of the respective textiles diverse test procedures will be learnt. | **Knowledge in** textiles, natural sciences (biology, chemistry, physics) and materials **Chemistry** (e.g. when examining a liquor for finishing a fabric)<br>**Physics** (e.g. determining the coefficients of friction and tensile strength of different fabrics and yarns)<br>**Mathematics** (e.g. to draw the right conclusions from a statistical distribution of measured values) | |
| **Professional education (Fachhochschule)** | | | |
| Clothing technology Assistant (Bekleidungstechnischer Assistent) | Clothing technical assistants participate in the design, cutting or production of clothing. The tasks include determining the details of the cutting and sewing specifications as well as grading, Converting the cuts for the different sizes. In doing so, both classic methods of manual design and the development of patterns and models using computer-aided design CAD can be used. He assists in the creation of collections and in the selection of materials. | **Knowledge in** textiles and materials, interested in fashion and design, feeling for colours and fabrics, skilled with fingers and in manual work, a sense of aesthetics | **Technical/professional:** technical insight, technical understanding, multidisciplinary knowledge, technical intuition, cross-sectoral knowledge, implementation of theoretic knowledge into practice, computer skills, good knowledge in English (e.g. for reading English technical texts and internet searches)<br>**Methodological:** creativity, accuracy, prioritizing of tasks, ability to structure tasks, interdisciplinary work, systematic approach, planning of process and then transfer into practice **Social:** social competence, ability to work in a team, communicative skills, reliability, open-minded, mutual respect<br>**Personal:** flexible, self-organized, ability to work structured, willingness to learn, patience, solution-oriented working |
| Clothing technician (Bekleidungstechniker) | Garment technicians work mainly in the industrial manufacture of garments and in production design.<br>The range of activities includes production-technical and administrative or economic tasks from model design, material selection, basic cut and modification to production readiness. Areas of activity include project management, the creation of fashion designs, the organisation of operational processes, equipment and deployment planning for operating resources, the industrial production of women's outerwear and men's and children's clothing, production planning and design and order processing. | **Knowledge in** materials and special techniques for manufacturing and processing (e.g. chemical dyeing, finishing) of textiles and fabrics of all kinds (organic, artificial). | |
| Textile technician/Textile engineer (Textiltechniker/Textilingenieur) | Textile technicians produce a wide variety of textiles with different properties and control and refine the production. They calculate the costs, plan the use of machines and select suitable employees for the respective manufacturing processes. | **Knowledge in** materials and special techniques for manufacturing and processing (e.g. chemical dyeing, finishing) of textiles and fabrics of all kinds (organic, artificial). | |
| Fashion designer | Fashion designers work mainly in fashion studios, in costume departments e.g. in film and television companies or in the theatre. Here the daily customer contact also belongs to your tasks. But fashion designers are also often employed by editors of fashion magazines and fashion magazines. | **Knowledge in** textiles and materials, interested in fashion and design, feeling for colours and fabrics, skilled with fingers and in manual work, a sense of aesthetics | |
| **Higher education (university)** | | | |
| Textile technologists (Textiltechnologe) | Textile engineering or textile technology comprises all technical equipment and processes for the production of textiles. The associated job title is textile engineer. | **Knowledge in** textiles, natural sciences (biology, chemistry, physics) and materials | **Technical/professional:** technical insight, technical understanding, multidisciplinary knowledge, technical intuition, cross-sectoral knowledge, implementation of theoretic knowledge into practice; good knowledge in English (e.g. for reading English technical texts and internet searches)<br>**Methodological:** creativity, accuracy, prioritizing of tasks, ability to structure tasks, interdisciplinary work, systematic approach, planning of process and then transfer into practice **Social:** social competence, ability to work in a team, communicative skills, reliability, open-minded, mutual respect, ability to think analytically<br>**Personal:** flexible, self-organized, ability to work structured, willingness to learn, patience, solution-oriented working |
| Life scientist (physisist, biologist, chemist) Naturwissenschaftler (Physiker, Biologe, Chemiker...) | Natural scientists observe, measure and analyse the states and behaviour of nature using methods designed to ensure the reproducibility of their results, with the aim of identifying regularities. Besides explaining natural phenomena, one of the most important tasks of natural science is to make nature useful The natural sciences are part of the theoretical foundations of disciplines as diverse as technology, psychology, medicine or environmental protection. | **Knowledge in** textiles, natural sciences (biology, chemistry, physics) and materials | |
| Process engineer (Verfahrenstechniker) | Process engineering is an independent engineering science and deals with all processes in which substances (gases, liquids or solids) are changed in terms of composition, type or properties. It uses physical, chemical or biological processes. Within production engineering, process engineering deals with the production of substances (raw material) and the transformation of substances with an undefined shape, while production engineering processes these raw materials into bodies with a geometrically defined shape. | **Knowledge in** textiles, natural sciences (biology, chemistry, physics) and materials | |

# 4. Annex “Self-evaluation questionnaires”

Innovative services require educated people with versatile skills. To support this, one of the main results of the ENTeR project is the development of high-level training modules.

Within the WP3 “Approach & Validation” relevant Training Paths have been identified, training modules have been developed using the experience and knowledge of the project partners and self-assessment questionnaires have been formulated for each training module. The training material can be used both as self-learning or e-learning courses, and for real training courses. The target groups were entrepreneurs, technicians, high-level students and authorities.

The training modules were proposed and disseminated on the website of the ENTeR project (https://www.interreg-central.eu/Content.Node/3.html - Pollicisation’s section) in order to give a clear reading of the training courses carried out. During the structuring phase of the courses, self-assessment questions were also developed to allow the participants to evaluate their learning level.

**1st Module: Circular economy and tools of the ENTeR project**

1. what are the barriers that hinder the transition to a circular economy?

   Correct answer: Difficulty in interpreting the current legislation on waste management, Chemical legacy, Separation and recycling (post-consumer) and Blends of fibers, coupled fabrics (slide by Luisa Minoli “1 Introduzione all’economia circolare”: 3,4 and 5)

2. what can help businesses to recycle their waste and be drivers of the circular economy/closed loop economy?

   Correct answer: Through a characterization of waste materials and through the M3P platform used for the ENTeR project to find new uses for the waste (slide by Donatella Macchia “1+3 and 4 Introduzione all’economia circolare”)

3. what are some of the challenges that companies might encounter in implementing a transition to the closed-cycle economic model?

   Correct answer: the challenge is in the New Action Plan for the Circular Economy (slide by Luisa Minoli “1Introduzione all’economia circolare”: 8,9 and 10)

4. what are the key obstacles at the level of government and what could be the solutions?

   Correct answer: Correct interpretation of the regulations (slide by Roberto Bottarini “1Introduzione all’economia circolare”)

5. what is the difference between a by-product and an end of waste?

Correct answer: Correct interpretation of the regulations (slide by Roberto Bottarini "1Introduzione all'economia circolare": slide 11)

6. how can you respond to individual companies that have specific recycling problems: the investment for the implementation of technologies aimed at recycling this material is not economically convenient for the individual company that currently has to pay to dispose of a waste that has still some usable potential?

   Correct answer: Through a characterization of waste materials and through the M3P platform used for the ENTeR project (slide by Donatella Macchia "1+3 and 4 Introduzione all'economia circolare")

7. how did the pilot cases develop in ENTeR?

   Correct answer: Through a characterization of waste materials and through the M3P platform used for the ENTeR project (slide by Donatella Macchia "1+3 and 4 Introduzione all'economia circolare – esempi di circolarità")

8. with reference to the technical criticality encountered in the recycling of textile products composed of a mix of fibers, what could be the solutions?

   Correct answer: correct characterization of materials and treatment technologies (slide presented in the 2Incontro Tecnologie di riciclo)

9. how important is the industrial symbiosis tool (M3P platform) compared to the figure of the designer in the Circular Economy?

   Correct answer: In ENTeR it was ulile to use the M3P platform (slide by Donatella Macchia "1+3 and 4 Introduzione all'economia circolare – esempi di circolarità")

10. At what level should ECODESIGN intervene?

    Correct answer: There is no single answer. Check the example the linear model and the designer for disassembly (slide Paolo Ghezzo "Ecodesign come strumento per l'innovazione": 5, 6 and 7)

2nd Module: Strategic Agenda & Regional Analysis

1. What has defined the STRATEGIC AGENDA - FOR MANAGEMENT AND RECYCLING OF TEXTILE WASTE in the ENTeR project?

   Correct answer: It was implemented in two phases: Search phase: in each partner region (Italy - Lombardy, Germany - Saxony, Poland - Łódský Region, the Czech Republic and Hungary), the situation in the area of processing and recycling of textile waste and summarized in specific regional reports. Regional news shows the legal, social and technical aspects of textile waste

management. Field phase: interviews with relevant stakeholders were conducted in each region parties. (Slide 3_projekt_ENTeR.pdf: from 14 to 18)

2. What is the SWOT analyzes analyzed in the strategic agenda for?

   Correct answer: It is a strategic planning tool used to assess Strengths, Weaknesses, Opportunities and Threats. (Slide 3_projekt_ENTeR.pdf: from 19 to 24)

3. How was the Strategic Agenda of the ENTeR project built?

   Correct answer: Strategic Agenda for the management and recycling of textile waste has been defined through 5 lines of actions. (Slide 16 of 3_projekt_ENTeR.pdf)

4. What are the main types of textile waste?

   Correct answer: Textile waste: industry, consumer (Slide 2 of 4_enter_hulladekcsokkentes_kutasi_cs_1.pdf)

5. what are the main regulations of the Hungarian regarding the management of textile waste?

   Correct answer: There are several regulations illustrating the situation of waste in the industrial sector since 1990 (2_innovatext_konferencia_textil_ujrahasznalat_es_hasznositas_magyarorszagon_hartay_mihaly_finalv.pdf

6. In Central Europe there is already a textile value chain capable of recycling fabrics, regenerating fibers and maximizing resources in production, but not in all regions and countries it is at a sufficiently high level. It's correct?

   Correct answer: yes, it is correct (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 51).

7. The strategic strategy of the ENTeR is defined on the basis of the relevant topics for the participating regions. Still, the strategic Agenda will present a common vision and an objective and priority medium and long term?

   Correct answer: yes, it is correct (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 34).

8. What are the pillars (action line) on which the strategic agenda has been developed?

   Correct answer: Legal and Policies, Waste management, Research trends and technologies, Communication and Education (slide 16 of 3_projekt_ENTeR.pdf)

9. Can the strategic agenda be used as a guide for other regions facing the same problems in the textile sector?

   Correct answer: yes, it is correct (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 34).

10. Acts as a guide to support innovation in waste management and resource efficiency in partner regions and to promote cooperation between partners and other actors / stakeholders - public authorities, industry and research. It's, correct?

    Correct answer: yes, it is correct (slide 15 of 3_projekt_ENTeR.pdf).

**3rd Module: Main textile recycling technologies and methods to recover, reuse and recycle textile waste**

1. What are the procedures for recovering textile materials (reuse waste material by reintroducing it directly into the production process, textile waste must be mechanically recycled, ...)?

   Correct answer: Favourite option is to re-utilize the waste material by returning it directly into the production process to save raw material. If not possible, the textile waste has to be recycled by mechanical, physical or chemical recycling to get secondary raw materials which can be used as raw material for new products. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 58)

2. The material obtained from mechanical recycling is mainly used for the production of which fabrics?

   Correct answer: yes, if not possible, the textile waste has to be recycled by mechanical, physical or chemical recycling to get secondary raw materials which can be used as raw material for new products. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 58)

3. Is physical recycling feasible for thermoplastics?

   Correct answer: Physical recycling is feasible for thermoplastic materials and the waste is re-granulated and can be used as raw material again. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 75)

4. Can the waste be re-granulated after physical recycling - extrusion and can it be reused as raw material?

   Correct answer: yes, it is possible. Extrusion of polyolefins, polyester, and others in the form of various plastic products and textile materials are processes which involve the melting, shredding or granulation of thermoplastic waste. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 75)

5. What is a main problem in the physical recycling (re-melting) of thermoplastic material?

   Correct answer: A main problem in the physical recycling (re-melting) of thermoplastic material is that reprocessing gives a heat impact to the material causing a change/reduction of properties and makes a re-use for the same application difficult. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 76)

6. Does Chemical Recycling include depolymerization into monomers?

   Correct answer: Chemical recycling is the production of chemical products from waste polymeric materials by economically feasible processing. It includes depolymerization into monomers with a purity level suitable for re-polymerization of material but also dissolving with suitable solvents while maintaining the polymer character. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 78)

7. Can chemical recycling be applied to recycle mixed synthetic textile waste?

   Correct answer: Reprocessed material: Suitable for chemical recycling are polymers from cellulose, polyester, polyamide, polyurethane. Chemical recycling can be applied to recycle mixed or unmixed synthetic textile waste and gained products can be easily returned into the production cycle. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 78)

8. Can the products obtained with chemical recycling be easily reinserted into the production cycle?

   Correct answer: Polymers from cellulose, polyester, polyamide, polyurethane are suitable for chemical recycling. Chemical recycling can be applied to recycle mixed or unmixed synthetic textile waste and gained products can be easily returned into the production cycle. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 78)

9. It is correct: Recycled fibers are processed by mechanical web formation (carding principle or random laid web formation) using 100% recycled carbon fibers or blended with other fibers and subsequent mechanical bonding.

   Correct answer: Recycled fibres are processed by mechanical web formation (carding principle or random laid web formation) using 100% recycled carbon fibres or blended with other fibres and subsequent mechanical bonding. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 81)

10. What are the three waste management options for used textiles and worn clothing?

    Correct answer: 1. They become part of the urban waste and are collected in bins for residual waste. 2. Larger quantities are collected and handled centralized in recycling centers operated by municipalities/city administrations or county governments. 3. Further collection of used textiles and worn clothing is organised by private companies or charity organizations such as Red Cross or Worker's Samaritan Organization. (ENTeR-High-Level-Training-STFI-compressed-(1)-(2) slide 88)

**4th Module: Projects and networks (national and European) related to textile recycling**

1. What is the current situation of textile waste management in Europe and in Poland?

Correct answer: The main goal of waste policy is waste prevention and recycling. This requires a technical, social and political framework as well as legal decisions. The provisions are directly applicable in the Member States, they have to be implemented into national law. (Broszura ENTER.pdf slide 13).

2. Solutions and business models must be sought that allow raw materials and products to remain in the production cycle for as long as possible. Why are such actions necessary?

   Correct answer: Its aim is to minimize the number of resources introduced into the production cycle, the amount of waste generated and the emission of pollutants by closing production and consumption circuits, which allows for reducing the negative impact of production processes on the natural environment. This can be achieved through long-term design, maintenance, repair, reuse, remanufacturing, refurbishment and recycling. (Broszura ENTER.pdf slide 20).

3. Does researching innovative methods of waste management and recycling in the textile industry allow waste to be reduced and reused?

   Correct answer: yes, Development of technologies for innovative materials and composite products entails the necessity to constantly search for new technologies / methods of waste management. (Broszura ENTER.pdf slide 63).

4. Does the transnational cooperation project funded by the Interreg Central Europe Program have as its main objective to create lasting links between innovative entities in central Europe?

   Correct answer: The transnational cooperation project is financed from the Interreg Central Europe Program (including 85% from the ERDF - European Regional Development Fund + from national funds for science in 2018-2020), and its aim is to create permanent links between innovative entities. (Broszura ENTER.pdf slide 11).

5. Are the main means and tools available within the ENTeR project as follows?

   a. Lines of action --> Strategic agenda

   b. Pilot cases (pilot) --> Best practices

   c. Training modules --> Lifelong learning

   d. M3P platform --> Database: waste / technology/ best practices

   Correct answer: yes, the main means and tools available within the ENTeR project have been correctly listed. (Broszura ENTER.pdf slide 11).

6. Which are the main methods of treating textile?

Correct answer: Textile waste treatment methods can be divided into: mechanical recycling - the most commonly used, physical recycling – extrusion, and chemical recycling. (Broszura ENTER.pdf slide 45).

7. Check the material before starting the right treatment. It is a procedure that can be carried out by carrying out a Pre-sorting by type of clothing and a Sorting by quality and type of material. It's, correct?

   Correct answer: Yes, it is correct to check the material before starting the right treatment. (Broszura ENTER.pdf slide 59).

8. Innovative services require educated people with versatile skills. To this end, one of the main activities of the ENTeR project was the development of training modules?

   Correct answer: High Level Training Modules: Innovative services require educated people with versatile skills. To this end, one of the main activities of the ENTeR project was the development of specialized training modules. (Broszura ENTER.pdf slide 12).

9. Textile waste changes in terms of types of raw materials (such as high-tech fibers), composition of the textile product, surface quality (functional coatings), use of electronic parts in so-called smart fabrics, etc. It's correct?

   Correct answer: yes, it is correct. (Broszura ENTER.pdf slide 60).

10. The textile sector is constantly evolving, so is it correct to say that new materials lead to a great variety of waste, in small quantities?

    Correct answer: new materials lead to a large variety of waste, in small amounts. It is important to target waste streams and establish a waste management network at the interregional level, for example via a database. (Broszura ENTER.pdf slide 60).

**5th Module: Technical and economic findings from the pilot cases and professional profiles**

1. What are the main technologies for the treatment and recycling of "waste textiles"?

   Correct answer: Textile waste treatment methods can be divided into: mechanical recycling - the most commonly used, physical recycling - extrusion and chemical recycling. (5_technologie-recyklace.pdf slides from 17 to 43).

2. what are the main regulations regarding the management of textile waste?

   Correct answer: The provisions are directly applicable in the Member States, they have to be implemented into national law. (4_textilní odpady z pohledu OH.pdf slide 6).

3. What are the quantities and types of waste produced by textile companies?

Correct answer: EU textile industry - 16 million tonnes of waste / year (EC2 estimate). Most - landfill, incineration, 2015 - in the EU consumption of more than 6 million tons of clothing). (4_textilní odpady z pohledu OH.pdf slide 2).

4. What were the key elements of the pilot case “Reduction of waste production due to extending the life of textile products”?

   Correct answer: extending the life cycle of textile products reduces the amount of released waste. (7_Pilotní p²ípad.pdf slide from 2 to 14)

5. What method was used to verify the quantities of waste generated in the pilot case “Reduction of waste production due to extending the life of textile products”?

   Correct answer: Survey questionnaire to obtain data for the study (11 laundries providing textile leasing for the healthcare sector / 5 answered). (7_Pilotní p²ípad.pdf slide 6).

6. Does knowledge of recycling technologies help and sensitize textile companies to recover or recycle textile waste?

   Correct answer: Yes, knowledge about recycling technologies and how to reuse or recycle textile waste should help to increase knowledge of recycling processes and methods and should help raise awareness among textile companies about these possibilities, motivate their active cooperation and improve the know-how and experience in recovery. (5_technologie-recyklace.pdf slide 3).

7. It is correct “A common option for reusing waste material (in production) is to return it directly to the production process to save raw materials”?

   Correct answer: A frequent possibility of reusing waste material (in production) is its return directly to the production process in order to save raw materials. (5_technologie-recyklace.pdf slide 4).

8. Industrial symbiosis is a process that can make it easier for companies to achieve the goal of a circular economy, helping the environment and bringing benefits to society. Is the M3P platform a useful tool for this activity?

   Correct answer: Online platform for the cataloging and enhancement of industrial textile waste. This system helps: strengthen innovation capacities, improve sustainable interconnection between the textile industry and other industrial areas, promote cooperation in the field of disposal with waste and the circular economy. (6_M3P_platforma.pdf slide 2).

9. New textile materials lead to a large number of types of waste. It's correct?

   Correct answer: It is important to monitor and direct waste streams and to create interregional waste management networks (e.g. through a database). (5_technologie-recyklace.pdf slide 39).

10. The platform is useful for ...:

Correct answer: identification of successful pilots cases between companies that offer waste and companies that use this waste as incoming raw materials. (6_M3P_platforma.pdf slide 3).

**6th Module: ECO DESIGN – Applications and challenges for fashion and textile industry**

1. What is 'eco-design'?

   Correct answer: Ecological design, or popularly: eco-design, a eco-design that integrates sustainability trends methods, product design is environmentally conscious approach, taking into account the environmental impact of the product throughout its whole life cycle. (Slide 6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak: slide 14).

2. To develop an innovative product, from an eco-designer perspective, it is necessary to follow the entire life cycle of the product. Is this statement correct?

   Correct answer: Yes, the sentence is correct. (3_papp_vid_dora_oko-_design_szemlelet_az_ipari_termek-_es_formatervezo.pdf slide 5).

3. Does sustainable fashion mean having a responsible design and production of fashion products?

   Correct answer: Sustainable fashion: responsible design and production of fashion products; taking into account the environmental and social impacts. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 6).

4. What are the three basic principles for a circular system?

   Correct answer: 1. make waste and pollution predictable, 2.long-term use of products and raw materials, 3 for the continuous regeneration of natural systems. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 10).

5. Is "eco-design" an approach to product design that takes into account the environmental impact of the product throughout its life cycle?

   Correct answer: yes. Eco-design" is an approach to product design which considers the environmental impact of the product throughout its life cycle. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 9).

6. What is 'eco-fashion'?

   Correct answer: Eco-fashion is an environmentally conscious approach to the design and manufacture of clothing and accessories, considering environmental considerations as well as the health of consumers and the working conditions of people who make clothes. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 16).

7. What are the factors that influence the sustainability of fabrics?

   Correct answer: the capacity and source of renewal of the fiber, the raw fiber processing process, the effect of the preparation and dyeing of the fibers and energy used in the production process. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 24).

8. A product can be defined as "green" if it has a low environmental impact during its life cycle and little or no environmental impact at the end of its life. It's correct?

   Correct answer: yes, it is correct. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 13).

9. In the context of the sustainability trend, it is correct to state that we must:

   a. reduce the environmental impact of industry in the long term;

   b. protect the environment for social responsibility.

   Correct answer: yes, it is correct. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 5).

10. Why is sustainability important in the textile industry?

    Correct answer: More and more people agree that sustainability is the only way for the fashion industry. Consumers are paying more attention to shopping. (6_interreg_enter_textraining_webinar_2020_5_28_eco_design_csanak.pdf slide 6).

# 5. Annex "Training path"

Below are the basic modules making up the training course developed for the ENTeR project.


ENTeR – WP T3 Approach & Validation / Task A.T3.1

# High Level Training Modules

Introduction

# INTRODUCTION

Innovative services require educated people with versatile skills. To support this, one of the main outputs of the ENTeR project is the development of High Level Training Modules. Within the WP3 “Approach & Validation” relevant Training Paths have been identified and Training Modules have been elaborated using the experience and knowledge of the project partners. The training material can be used either as self-learning or e-learning courses as well as for real training courses. Target groups are entrepreneurs, technicians, high level students and authorities.

The training course has a modular structure and can be adapted to the needs of the participating target groups. The following single modules are available:

# INTRODUCTION – TRAINING PATHS

| Training Path | Title |
|---|---|
| 1 | ENTeR project and M3P platform with its functionalities |
| 2 | Strategic Agenda including Regional Analysis and Action Lines |
| 3 | Main textile recycling technologies and methods to recover, reuse and recycle textile waste |
| 4 | Projects and networks (national and European) related to textile recycling including research trends and needs coming from the industry |
| 5 | Technical and economic findings from the Pilot Cases and professional profiles |
| 6 | Eco-design techniques applied to textile processes |


# ENTeR – WP T3 Approach & Validation / Task A.T3.1

## High Level Training Modules
## Training Path 1: Circular Economy & Tools from ENTeR Project

ENTeR Project Partners CENTROCOT & UNIVA (IT)

# MODULE 1 - CIRCULAR ECONOMY & TOOLS FROM ENTER PROJECT

**Foreword**

Interreg Central Europe Programme and ENTeR project

**Introduction**

Sustainability, Circular Economy and Industrial Symbiosis

**Resources & Tools**

available from ENTeR project

**M3P Platform**

# FOREWORD

## Interreg Central Europe Programme

(https://www.interreg-central.eu/Content.Node/home.html)

This course has been developed within the ENTeR project (CE 1136) thanks to the funding received from the European Union under the Interreg Central Europe Programme (2nd call 2016).

The training course reflects only the authors' view and neither the European Commission nor the Interreg Central Europe Managing Authority are responsible for any use that may be made of the information it contains.

ENTeR

## Expert Network on Textile Recycling

The **ENTeR project** focuses on waste reduction of textile sector to prevent depletion of non-renewable resources.

The approach is based on **collaboration** between textile companies and **regional innovation systems** to find:

- new green markets for scraps/waste;
- recycling opportunities for textile materials;
- alternative solutions to raw materials.

# ENTER OBJECTIVE

To demonstrate the benefit of an **operational collaborative model** (“virtual centre”)

between research and business partners,

based on **shared skills and know-how**

focused on circular economy, waste eco-design and resource efficiency.

# ENTER PARTNERSHIP

Interreg CENTRAL EUROPE
European Union European Regional Development Fund
ENTeR

CENTROCOT Innovation experience
Textile Cotton and Clothing Centre

Unione degli Industriali della Provincia di Varese
Industrial Unione of the Province of Varese

Pannon Business Network PBN
Pannon Business Network Association

INNOVATEXT
INNOVATEXT Textile Engineering and Testing Institute Co.

stfi SÄCHSISCHES TEXTIL FORSCHUNGS INSTITUT e.V.
Saxon Textile Research Insitute

SACHSEN!TEXTIL
SACHSEN!TEXTIL e V.

inoTEX®
INOTEX LTD

CTPT CZECH TECHNOLOGY PLATFORM FOR TEXTILE
CTPT - Czech Technology Platform for Textile

RESEARCH NETWORK ŁUKASIEWICZ
Textile Research Institute
Textile Research Institute

PIO-T
PIOT - Federation of Appareal & Textiles Industry Employers

# SUSTAINABILITY

## It refers generally to the capacity for the biosphere and human civilization to coexist

- meeting the needs of the present
- without compromising the ability of future generations to meet their needs

3 Pillars:

- Economic → Prosperity
- Environmental → Planet
- Social → People

# Expected results

### *Social benefits*

- *Better standard of living*
- *Increase occupation (green jobs)*
- *Cultural change (sharing economy)*


### *Economic benefits*

- *Reduction of costs for raw materials and energy and for waste disposal*
- *Creation of a business network*
- *New market opportunities*

### *Environmental benefits*

- *Optimisation of resource consumption*
- *Reducing environmental impact and emissions*
- *avoid landfilling*

# WHAT IS SUSTAINABILITY

## Watch the video

# LINEAR ECONOMY

## Traditional linear economy

In a linear economy raw materials are extracted or cultivated, and then processed into a product that is thrown away after use.


## Textile Sector:

The textile sector traditionally follows this model, the main phases are:

| Extraction, Cultivation | Manufacturing (Industrial processes) | Distribution, Use, Maintenance (Consumer phase) | Landfill, Incineration (End of Life) |
|---|---|---|---|

# CIRCULAR ECONOMY

A circular economy is fundamentally different from a linear economy.

In a circular economy the cycles of all raw materials are closed.

Closing these cycles requires much more than just recycling.

It changes the way in which value is created and preserved, how production is made more sustainable and which business models are used.

# Is Circular Economy a new concept?

- K. Boulding, The economics of the coming Spaceship Earth (1966)
- **Barry Commoner, The Closing Circle** (1972)

Awareness of

limits of current growth model

is now part of

the cultural background of

many opinion makers

# CIRCULAR ECONOMY

## Circular Economy in the European Union

- Closing the Loop - An EU action plan for the Circular Economy
  (COM(2015) 614 final, 02/12/2015)


EUROPEAN COMMISSION

Brussels, 2.12.2015
COM(2015) 614 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Closing the loop - An EU action plan for the Circular Economy

- Circular Economy Package
  (Direttiva (UE) 2018/851, 30/05/2018)

# Watch the video

# Connecting Economic & Environmental Gains

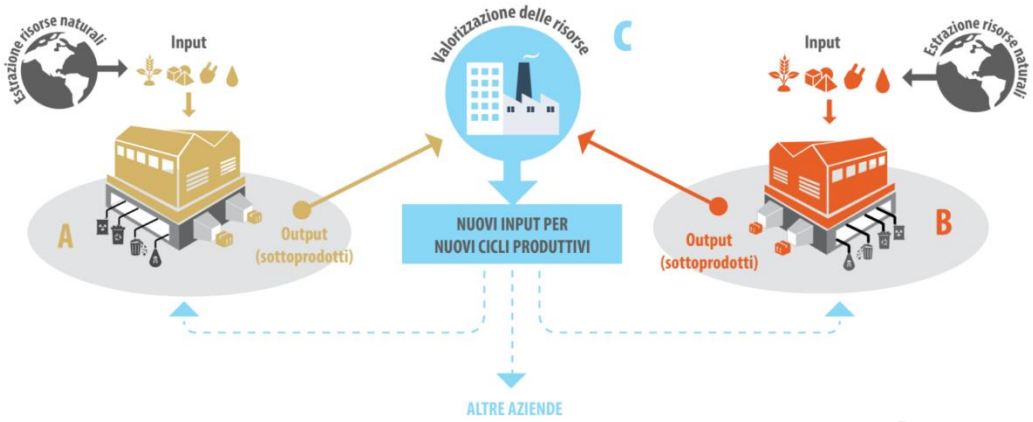
As citizens across the globe aspire towards a **better standard of living**,

- **competition for resources** is growing rapidly,
- with subsequent immense and unsustainable **pressure on our natural environment**

# CIRCULAR ECONOMY & INDUSTRIAL SYMBIOSIS

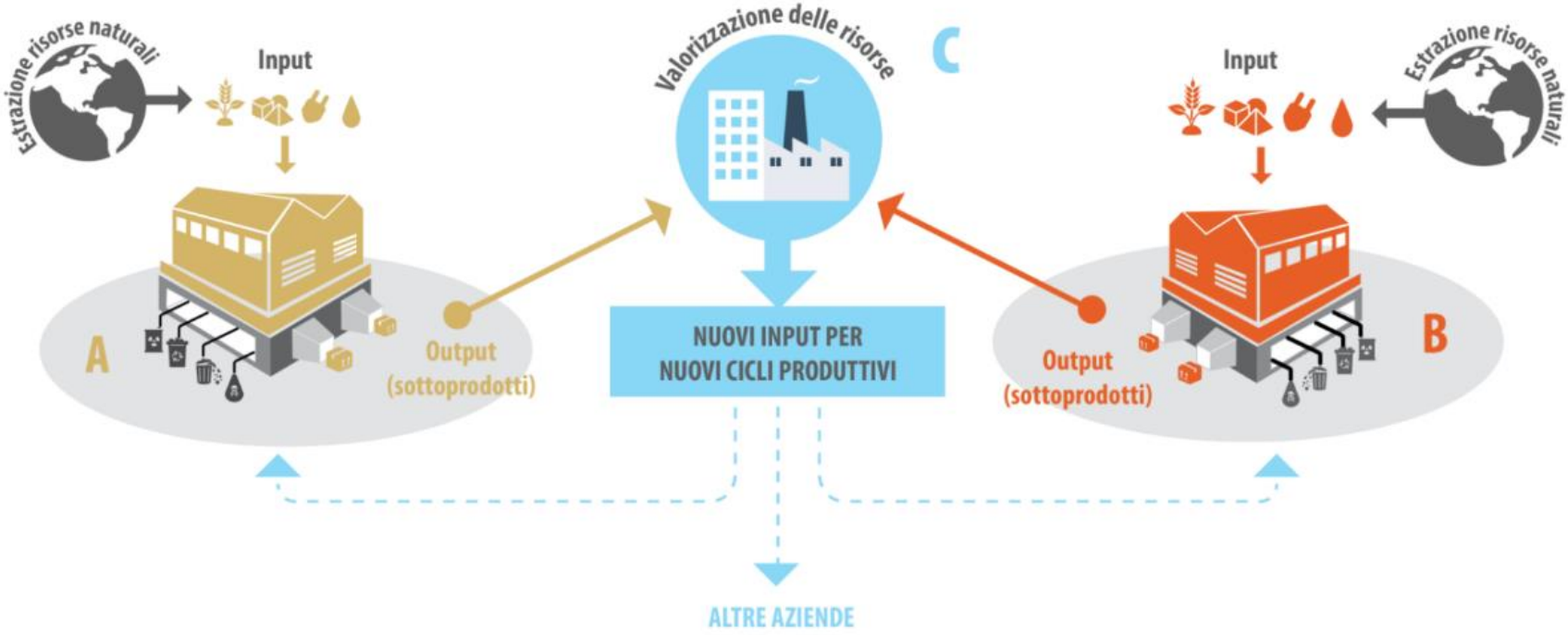
## Several different areas of R&I policy are already supporting the transition to a circular economy

- Catalysis to eliminate pollutants and to convert carbon dioxide
- Industrial biotechnology
- **Sustainable process industry**
- **Waste and resource management**
- **Closed-loop manufacturing systems**
- **Water in the circular economy**
- The circular bioeconomy



# INDUSTRIAL SYMBIOSIS

**Industrial symbiosis** is the process by which waste or by-products of an **industry** or **industrial** process become the raw materials for another



# MODULE 1 - CIRCULAR ECONOMY & TOOLS FROM ENTER PROJECT

**Foreword**

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Sustainability, Circular Economy and Industrial Symbiosis

**Resources & Tools**

available from ENTeR project

**M3P Platform**

# RESOURCES & TOOLS

## available from ENTeR project

- Action Lines - Strategic Agenda
- Pilot Cases ➔ Best practices
- Training Path ➔ Lifelong Learning
- M3P Platform ➔ Database
  - Wastes
  - Technologies
  - Best practices

# MODULE 1 - CIRCULAR ECONOMY & TOOLS FROM ENTER PROJECT

**Foreword**

Interreg Central Europe Programme and ENTeR project

**Introduction**

Sustainability, Circular Economy and Industrial Symbiosis

**Resources & Tools**

available from ENTeR project

**M3P Platform**

## Material Match Making Platform

An online platform for the cataloguing, use and exploitation of industrial textile waste.

This system help to

- **strengthen the innovation** capacity
- **improve a sustainable link** within an industrial textile area and between more industrial areas
- **foster cooperation** on waste management and circular economy

Life M3P
Material Match Making Platform

M3P Platform has been developed thanks to co-funding by the European Life Programme (Life M3P project, LIFE15-ENV_IT_000697)

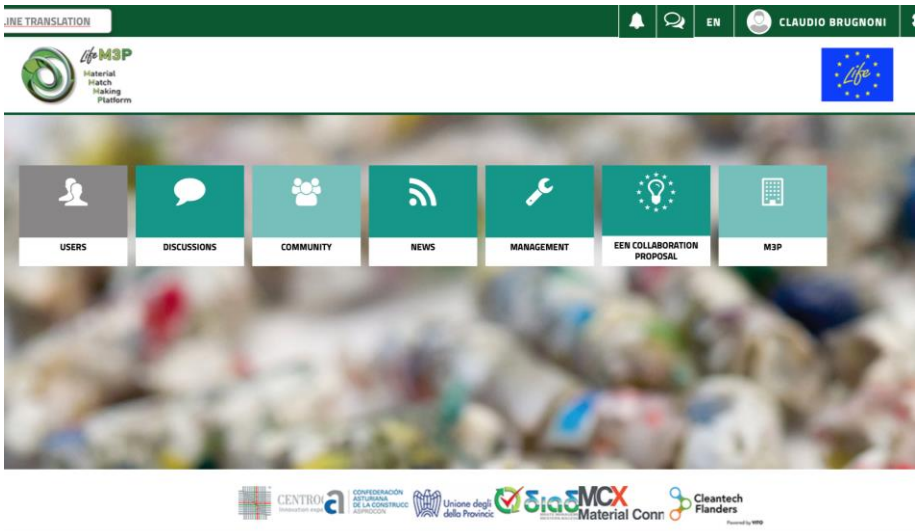
## The on-line Platform: an Overview

The on-line Platform is:

- the “one-stop shop” for industrial symbiosis services with a cross sectoral and cross territoriality scope

The Platform is useful for:

- identification of successful pilot cases between companies offering waste streams and those requiring these as input materials (secondary raw materials)
- new creative concepts for new waste applications




www.lifem3p.eu

# M3P PLATFORM

## Tool for Industrial Symbiosis to find matches between waste and needed (secondary) raw materials by 5 simple steps

1. Register yourself
2. Register your company
3. Register waste offered by your company
4. Search and look at waste useful for your company
5. Ask for found waste

# M3P PLATFORM

## Strengths

- Find a company / other sector in which to give your waste
- Increase your profit margins on products
- Eliminate waste disposal and management costs by treating your residue as a by-product
- Control the whole chain of your product
- Respect the environment and ENTeR the network of companies of the Circular Economy

An example

One of the 150 creative concepts:
tensioner for shoe manufactured from trimmings of shoe carriers.

# CONCLUSIONS

Industrial symbiosis is a process that can facilitate companies to pursue the circular economy goal, helping the environment and achieving benefits for the society.

The industrial symbiosis is an opportunity :

1. for economy industrial areas and districts;
2. to improve local development;
3. to valorize resources in an aggregative way (scale factor).

M3P Platform is a useful tool for this scope.

# CONTACT INFO

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# ENTeR – WP T3 Approach & Validation / Task A.T3.1

## High Level Training Modules
## Training Path 2: Strategic Agenda & Regional Analysis

ENTeR Project Partner PBN (HU)

# FOREWORD

## Interreg Central Europe Programme

(https://www.interreg-central.eu/Content.Node/home.html)

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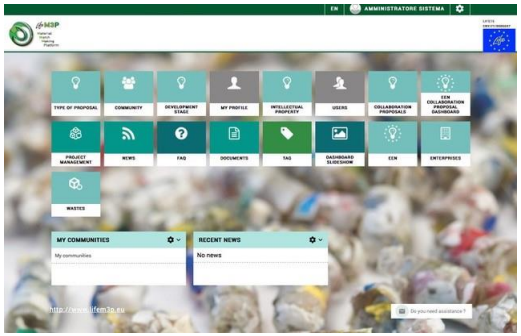
# PROJECT OBJECTIVES

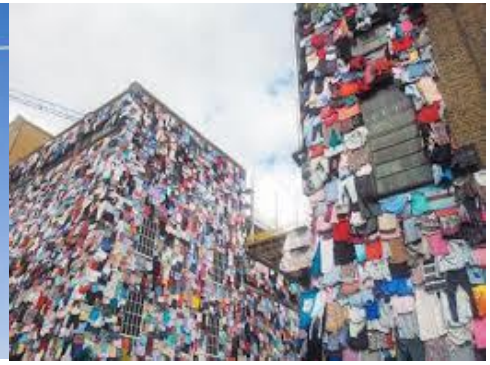



ENTeR


- Promoting a joint offer of innovative services by the main local R&D centres and business associations/clusters
- Reducing the production of textile waste to prevent the consumption of non-renewable resources
- Fostering the Circular Economy approach and the Industrial Symbiosis
- Supporting the networking between companies through the use of the “Life M3P” platform

# PROJECT FOCUS





**Focusing on:**

- *waste reduction to prevent depletion of non-renewable resources*

→ *Boosting collaboration between textile companies and innovation system to find new green markets for waste and alternative solutions to raw materials*

# DEFINITIONS

## Strategic Agenda:

- Common vision, set objectives and priorities in long-mid term perspective
- Transnational/regional strategy with relevant stakeholders involvement
- Out of findings coming from the Strategic Agenda, the Action plan has to be delivered

## Action Plan:

- Sequence of steps that must be taken
- What will be done (by whom?), when? (time horizon), what specific funds are available (resource allocation)

# THE EUROPEAN TEXTILE AND CLOTHING INDUSTRY

## Few facts:

- in Europe around 1.7 million people are employed in 178,000 companies in the textile and clothing industry
- It covers the entire textile value chain and wide range of activities (the production of woven, knitted or non-woven fabrics, the treatment of textile materials (finishing, dyeing, coating)
- The retail and B2B sector is also an important part
- Biggest producers: France, UK, Italy, Spain and Germany (together they produce around three quarter of EU production)

# THE EUROPEAN TEXTILE AND CLOTHING INDUSTRY

## Competitiveness of this industry:

- During the last decade, the sector has undergone a strong diversification process (due to a combination of technological changes, increase of production costs etc.)
- Globalisation and technological progress has caused a rethinking process

## For the coming years the most important 4 innovation topics:

1. Smart, high-performance materials
2. Advanced digitised manufacturing, value chains and business models
3. Circular economy and resource efficiency
4. High value added solutions for attractive growth markets

# THE EUROPEAN TEXTILE RECYCLING SECTOR

- Textile production accounts for 10% of the world's carbon emissions, is reportedly the second most polluting sector in the world and represents a complex, problematic waste stream

- Textile industry is all about transforming resources (materials, energy, water, chemicals) into value added products for business or private usage

- The end user and costumer behaviour has changed over the years

# LEGISLATION AND POLICY FRAMEWORK, EU ACTIONS

**The central concern of waste policy is to avoid and recycle waste.**

- Requires technical, social and political framework, and also legal decisions.
- Regulations are directly applicable in the Member states, derives must be implemented into national law
- **A few example**:

-**The European Waste Framework Directive (Directive 2008/98/EC):** it defines essential waste-related terms and defines among other things, a five-stage waste hierarchy

-**Directive 2008/98/EC**: sets the basic concepts and definitions related to waste management (definitions of waste, recycling and recovery)

-**Regulation (EC) No. 1013/2006 of the European Parliament and of the Council:** it defines which conditions waste can be shipped between countries

-**Decision 2000/532/EC:** establishing a list of wastes

-**May 22. 2018**: new EU Circular Economy Package: the aim is to promote circular economy, waste prevention and recycling Europe-wide

# TEXTILE WASTE FROM END-OF-LIFE CLOTHING

There are three options regarding the waste management for used textiles and worn clothing:

1. They become part of the residential waste and are collected in bins for residual waste
2. Larger quantities are collected and handled centralized in recycling centres operated by municipalities/city administrators or county governments. This is free of charge! for registered citizens, but companies have to pay a certain fee
3. Further collection of used textiles and worn clothing is organised by private companies or charity organisations (e.g. Red Cross or Worker's Samaritan Organization)

# TEXTILE WASTE FROM END-OF-LIFE CLOTHING

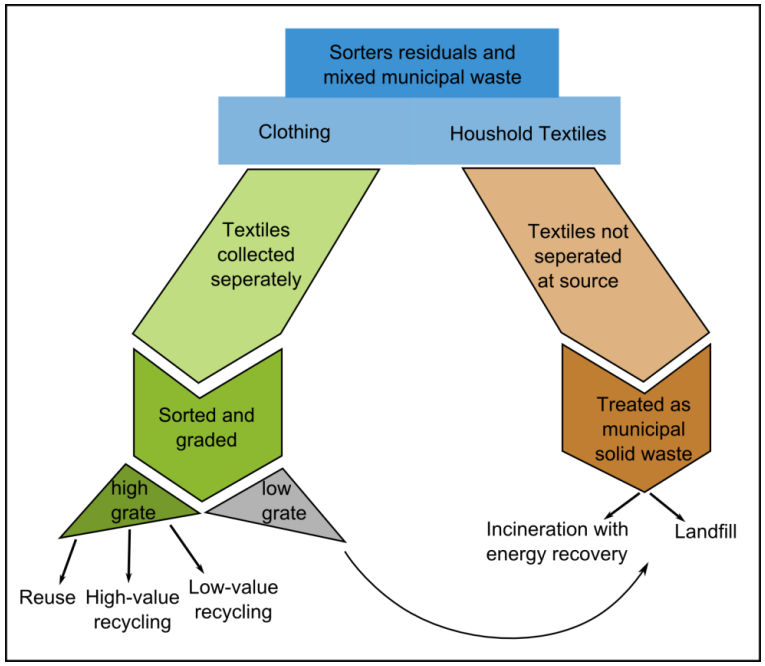
Sorting:

The sorting of the collected goods determines which recycling path a garment goes through. The more accurate the sorting is tailored to the customer's needs, the more goods can be used for high-quality recycling, ideally for reuse as second-hand goods.

Treatment:

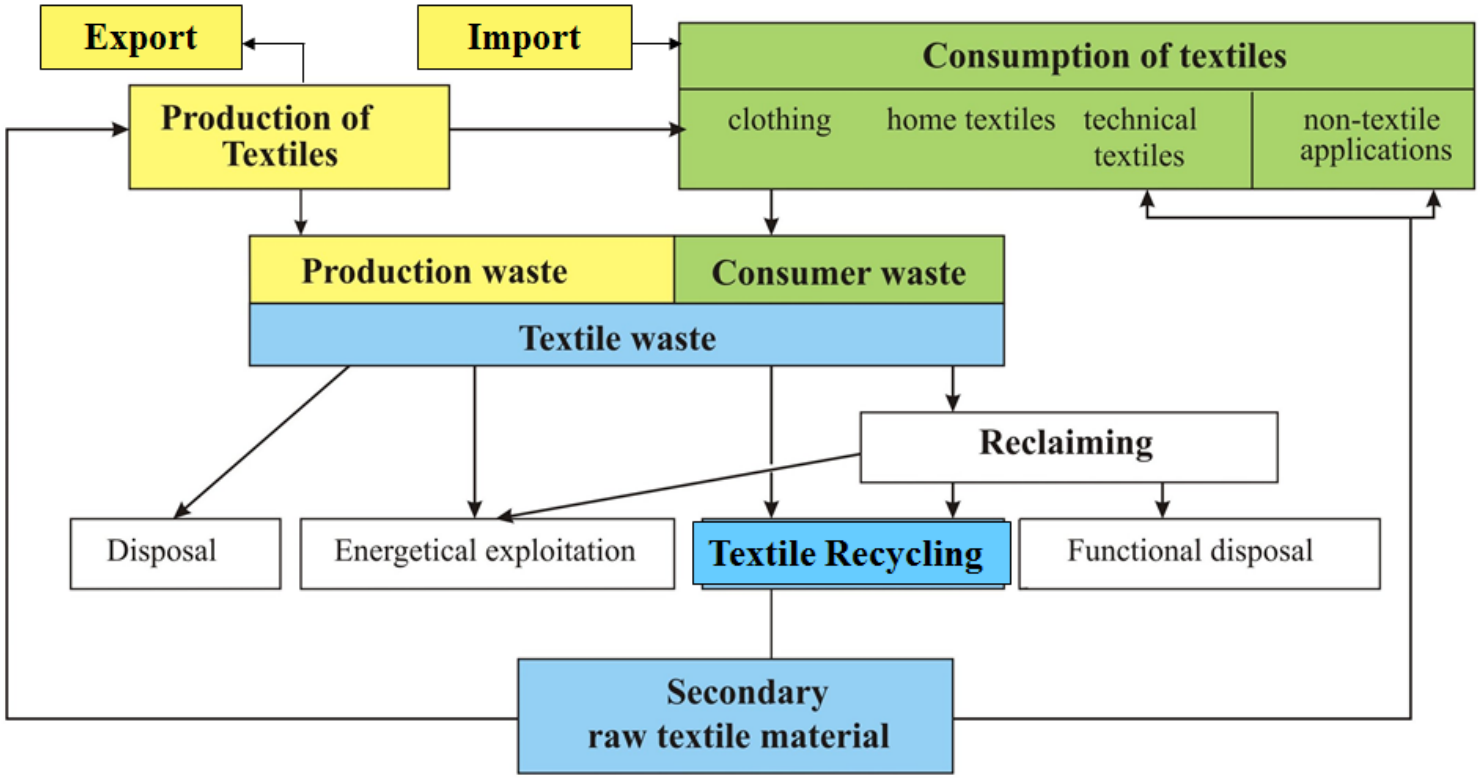
Clothing and household textiles are complex materials due to the variation in their composition, their quality at the point of disposal.

Several companies have problems in storing their textile production waste due not enough storage space.




**Flow diagram of end-of-life clothes and household textiles from source to treatment**

# WASTE TREATMENT AND RECYCLING




Material cycles for textile waste

# EURATEX

**EURATEX**: is the European Apparel and Textile Confederation representing the interest of the European textile and clothing industry at the level of EU institutions.

**The following research priorities are identified:**

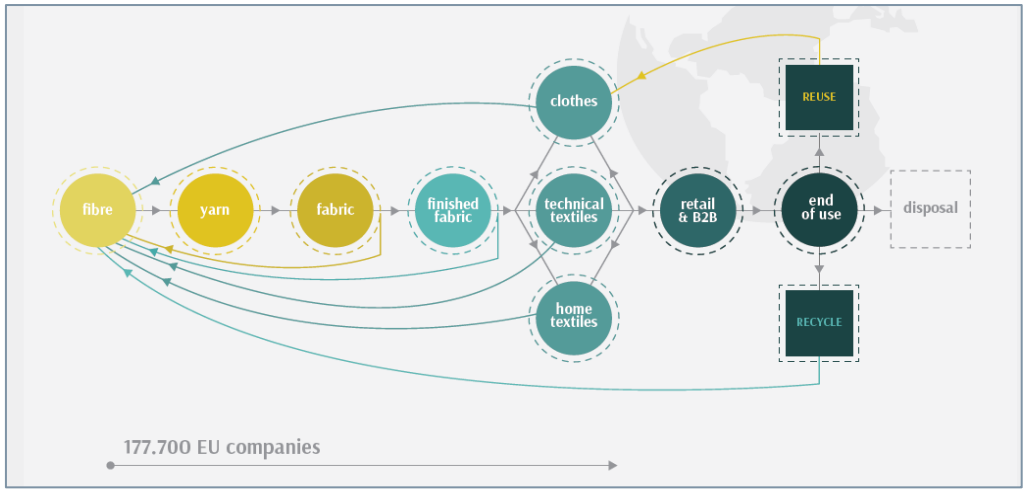
1. Novel flexible process technologies to save water, energy and chemicals
2. High-tech textile recycling for circular economy concepts
3. Sustainable substitutes for hazardous or restricted textile processing and chemicals and bio-chemistry based textile processing
4. Bio-refinery concepts utilising European agricultural and forestry resources, waste or by-products for textile fibres and developing their processing and application aspects
5. Greater use of EU-origin natural fibres and improving their processing and application aspects

# CIRCULAR ECONOMY AND RESOURCE EFFICIENCY

Circular Economy is a production and consumption model which involves reusing, repairing, refurbishing and recycling existing materials and products to keep materials within the economy wherever possible.

"The Circular Economy" is rapidly becoming one of the most used terms in the European textile and clothing industry.

Prospering in the Circular Economy will truly be achieved by bringing together the existing private and public initiatives, removing barriers, investing to foster technological innovation and stimulating the demand.




**Circular economy approach in textile and clothing manufacturing**

# OBJECTIVES OF THE STRATEGIC AGENDA

- Analyses the current technical and regulatory context valid in the participating regions.
- Is based on data and studies coming from the Regional analysis. It links and drives the Circular Economy considerations and strategic actions.
- Describes waste management strategies and action lines
- Defines the strategy to address the waste management, objectives, and concrete actions to be developed
- Derives objectives to foster the textile industry in the partner regions towards the Circular Economy.
- Acts as guideline to foster innovation on waste management and resource efficiency in the partner regions and to push the collaboration between partners and others actors/stakeholders from authorities, industry and R&D.
- Can be used as guideline for other regions that are faced with the same problems and topics.

# METHODOLOGY

The Strategic Agenda of ENTeR is jointly defined on the basis of problems which are relevant for the participating regions. It provides a common vision and sets objectives and priorities in a mid- to long-term perspective.

**It was done in two phases: desk phase and field phase**

**Desk phase**: the state of the art of textile waste management and recycling in each partner region (Italy – Lombardy, Germany – Saxony, Poland – Lodzkie Region, Check Republic, and Hungary) was studied and summarized in specific regional reports. The regional reports show the legal, social and technical aspects concerning textile waste management.

**Field phase**: relevant stakeholders in the individual regions were interviewed. Questionnaires on the current situation of textile waste management were prepared and distributed among companies and industrial partners in the textile branch.

Based on these data the Strategic Agenda was prepared.

# SUMMARY OF REGIONAL ANALYSIS

## 6.1. Summary of Regional Analysis Czech Republic

**Number of interviews/ questionnaires: 22**

**Findings:**

At the moment:

- municipal waste management system available - textile waste is not sorted and disposed with other municipal waste
- collection of textiles and outworn clothing organised by private companies/charities
- collected textiles sorted according to quality and offered for further use (charity), sold in second-hand shops, forwarded to third world countries, recycled and the unusable share disposed
- textiles which cannot be redistributed or recycled are usually used for energy recovery or disposed to landfills
- textile recycling is operated on the private commercial basis
- companies already reuse their textile waste internally
- companies look individually for external business partners

Technology:

- mechanical processing like cutting and tearing
- obtained textile material is usually used for manufacturing of nonwovens or for production of cleaning materials, various fillings, insulation material, parts for automotive industry etc.

Challenges:

- lack of opportunities for reuse of waste coming from technical textiles caused especially by the technical character of such textiles (heavy coated or laminated, composites with latex, paper etc.)

**SWOT analysis:**

| Strengths: | Weaknesses: |
|---|---|
| ▪ regular waste generation<br>▪ sorting<br>▪ large quantities of waste<br>▪ mono-fraction or valuable waste | ▪ long distances to the recycling company<br>▪ poor quality of waste<br>▪ low quantities of waste |
| **Opportunities:** | **Threats:** |
| ▪ re-use of textile waste in new products<br>▪ offering waste via a recycling exchange platform<br>▪ internal recycling<br>▪ investments in new technologies, R&D activities | ▪ the required investments needed for solving<br>▪ lack of market for recycled products<br>▪ contamination of textile waste with chemicals |

# SUMMARY OF REGIONAL ANALYSIS

## 6.2. Summary of Regional Analysis Hungary

**Number of interviews / questionnaires: 26**

**Findings:**

At the moment:

- Hungarian companies are looking for solutions to recycle their textile waste as much as possible
- no separated collection of textiles waste and communal waste; it is handled and transferred as a communal waste - without separation and selection
- most common way the companies handle their waste is send it to disposal in landfills or to incineration
- issue of textile waste management system and recycling is very urgent

Technology:

- textile waste recycling technologies are available in Hungary but only in a small range
- mechanical processing as tearing and cutting (Temaforg, TESA)
- the obtained textile material is usually used for manufacturing of non-woven textiles or for production of cleaning materials, various fillings, upholster materials, insulations, geotextiles
- this solution is mostly available only for "simple" textile waste without any heavy chemical treatment (coating, laminating)

Challenges:

- need of new technologies related to textile & clothing sector and complicated textile waste
- improvement of waste collection and sorting

**SWOT analysis:**

| Strengths: | Weaknesses: |
|---|---|
| ▪ regular waste generation<br>▪ with large quantities of waste | ▪ no relevant recycling company in the region<br>▪ no regional waste management system available<br>▪ lack of recycling knowledge<br>▪ lack of capital for investment<br>▪ long distances to the recycling company to find a recycling possibility is very difficult<br>▪ poor quality and small quantities of the waste<br>▪ lack of waste utilization possibilities |
| **Opportunities:** | **Threats:** |
| ▪ offering waste via a recycling exchange platform, together with business partner<br>▪ search not only in regional but also in interregional level. | ▪ required investments needed for problem solving<br>▪ lack of market for recycled products<br>▪ high processing costs |

# SUMMARY OF REGIONAL ANALYSIS

### 6.3. Summary of Regional Analysis Italy

| | |
|---|---|
| Number of interviews/ questionnaires: 13 | |
| Findings: | |
| At the moment:<br>▪ textile companies are increasingly oriented towards environmental subjects: sustainability, circular economy and new materials<br>▪ the waste production coming from provincial textile sector for 2016 is about 19.510 tonnes/year, where 87.7% of derives from textile industry, while 13.3% from production processes of clothing and articles in leather and fur<br>▪ large quantities of liquids deriving from tanning activities, such as sludge coming from on-site treatment of effluents and tanned leather (scraps, waste, scraps, polishing powders), containing chromium | |
| Technology: | |
| Challenges:<br>▪ increase the market acceptance for recycled products (social/cultural barrier)<br>▪ overcome the lack of technological know-how<br>▪ decrease in bureaucracy and simplification in administration<br>▪ establishment of recycling plants for the strongest sectors on the territory | |
| SWOT analysis: | |
| **Strengths:**<br>▪ well-established sector in the Lombardy region both in terms of number of companies and employees, as well as growing in annual turnover (+ 2.4%); in 2017 the sector generated roughly 13 bilions € in export (+3,6% with respect to 2016, source ISTAT);<br>▪ presence of associative and industrial product groups that lead companies to a more sustainable production (Confindustria);<br>▪ constant support and continuous involvement of public administrations and stakeholders to lead and encourage environmental sustainability in the textile sector;<br>▪ interest of companies on environmental issues also due to the request by customers of products with a reduced environmental impact or | **Weaknesses:**<br>▪ high number of disconnected SMEs with individually quantities of waste too small for a continuous supply for new recycling possibilities;<br>▪ negative dynamics of domestic demand, in terms of business-to-business and sell-out demand;<br>▪ staff often poorly prepared (insufficient academic preparation) on environmental issues or lack of personnel dedicated to sustainability;<br>▪ reduced availability of investments for research of green alternatives in production;<br>▪ difficult interpretation of legislation on circulation of waste destined for recycling. |
| ▪ deriving from recycling processes;<br>▪ quick response and flexibility of processes and products, achieved through new and innovating technologies. | |
| **Opportunities:**<br>▪ development of projects for the involvement of companies in this sector;<br>▪ dialogue between Public Administrations and stakeholders and other actors in the sector to identify needs and to break down the barriers that hinder the transition to a circular economy and recycling of materials;<br>▪ involvement of design schools and start-up companies for the development of new materials or technologies aimed at reducing the environmental footprint of the textile supply chain;<br>▪ implementation of specific university courses on LCA (through development of specific software) for the promotion of transition from Linear Economy to Circular Economy;<br>▪ development of specialized databases and exchange platforms for information, materials and technologies;<br>▪ approach to PEF (Product Environmental Footprint) methodology;<br>▪ financial contribution issued by the UE and Piano Nazionale Industria 4.0. | **Threats:**<br>▪ purchasing policies based only on product cost without considering environmental costs;<br>▪ textile trends, such as: fast fashion, low cost products;<br>▪ low competitiveness with foreign production (mainly Far East);<br>▪ customers' cultural barriers in accepting products deriving from recycling chain;<br>▪ regulatory barriers, administrative immobilization in the implementation of new European provisions within the Circular Economy;<br>▪ many competitors operate in contexts with fewer environmental restrictions. |

# SUMMARY OF REGIONAL ANALYSIS

## 6.4. Summary of Regional Analysis Poland

**Number of interviews/ questionnaires: 13**

**Findings:**

At the moment:

- textile waste recycling in Poland is complex and expensive
- technologies for textile recycling are very expensive
- high effort in registration and processing (separation, storage, logistics)
- lack of available technological or technical solutions
- textile recycling is economically not attractive
- no structural support of the government, possibilities of financial support from EU or national funds
- companies, which achieved significant progress in the field of textile
- waste management, made it with their own financial resources

Technology:

- technologies that allow textile waste management in 100% are very expensive
- lack of available technological or technical solutions and too much effort in registration and processing (separation, storage, logistics)

Challenges:

- continued growth of the textile waste stream is not in correlation with the development of the collection system and the construction of installations for textile waste processing
- problem with textile waste management in Poland remains still unresolved
- problem of textile waste in Poland is global and requires substantial funds and regulation
- urgent need of finding recycling possibilities

**SWOT analysis:**

| Strengths: | Weaknesses: |
|---|---|
| ▪ initiatives are taken to prevent waste generation.<br>▪ one of the basic activities in waste prevention is raising the environmental awareness of the Region's inhabitants through educational campaigns<br>▪ the strong point of the region is its location in the central part of Poland, and the biggest advantage is location in the transit and transport node.<br>▪ strong road infrastructure has a major impact on other industry sectors, including improvement of waste management rationalization | ▪ insufficient infrastructure serving integrated waste management.<br>▪ inadequate number of installations for processing municipal waste<br>▪ a large number of landfills that have not yet been reclaimed but are excluded from use and low efficiency of selective municipal waste collection |

# SUMMARY OF REGIONAL ANALYSIS

### 6.5. Summary of Regional Analysis Saxony

**Number of interviews/ questionnaires: 15**

**Findings:**

At the moment:

- in Germany, 1.5 to 1.9 million tonnes of textile waste (old textiles and textile production waste) are produced each year
- well-organised clothing collection system → large part of textile waste can be reused
- technological solutions to treat conventional textile waste are sufficiently available and state-of-the art.
- nevertheless 300,000 tonnes of textile waste are incinerated or sent to landfills
- volume of textile waste continues to grow
- transition from clothing textiles to technical textiles → smart textiles with electronics, high-performance textiles with special coatings or finishes, composite materials, etc.

Technology:

- waste from textile production and the clothing industry can be processed very well with tearing, cutting, carding, processing of individual fibres, re-use in nonwovens, insulation materials, automotive industry, etc.

Challenges:

- structural changes of the national and regional T&C sector from the classical production towards the production of technical textiles are ongoing
- textile waste is changing concerning the kinds of raw materials (high performance fibres), the composition of textile fabrics, the surface quality (functional coatings), use of electronic parts in smart textiles, etc.
- recycling industry is not in a position to successfully process waste from technical textiles (such as composites, textile-based components, smart textiles) using the current state of the art technologies
- new methods/approaches to treat novel materials are required increase of n
- new materials lead to a great variety of types of waste with small amounts of waste. Important is to channel the waste streams and build up networks for waste management at interregional level (for instance via a database)

**SWOT analysis:**

| Strengths: | Weaknesses: |
|---|---|
| ▪ varietal purity of textile waste<br>▪ separated waste collection (sorting)<br>▪ high amounts of waste available<br>▪ regular volume available<br>▪ textile waste is valuable (intrinsic value)<br>▪ short distances to disposal companies | ▪ non-defined waste<br>▪ only small amounts are available<br>▪ no regular volume available<br>▪ poor quality waste<br>▪ long distances to the recycling company |

| Opportunities: | Threats: |
|---|---|
| ▪ reutilization of waste in the own company (production cycle)<br>▪ reutilization in new products (own or other company<br>▪ offering waste via a recycling platform<br>▪ investment in novel technologies / applying of funding<br>▪ activities in research and development (R&D) | ▪ high expenses for treatment and re-processing<br>▪ investments to solve the waste problems required (additional costs)<br>▪ missing market acceptance for recycled products<br>▪ waste is contaminated (polluted), reutilization is not possible<br>▪ legal rules / guidelines (for instance REACH or special certificates) |

# DISCUSSION OF THE RESULTS

Technological solutions to treat conventional textile waste are sufficiently available and state-of-the art for Germany and Check Republic. For Hungary and Poland there is still a lack of technological solutions and also the availability for a wide range of companies in the textile sector is not given.

Summarizing the results of the interviews, questionnaires and SWOT-analysis of the partner regions, the following future fields and trends in terms of textile waste management and recycling with relevance for the European (Central Europe) textile industry can be identified:

- increasing the degree of recycling through state-of-the-art processes,
- closing material cycles,
- conversion to environmentally friendly production techniques and the use of recyclable materials,
- designing in line with recycling requirements (Eco-design),
- the promotion of textile-based composites and
- the IT-based reduction of waste.

In Central Europe a textile value chain capable of recycling fabrics, regenerating fibres and maximising resources in production is already existing but not established in a high advanced level for all regions and countries

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# ENTeR – WP T3 Approach & Validation / Task A.T3.1

**High Level Training Modules – Training Path 3: Main textile recycling technologies and methods to recover, reuse and recycle textile waste**

ENTeR Project Partner STFI (DE)

# CONTENT OF TRAINING PATH 3

Introduction

Definition of terms related to textile recycling

Textile waste - materials cycle

Processing of textile waste

a) Mechanical
b) Physical
c) Chemical

Recycling of special waste - Carbon fibres

Textile waste from end-of life clothing

Conclusions

# FOREWORD

## Interreg Central Europe Programme

(https://www.interreg-central.eu/Content.Node/home.html)

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The training course reflects only the authors' view and neither the European Commission nor the Interreg Central Europe Managing Authority are responsible for any use that may be made of the information it contains.

# INTRODUCTION

Nowadays, a sustainable textile recycling can be seen as a global challenge since the economy needs a continuous supply with raw material at any time. On the other hand natural limits are given to the world-wide consumption of resources. The utilization and recycling of waste is becoming even more important due to the shortage of virgin materials and strong concerns of a non-sustainable use of natural resources. Furthermore, the increasing costs of waste management and limited landfill capacities have also increased the interest in recovering waste as material or energy.

This training module on recycling technologies and how to recover, reuse or recycle textile waste should help to deepen the knowledge about such recycling processes and methods to raise the awareness of textile companies, to motivate their active cooperation and to improve know-how and experience in recovering or recycling textile waste.

# DEFINITION OF TERMS RELATED TO TEXTILE RECYCLING

Closed Loop: Aim is to redirect the raw materials contained in the products after their exploitation in the resource cycle for the production of new products.

Cradle-to-Cradle: System to manufacture products by keeping the materials in a close cycle. Already the raw materials should be produced in such way that makes feasible their later re-use.

Downcycling: Products are supplied to a recycling process. The result of the recycling are new products which are lower in their quality and value than the initial product.

Open loop: Another product with a different application is produced from the material or parts of an end-of-life product.

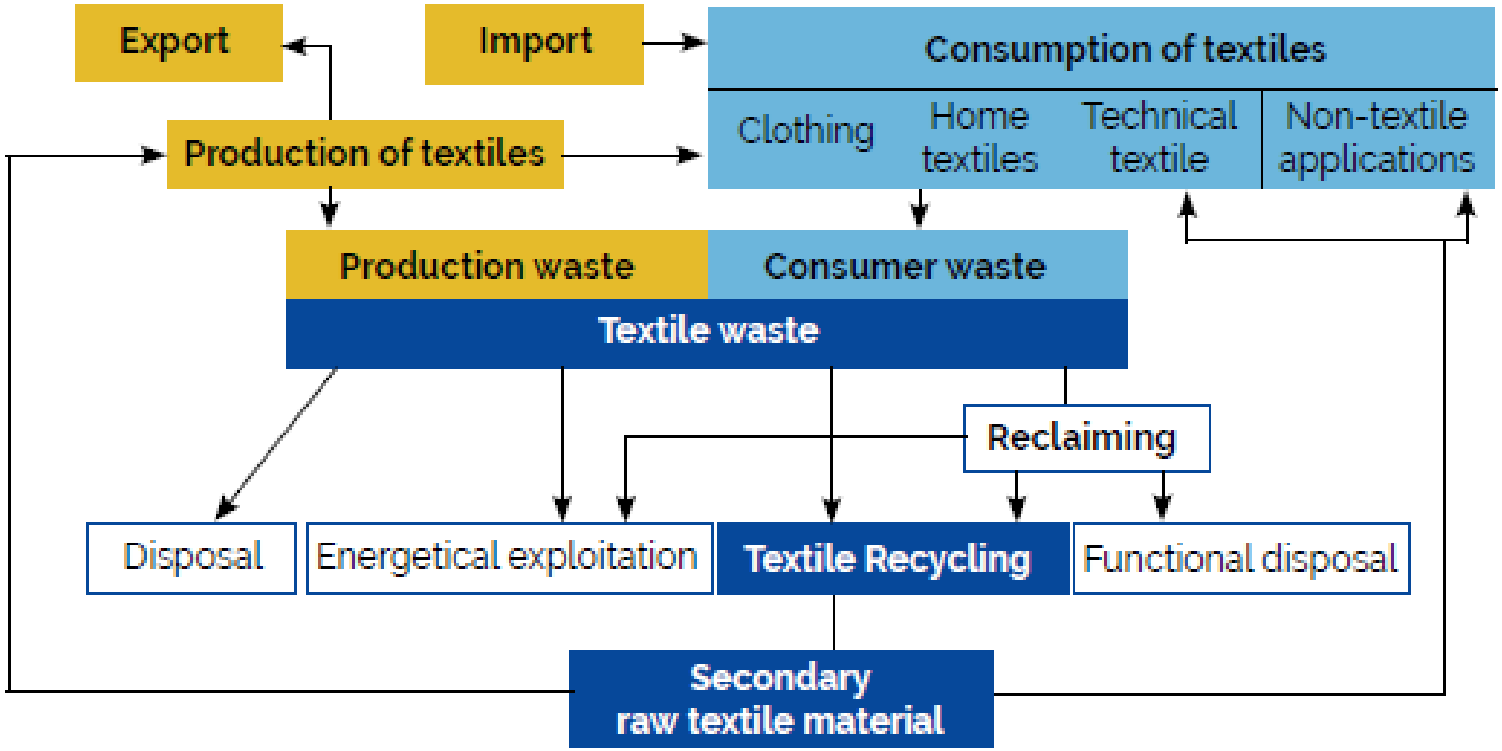
Primary raw material: Natural raw materials are extracted from nature or mainly produced from natural raw materials.

Recovery: is the regaining or returning of waste material by processing in ways other than being destroyed.

# DEFINITION OF TERMS RELATED TO TEXTILE RECYCLING

Recycling/reuse: are the frequently used methods of waste disposal and means giving waste a second life.
Secondary raw material: is raw material regained by recycling and used as raw material for new products.
Upcycling: The aim is to completely reuse the original components of used cloths or shoes and to produce an equivalent recycling product, for instance to manufacture from shoes waste shoes again.
Textile waste: as raw material for textile recycling is divided into production waste and used textiles (consumer waste).
Textile production waste: is coming from the manufacturing of all kinds of textile products.
Used clothing/textiles: comprise all worn clothing but also all other used textile goods from home and household (curtains, bed linen, towels…)

# TEXTILE WASTE – MATERIALS CYCLE




(**Source:** STFI)

# TEXTILE WASTE – MATERIALS CYCLE

- **Textile waste** is coming from the production of textile goods (**production waste**) and from the consumption of textiles (clothing, home and household textiles) as so called **consumer waste**.
- Favourite option is to **re-utilize** the waste material by returning it directly into the production process to save raw material.
- If not possible, the textile waste has to be **recycled** by mechanical, physical or chemical recycling to get secondary raw materials which can be used as raw material for new products.
- If no re-utilization, no recycling or functional disposal (secondary use by another application) can be done, then a **thermal/energetic exploitation** is applied in public incineration plants.
- Finally, if no other option is possible, the waste has to be **disposed in landfills**.
- **Used clothing** is collected and redistributed by charity organizations to socially needy people. Low-quality clothing is often exported to the third world countries or for recycling.

# TEXTILE WASTE – TYPES OF WASTE

**Textile production waste material:** fibre waste (also including dust and fluff), yarn residues, textile fabrics, pieces of textile fabrics (selvedges), cutting waste, defective products, fibres





**Textile consumer waste:** worn clothing but also all other used textile goods from home and household (curtains, bed linen, towels…)




(**Source:** STFI)

# PROCESSING OF TEXTILE WASTE - MECHANICAL RECYCLING

**Processing**

The traditional method for the recycling of textile waste is the use of cutting and tearing processes to obtain reclaimed fibres. Fibre/thread opening is carried out by breaking the textile structure through cutting, shredding and tearing to produce reclaimed fibres. By mechanical processes, such as carding, a web formation can follow subsequently.

**Use of reclaimed fibers**

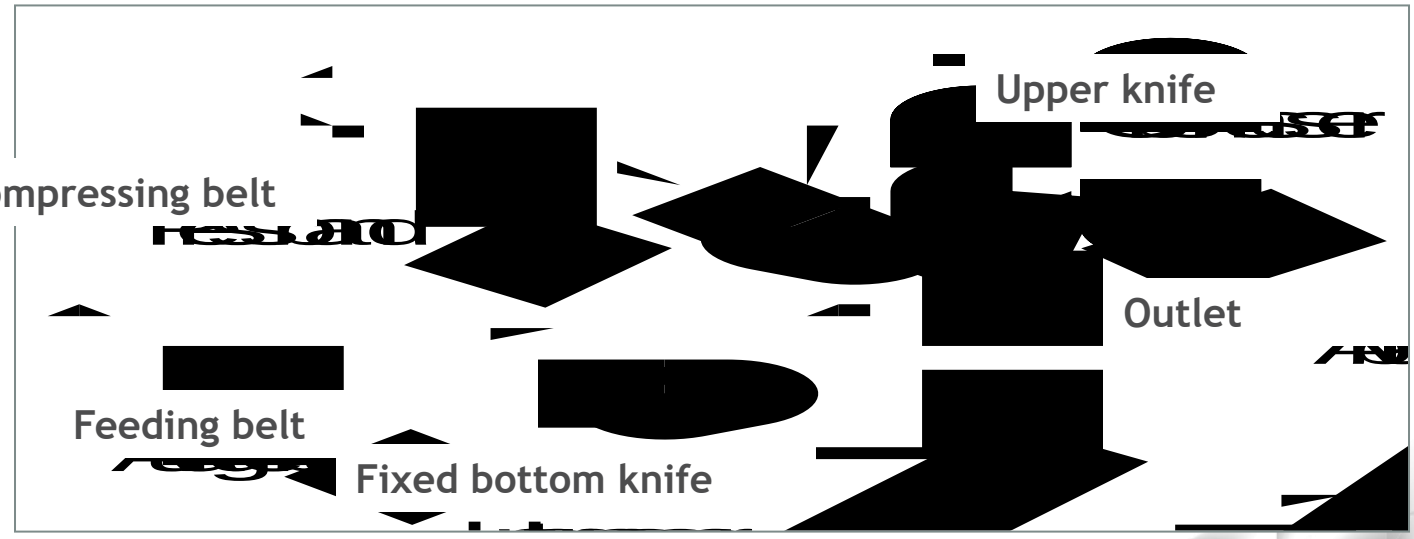
The material obtained is mostly used for manufacturing of fibre nonwovens (needle-punched or stitch-bonded nonwovens) or for the production of cleaning rags, filling material, insulation material, geotextiles, upholstery and automotive textiles which means a secondary use of waste.

# PROCESSING OF TEXTILE WASTE - TEARING PROCESS PRINCIPLE

Cutting machine

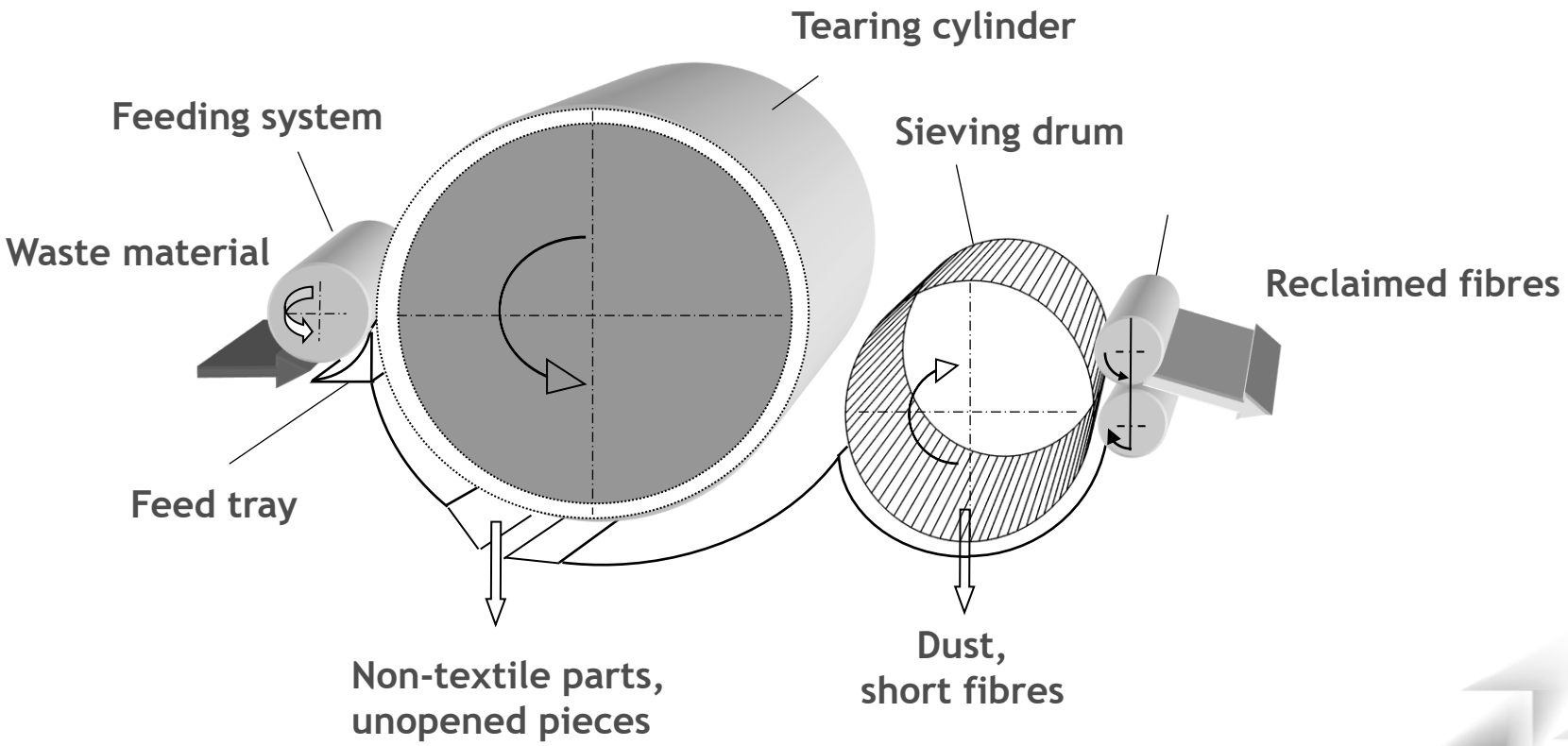
**First step:**
Cutting the waste material into pieces

Guillotine-like principle



# PROCESSING OF TEXTILE WASTE - TEARING PROCESS PRINCIPLE

## Second step:
## Processing textile waste into fibres

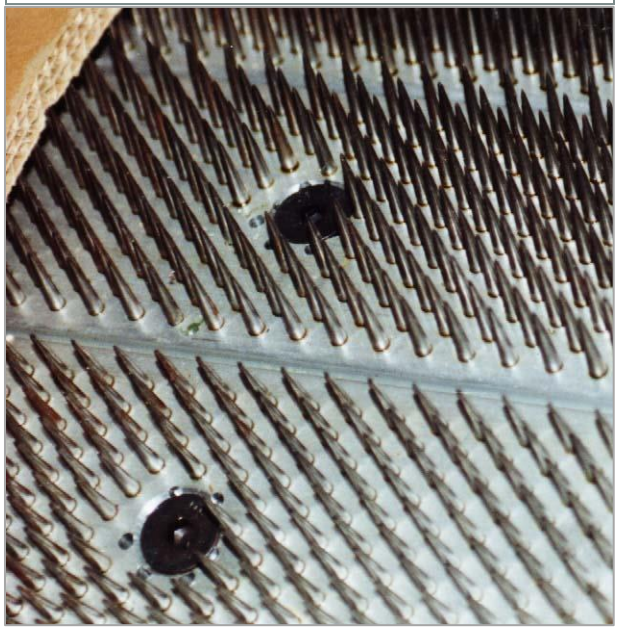


# PROCESSING OF TEXTILE WASTE - TEARING PROCESS PRINCIPLE

## Second step:
## Processing textile waste into fibres

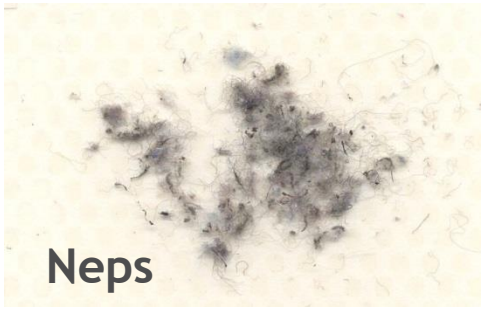
Lab-scale tearing machine

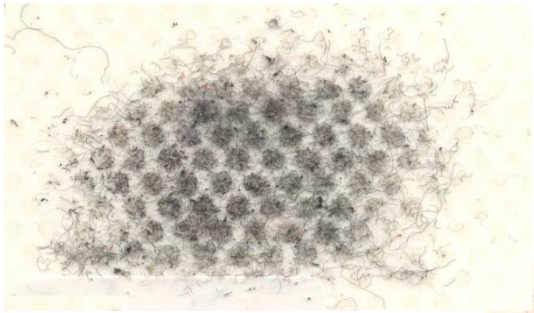
Pin-coated tearing cylinder



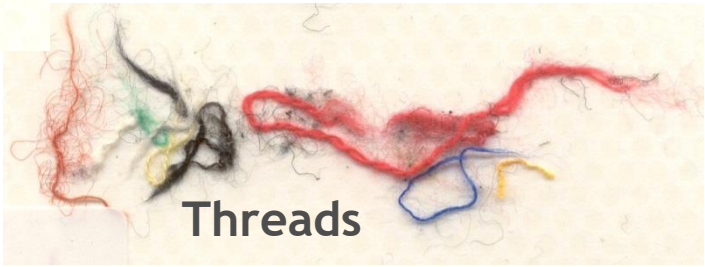
(Source: STFI)

# PROCESSING OF TEXTILE WASTE - TEARING PROCESS RESULT


Neps



Fibre dust, short fibres


Threads

Reclaimed fibres as a blend of:


Unopened pieces

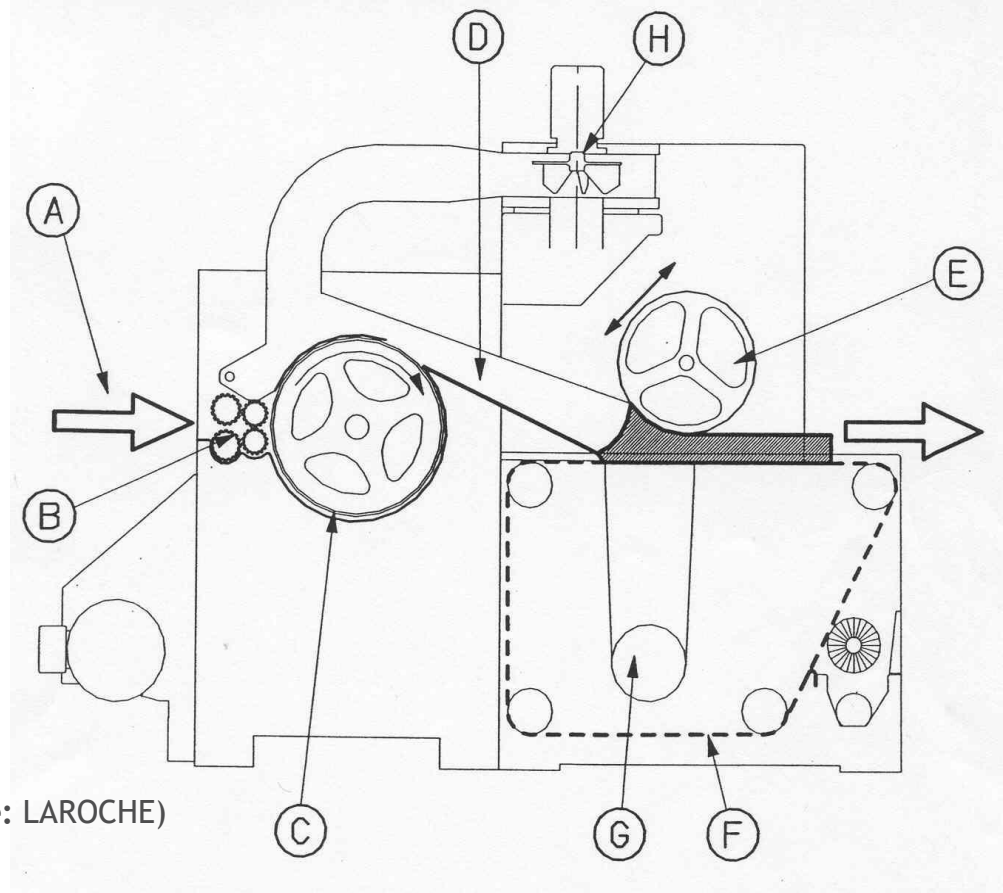

Fibres with different lengths

(Source: STFI)

# PROCESSING OF TEXTILE WASTE - RECLAIMED FIBRES

| Use of reclaimed fibres in | Required fibre quality | | | | |
|---|---|---|---|---|---|
| | Type of Polymer | Fineness | Strength | Length | Colour |
| Reinforcement (Concrete) | X | | X | X | |
| Protection against Erosion | X | | | | X |
| Geotextiles | X | X | X | X | |
| Upholstery | X | X (Crimp) | | X | |
| Wipes | X | X | | X | |

## Raindom laid web - principle of system matformer (Fa. Laroche/F)

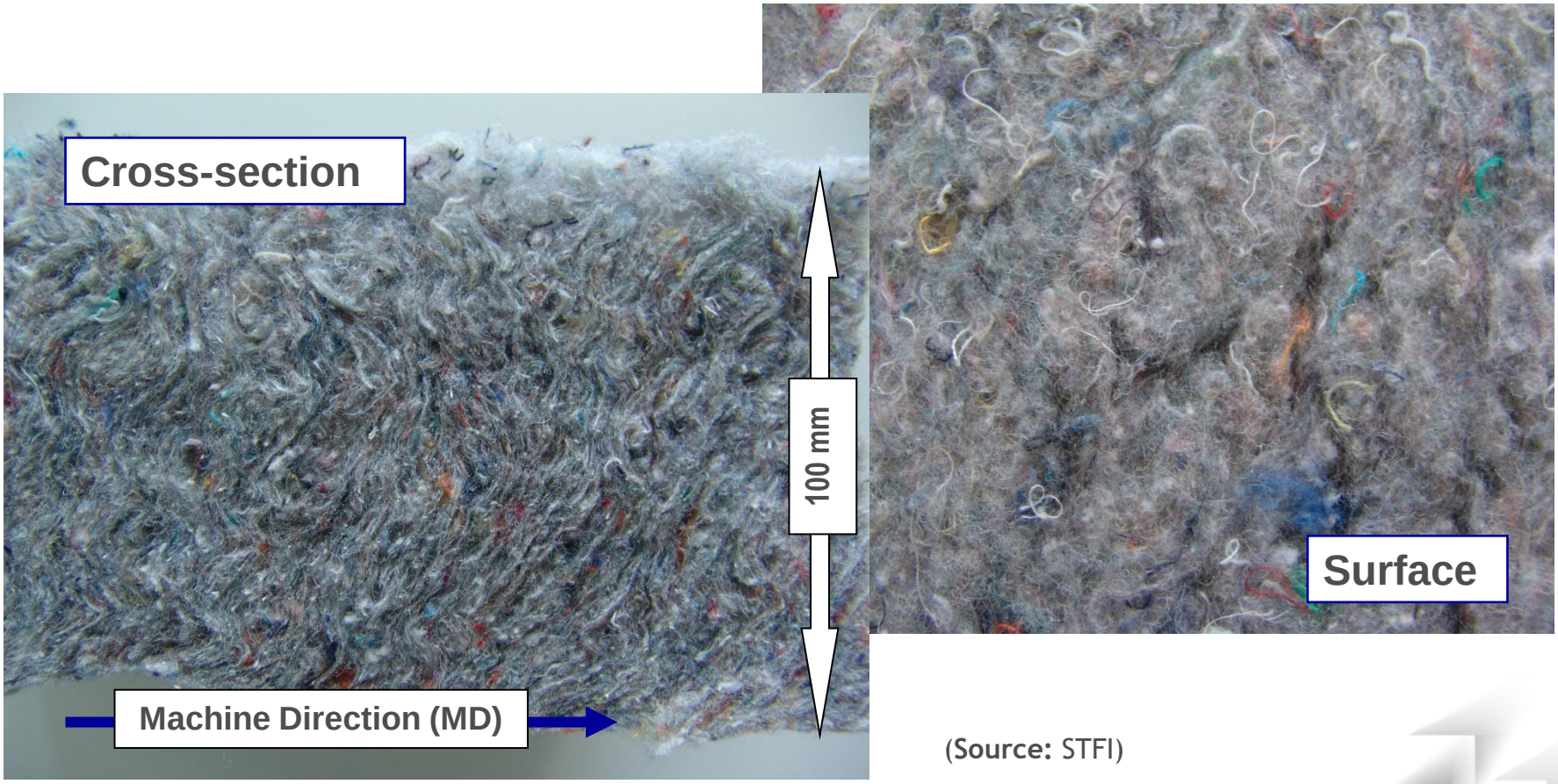



(Source: LAROCHE)

A Fibre fluff
B Material feed
C Opening roller
D Air channel
E Pressure roller
F Sieving conveyor
G Intake suction
H Additional air

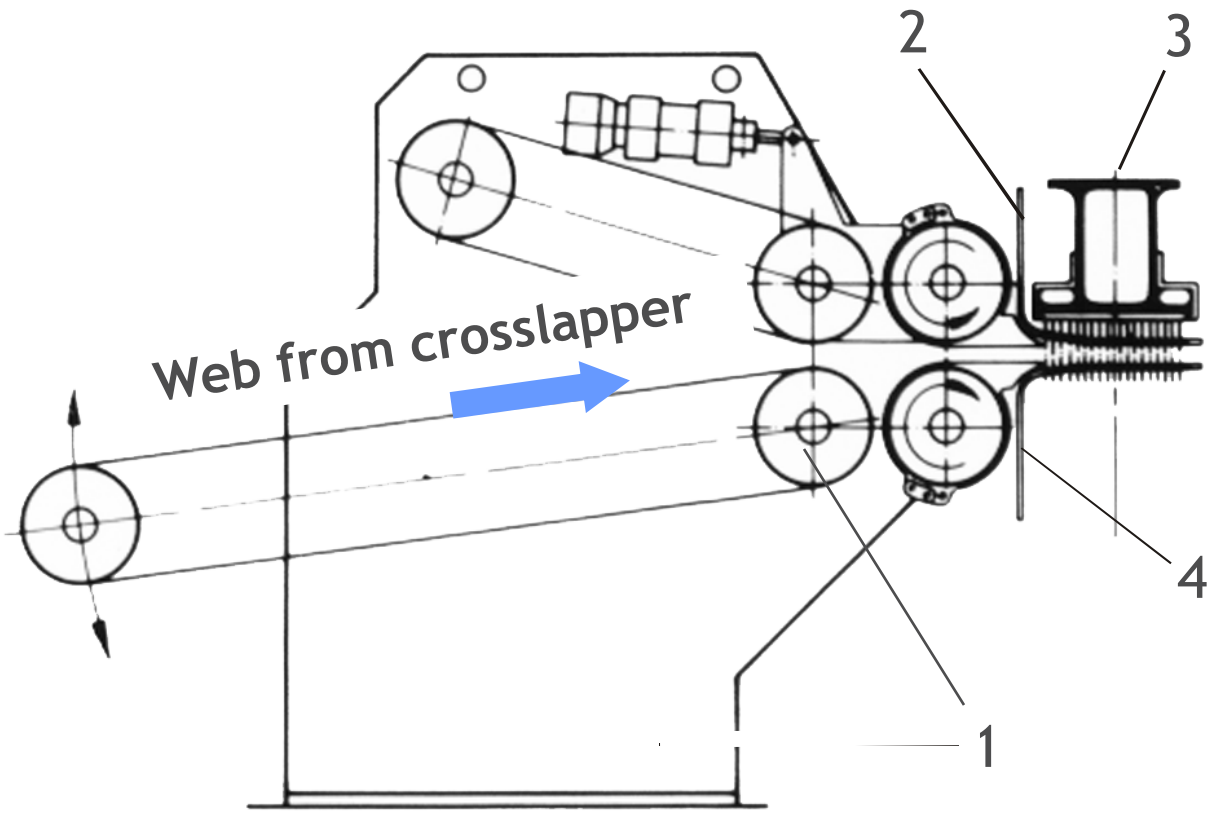
LAROCHE

## Raindom laid nonwoven structure after thermal bonding



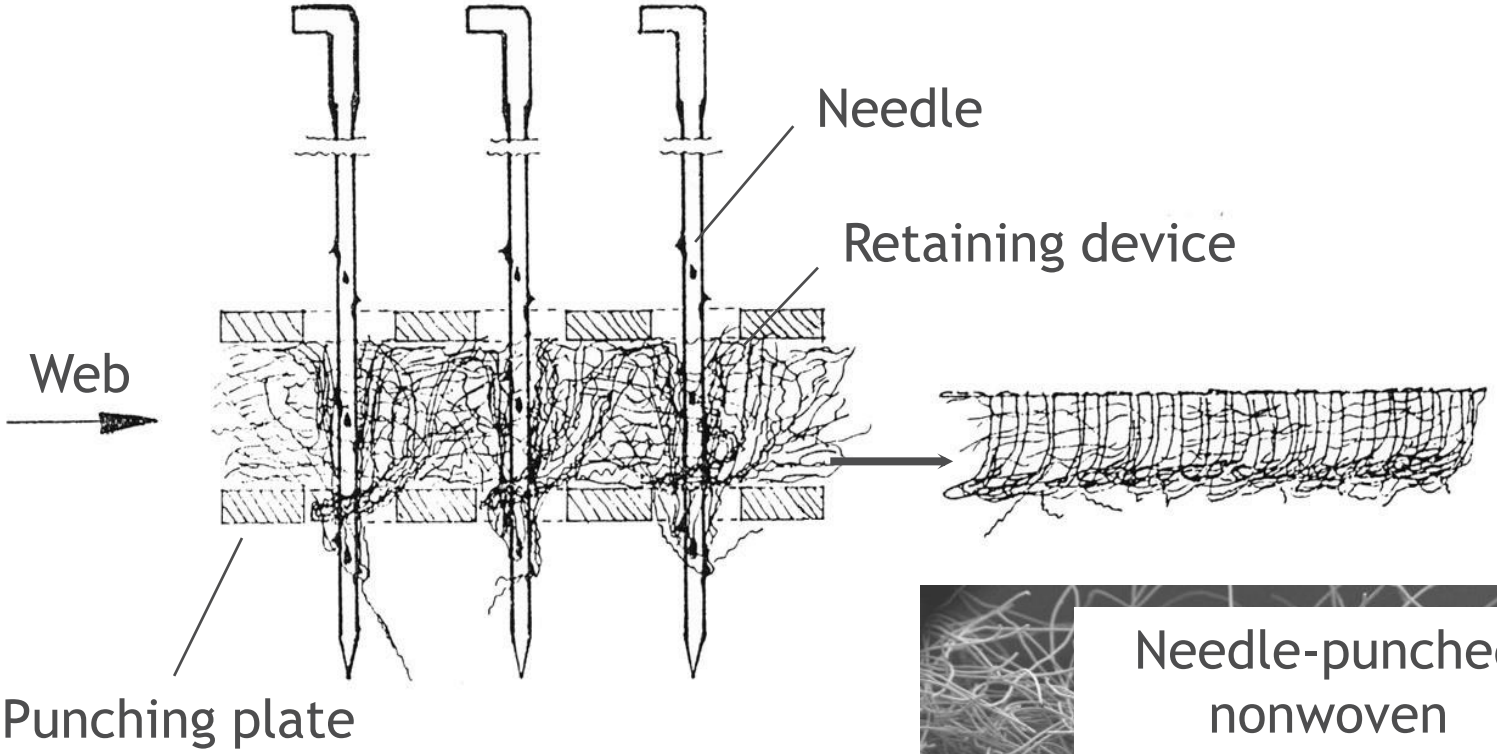

(Source: STFI)

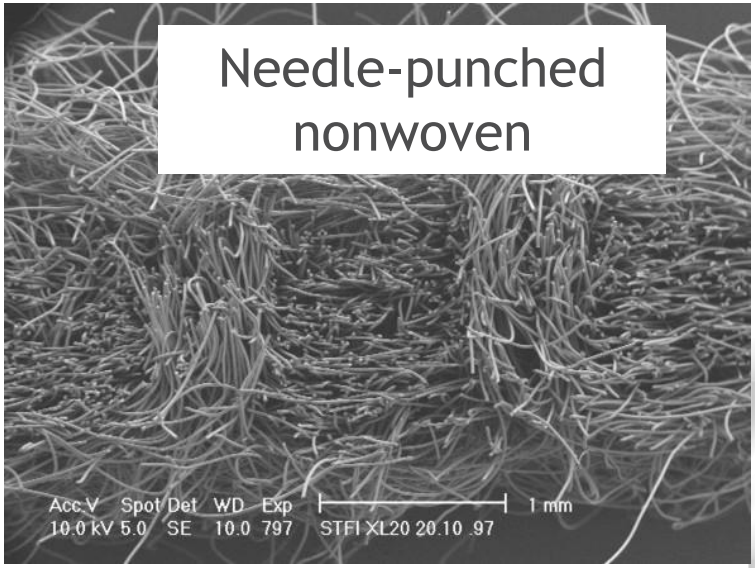
## Web bonding by needle-punching (principle)




1 Feeding system
2 Retaining device
3 Needle board
4 Punching plate

# PROCESSING OF TEXTILE WASTE - PROCESSING OF RECLAIMED FIBRES




**Needle-punching**
**Fibre orientation and entanglement**

(**Source:** STFI)

# PROCESSING OF TEXTILE WASTE – MECHANICAL RECYCLING MACHINERY (EXAMPLES)

- Modern technology/equipment for processing of nearly all kinds of textile waste is available
- Quantity specialised or product specialised plant line concepts
- Random web forming as cost-effective processing technology/concept
- Other web bonding through needle-punching process
- Machinery manufactured in Europe is available for the world markets

# PROCESSING OF TEXTILE WASTE - MECHANICAL RECYCLING: MACHINERY (EXAMPLES)

## Cutting of textile waste

**Cutting line „ROBOT“**
- **Up to 8000 kg/h**
- **Cutting length: 6 mm to 160 mm**

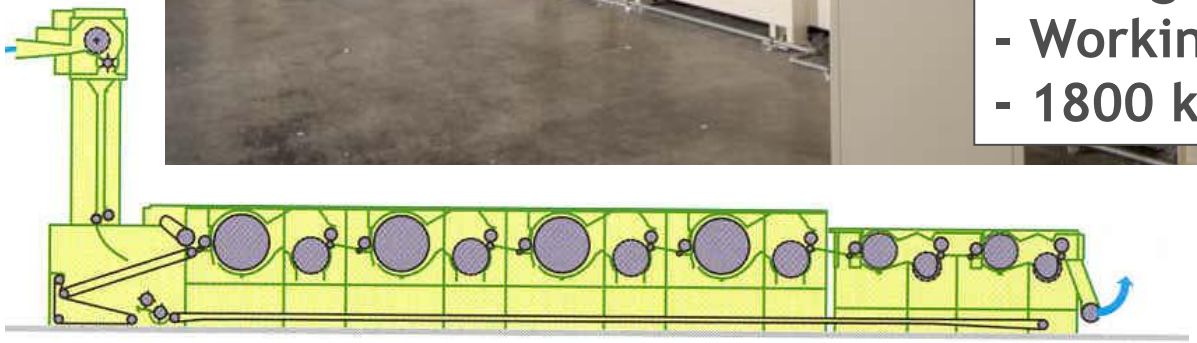
(Source: PIERRET)

**PIERRET INDUSTRIES S.P.R.L., Corbion/Belgium**

# PROCESSING OF TEXTILE WASTE - MECHANICAL RECYCLING: MACHINERY (EXAMPLES)

Tearing line - processing of production waste

(Source: LAROCHE)

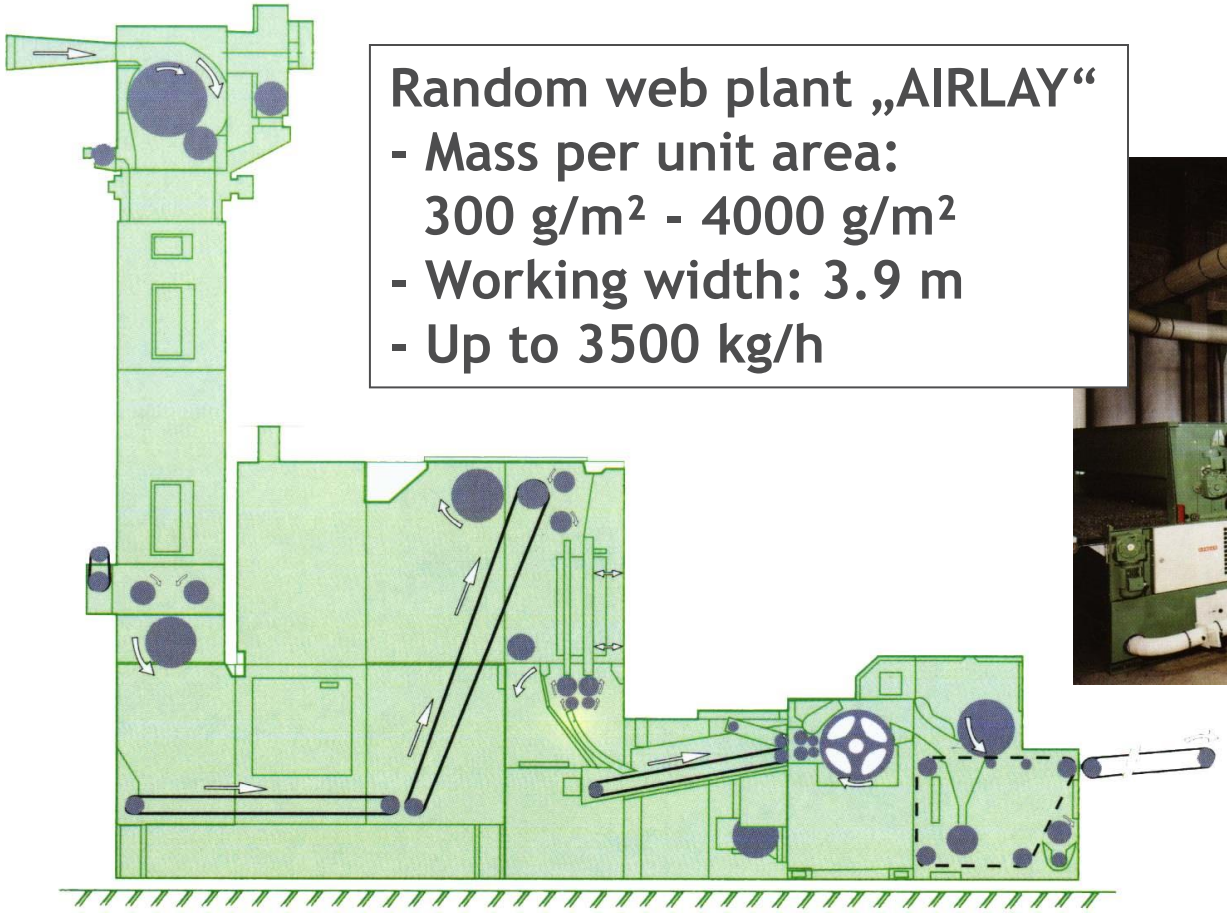


Tearing line „JUMBO + EXEL“
- Working width: 2000 mm
- 1800 kg/h

LAROCHE S.A., Cours La Ville/France

# PROCESSING OF TEXTILE WASTE – MECHANICAL RECYCLING: MACHINERY (EXAMPLES)





Random web plant „AIRLAY“
- Mass per unit area:
  300 g/m² - 4000 g/m²
- Working width: 3.9 m
- Up to 3500 kg/h

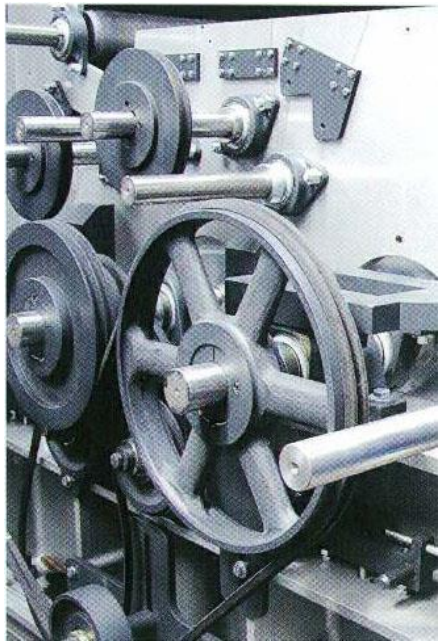
(**Source:** LAROCHE)

Processing of reclaimed fibres

LAROCHE

LAROCHE S.A., Cours La Ville/France

# PROCESSING OF TEXTILE WASTE – MECHANICAL RECYCLING: MACHINERY (EXAMPLES)



(Source: STFI)

## Web bonding by needle-punching

DILO GROUP
FOR NONWOVENS TECHNOLOGIES

(Source: DILO)

# PROCESSING OF TEXTILE WASTE - PHYSICAL RECYCLING - EXTRUSION

**Processing**

- Physical recycling is feasible for thermoplastic materials and the waste is re-granulated and can be used as raw material again.
- Extrusion of polyolefins, polyester, and others in the form of various plastic products and textile materials are processes which involve the melting, shredding or granulation of thermoplastic waste.
- The primary criterion for this mechanical recycling (melt processing) is the purity of the end product. Therefore, the waste must be sorted prior to recycling.
- Sorting of plastics can be carried out by hand or machine according to colour and chemical structure of the plastics. Nowadays mainly automatic sorting is used.
- After sorting, the thermoplastic waste is melted down directly and moulded into a new shape, or melted down after being shredded into flakes and then processed into regranulates.

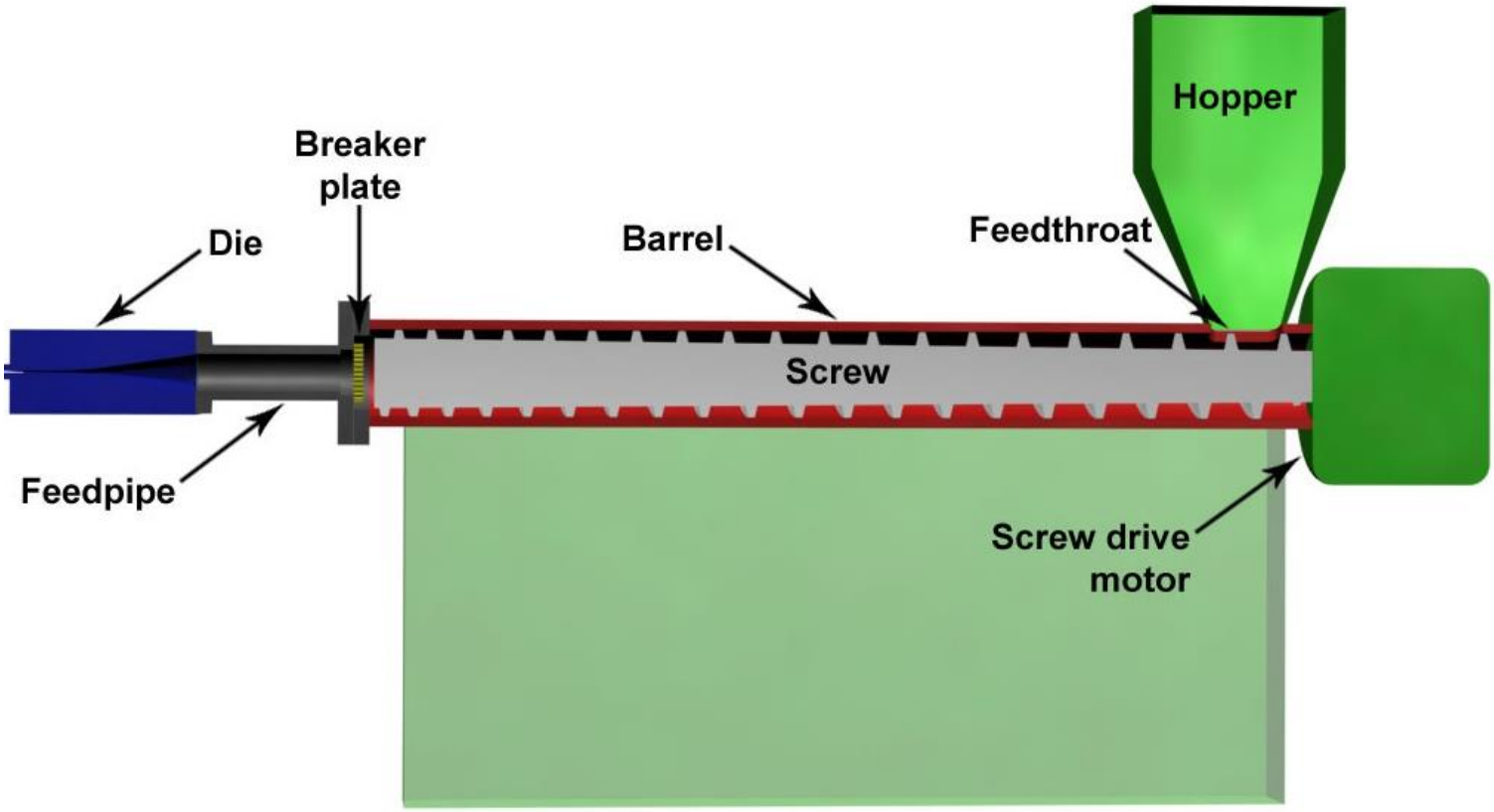
# PROCESSING OF TEXTILE WASTE - PHYSICAL RECYCLING - EXTRUSION

**Reprocessed material**

- A main problem in the physical recycling (re-melting) of thermoplastic material is that reprocessing gives a heat impact to the material causing a change/reduction of properties and makes a re-use for the same application difficult.
- Effects of recycling processes on physical, mechanical and degradation properties can be decreased tensile properties, changed thermal characteristics, photo-sensitivity or a worse degradation behaviour.

**Extrusion unit at STFI's spunbond lab**
(Source: STFI)

# PROCESSING OF TEXTILE WASTE - PHYSICAL RECYCLING - EXTRUSION




**Extrusion process** (Source: Wikipedia)

# PROCESSING OF TEXTILE WASTE - CHEMICAL RECYCLING

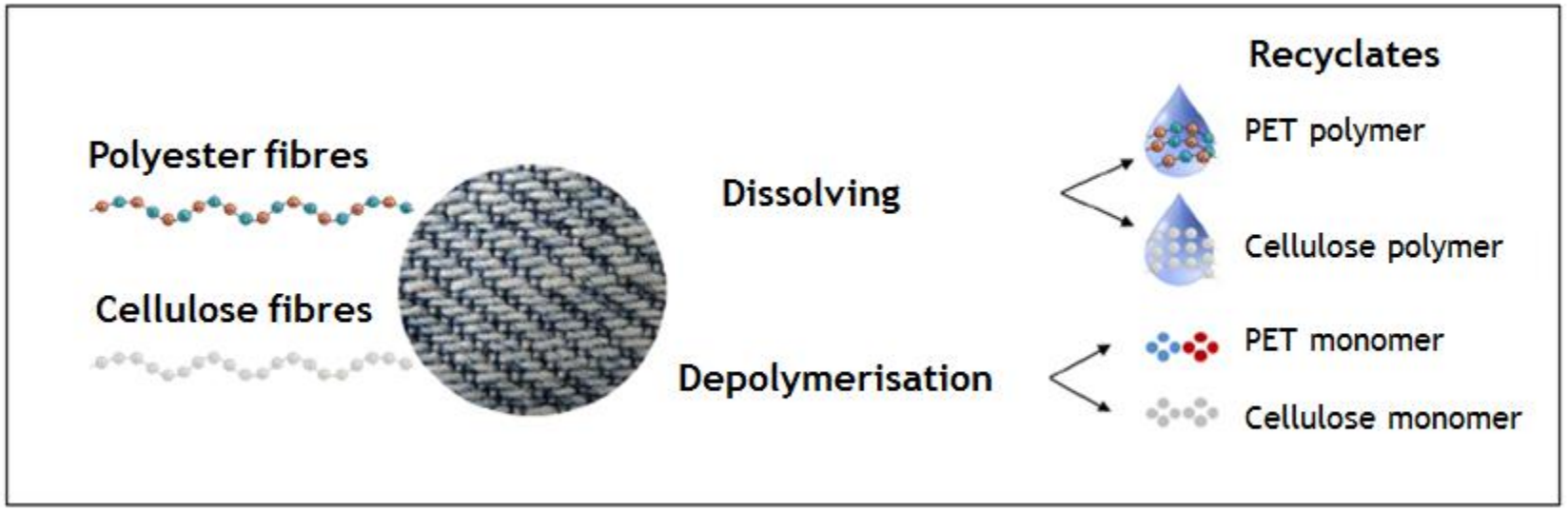
**Processing**

- Chemical recycling is the production of chemical products from waste polymeric materials by economically feasible processing.
- It includes depolymerisation into monomers with a purity level suitable for re-polymerization of material but also dissolving with suitable solvents while maintaining the polymer character.
- Other methods for chemical recycling are pyrolysis (depolymerisation by means of selected parameters, use of catalysts and heat) or targeted depolymerisation processes (like hydrolysis, alcoholysis, ammonolysis,).

**Reprocessed material**

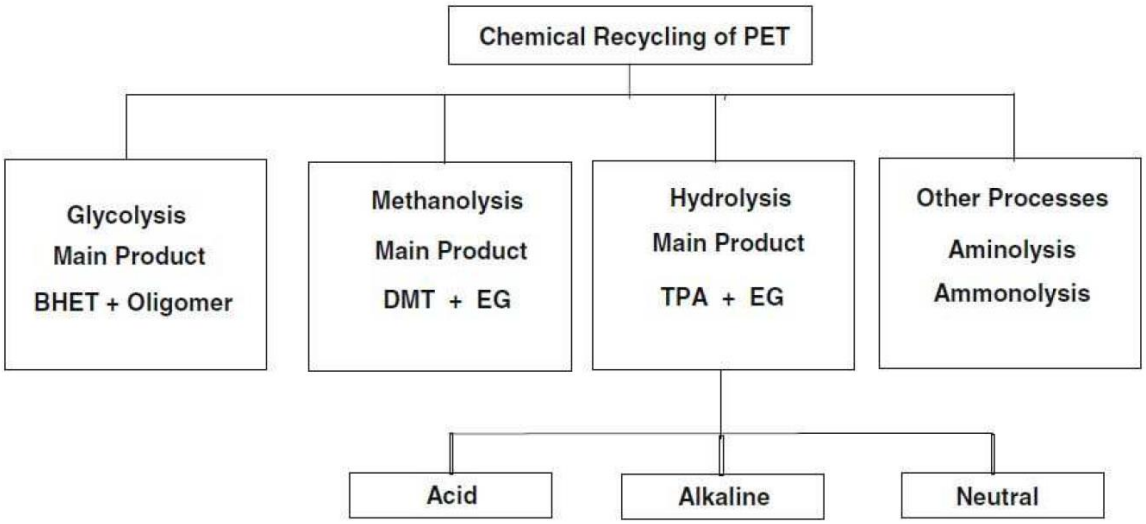
- Suitable for chemical recycling are polymers from cellulose, polyester, polyamide, polyurethane. Chemical recycling can be applied to recycle mixed or unmixed synthetic textile waste and gained products can be easily returned into the production cycle.

# PROCESSING OF TEXTILE WASTE – CHEMICAL RECYCLING

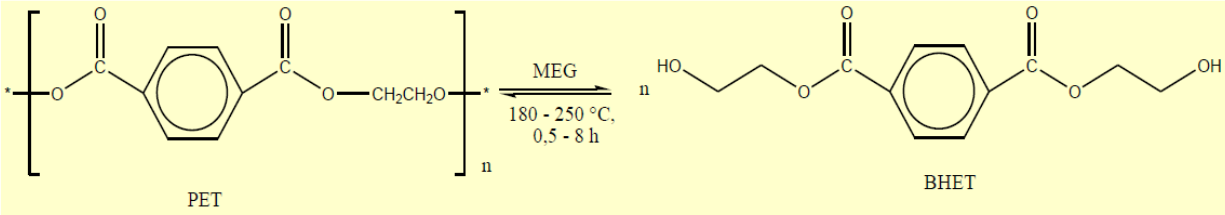



Source: Paper „Aktueller Stand der Technik zum Chemischen Recycling von Chemiefasern", Fachtagung des Innovationsforums „TexCycle" –Chemnitz (DE), 13 March 2019

# PROCESSING OF TEXTILE WASTE - CHEMICAL RECYCLING




## Example: Glycolysis of PET



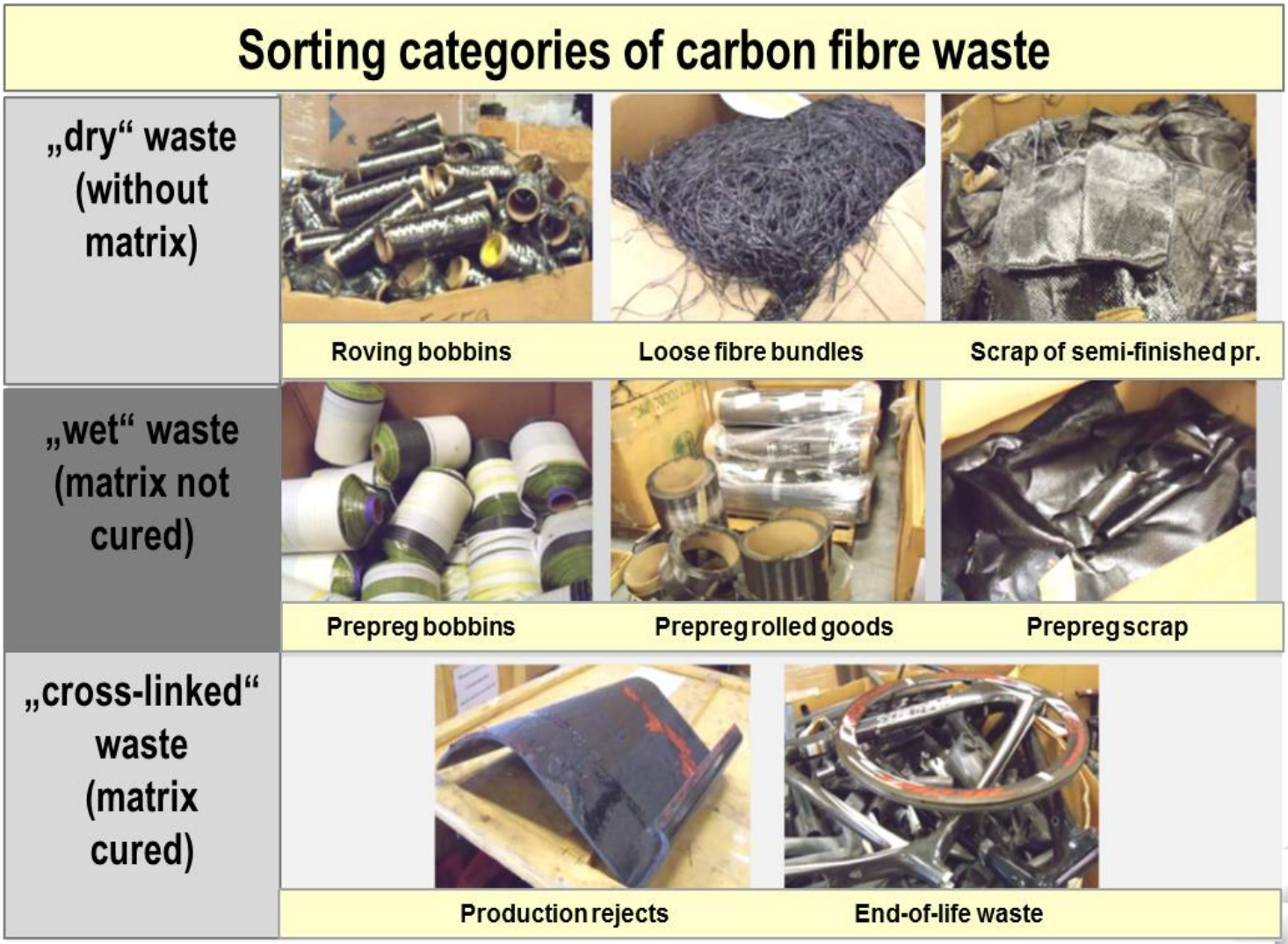

Source: Paper „Aktueller Stand der Technik zum Chemischen Recycling von Chemiefasern“, Fachtagung des Innovationsforums „TexCycle“ –Chemnitz (DE), 13 March 2019

# RECYCLING OF SPECIAL WASTE – CARBON FIBRES

- Preparation of dry carbon fibre waste is technically proven and economically useful.
- Recycled fibres are processed by mechanical web formation (carding principle or random laid web formation) using 100% recycled carbon fibres or blended with other fibres and subsequent mechanical bonding.
- Carbon fibre nonwovens show a property profile qualifying them especially for lightweight  applications.

Source: STFI

# RECYCLING OF SPECIAL WASTE – CARBON FIBRES



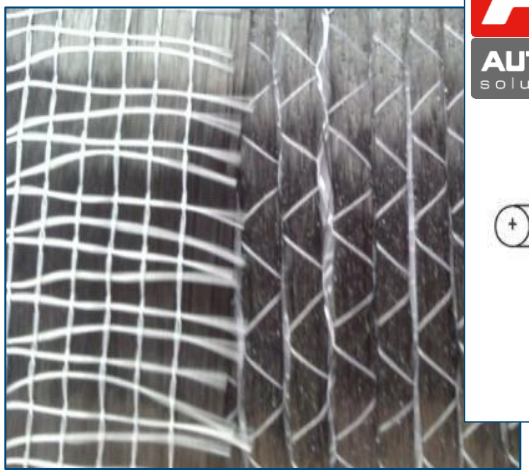

**Source:** Fraunhofer ICT

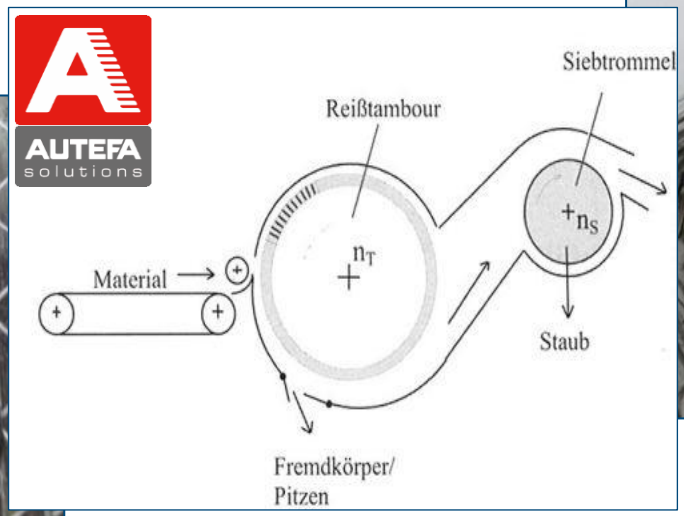
# RECYCLING OF SPECIAL WASTE - CARBON FIBRES


**Source:** STFI

## Pre-treatment step - tearing

- Receiving an average fibre length of about 85% of the precut, preferably 50 mm to 80 mm
- Technological developments for the transfer towards an industrial scale together with mechanical engineering companies
- Throughputs in the economically interesting range of 120 kg/h to 200 kg/h






Source: STFI

## Stages of nonwoven production

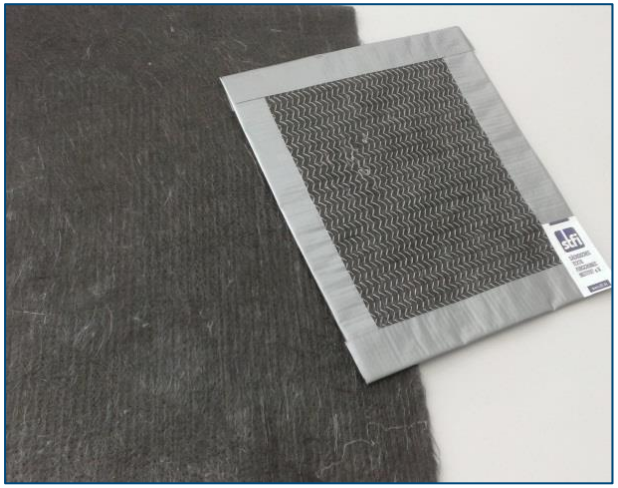
Fibre opening

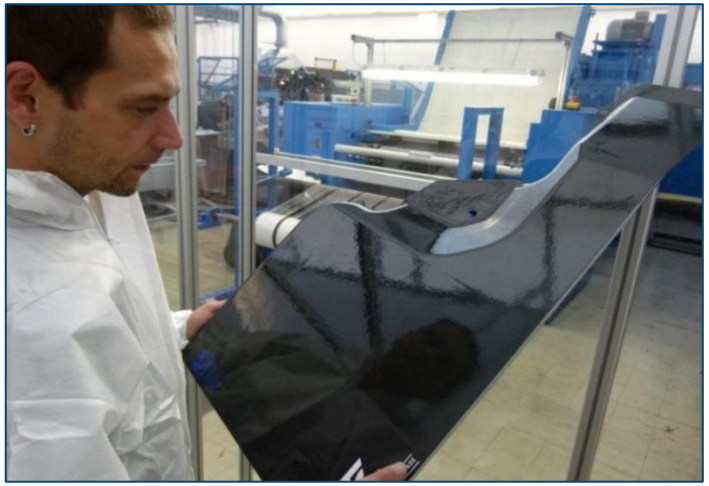
Web formation

Bonding

Source: STFI

# RECYCLING OF SPECIAL WASTE - CARBON FIBRES



Source: STFI

# TEXTILE WASTE FROM END-OF LIFE CLOTHING

**There are three options regarding the waste management for used textiles and worn clothing.**

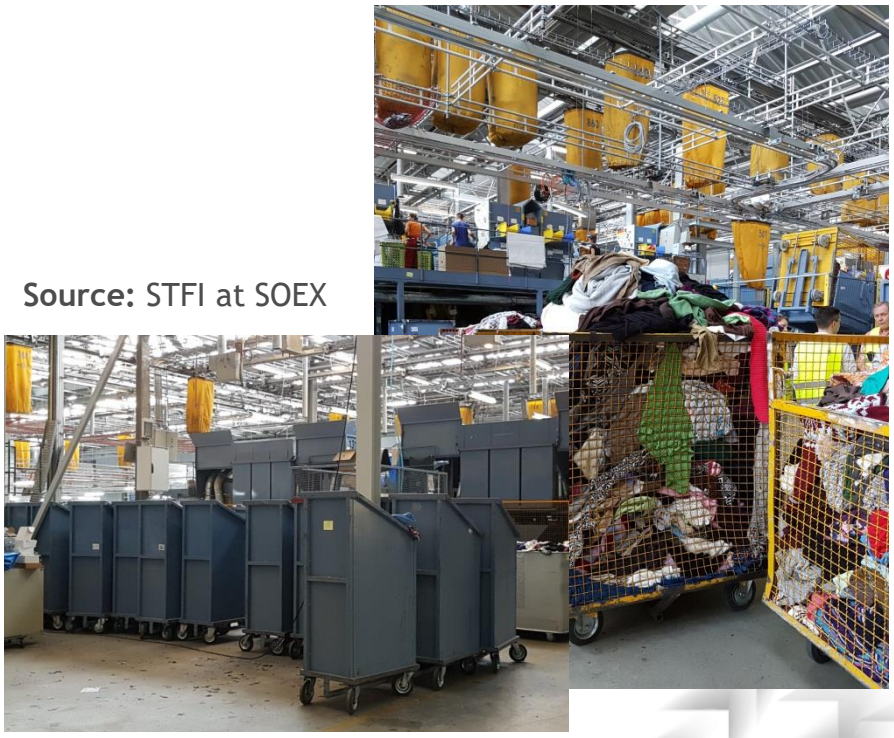
1. They become **part of the residential waste** and are collected in bins for residual waste. They are not sorted and mixed together with other residential waste. This makes it completely unusable for any further use. Finally, it is incinerated (energetical exploitation) or disposed in landfills.

2. Larger quantities are **collected and handled centralized in recycling centres** operated by municipalities/city administrations or county governments. This is free of charge for registered citizens, companies have to pay a certain fee. A part of the used textiles is sold afterwards to sorting companies for further processing. The remaining part finally goes the same way as residential waste and ends-up in incineration plants or landfills.

3. Further collection of used textiles and worn clothing is organised by **private companies or charity organizations such as Red Cross or Worker's Samaritan Organization**. The collection of clothing is done via publicly accessible containers placed at spots easily accessible to many people, for instance near to shopping malls or streets which are highly frequented. The collected garments, textiles (home and household textiles, beddings) and shoes are sorted afterwards by quality criteria and distributed via clothing store (without money) or second-hand shops by selling to finance charitable and social projects. Furthermore, they are transported to third world countries and the part which is unusable is disposed.

## Industrial sorting of used clothing at SOEX Recycling Germany GmbH, Bitterfeld-Wolfen (DE)
## High standard sorting plant, sorting out by 400 criteria

- Sighting of material input
- Pre-sorting by type of clothing
- Sorting out by quality and material
- Capacity: 300 tons per day



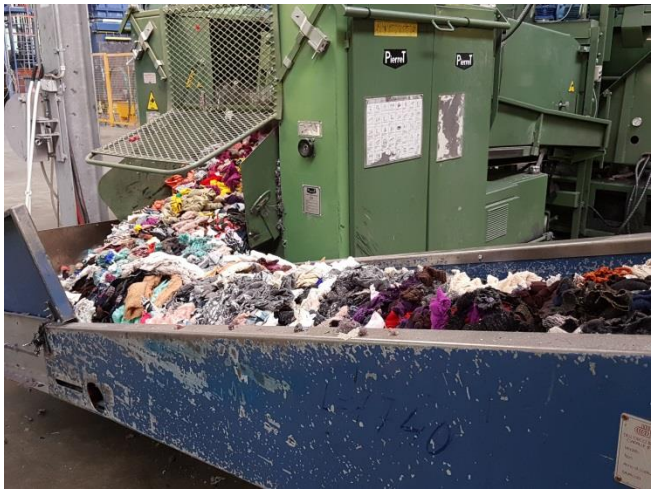
**Source:** STFI at SOEX

### Flow of material:

15 % tearing into reclaimed fibres
70 % secondary use (rags, clothes)
15 % refuse

**www.soex.de**

# SOEX Recycling Germany GmbH, Bitterfeld-Wolfen (DE) High-scale production of reclaimed fibres from used clothing



Source: STFI at SOEX

- Tearing line with 1.90 m working width, seven cylinders
- Automatic separation of non-textile parts
- Machine manufacturer: Dell'Orco & Villani/Italy
- Throughput : 1500 to 2000 kg/hour,  24 hours per day,  46 tons per day

# CONCLUSIONS – TRENDS IN TEXTILE RECYCLING

- **Structural changes** of the international, national and regional T&C sectors from the **classical production towards the production of technical textiles** are ongoing.
- Following this, the **textile waste is changing** concerning the kinds of **raw materials** (such as high performance fibres), the **composition** of textile fabrics, the **surface quality** (functional coatings), use of **electronic parts** in smart textiles, etc.
- **Technological solutions** to treat conventional textile waste are sufficiently available and **state-of-the art.**
- **New methods/approaches** to treat novel materials are required.
- New materials lead to a great variety of types of waste with small amounts of waste. Important is to **channel the waste streams** and **build up networks** for waste management at interregional level (for instance via a database).

# CONTACT INFO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https://www.interreg-central.eu/Content.Node/3.html

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# ENTeR – WP T3 Approach & Validation / Task A.T3.1

## High Level Training Course - Training Path 4: Projects and networks (national and European) related to textile recycling

ENTER Project Partners PIOT & IW

# CONTENT OF TRAINING PATH 4

TRENDS AND RESEARCH TECHNOLOGIES

LIST OF EUROPEAN PROJECTS WITH RELATION TO TEXTILE WASTE AND WASTE MANAGEMENT

# FOREWORD

## Interreg Central Europe Programme

(https://www.interreg-central.eu/Content.Node/home.html)

This course has been developed within the ENTeR project (CE 1136) thanks to the funding received from the European Union under the Interreg Central Europe Programme (2nd call 2016).

The training course reflects only the authors' view and neither the European Commission nor the Interreg Central Europe Managing Authority are responsible for any use that may be made of the information it contains.

Limiting waste generation and treatment (circular economy) is a priority for Europe.

This is a serious challenge for the clothing and textile sector, and hence the Enter project focuses its efforts on finding possible, catching up solutions for the sector in order to adapt sectoral activities to the requirements of the European Waste Directive - 2008/98/EC.

Textile waste is considered to be special waste, allocation to this category significantly affects the costs of enterprises that must comply with European and national waste management regulations and incur high environmental charges as a result.

# TRENDS AND RESEARCH TECHNOLOGIES

Product and process innovations are developing at an extremely dynamic pace to ensure their low environmental impact, they require integration and optimization of production in relation to the product life cycle.

Therefore, innovations conditioned by sustainability criteria constitute the perspective of the competitiveness of European industry.

# TRENDS AND RESEARCH TECHNOLOGIES

Technological solutions for processing conventional textile waste are available in most EU countries, Poland and Hungary point to the lack of technological solutions as well as the lack of access to recycling companies.

New waste treatment technologies are constantly sought after in relation to the creation of innovative materials and composite products of the sector.

New materials lead to a large variety of types of waste with a small amount at the same time.

The challenge is to direct waste streams and create a waste management network at interregional level.

# TRENDS AND RESEARCH TECHNOLOGIES

The following are identified as future trends and developing fields to reduce the environmental harmfulness of textile waste and maximize its reuse:

- increasing recycling through state-of-the-art processes,
- closing material cycles,
- conversion to environmentally friendly production techniques and use of recyclable materials,
- design in accordance with recycling requirements (ecodesign),
- promotion of textile composites,
- IT waste reduction.

# TRENDS AND RESEARCH TECHNOLOGIES

In connection with the constant progress and development of the European T&C sector towards 4. industrial revolution, but also in relation to social factors such as the increase in the world's population,longer life expectancy, a growing percentage of free time due to innovative technologies development and greater emphasis on health care and prevention, the following studies priorities have been set for the coming years 23.

# TRENDS AND RESEARCH TECHNOLOGIES

**The four innovation topics:**

- smart, high-performance materials;
- advanced digitised manufacturing, value chains and business models;
- circular economy and resource efficiency;
- high added value solutions for attractive growth markets.

**The identfied topics should focus on:**

high-performance materials, intelligent and multi-functional textiles, digitization, virtual modeling, new business models, recycling of advanced technologies and the circular economy concepts, sustainable production and product development, intelligent and functional wearable products health, sport and personal production, light applications and energy-efficient buildings.

# List of European Projects with relation to textile waste and waste management approaches

- **Trash2Cash**

  Designed high - value products from zero-value waste textiles and fibers via design driven technologies

  Duration: 01.06.2015 – 30.11.2018

  Funding programme: HORIZON2020, research and innovation EU programme

- **RESYNTEX**

  A new circular economy concept: from textile waste towards chemical and textile industries feedstock

  Duration: 01.06.2015 – 30.11.2018

  Funding programme: HORIZON2020, research and innovation EU programme

# List of European Projects with relation to textile waste and waste management approaches

- **SPORT INFINITY**

  Waste-Based Rapid Adhesive-free Production of Sports goods

  Duration: 01.06.2015 – 31.05.2018

  Funding programme: HORIZON2020, research and innovation EU programme

- **ECWRTI**

  EColoRO: Reuse of Waste Water from the Textile Industry

  Duration: 01.06.2015 – 30.11.2018

  Funding programme: HORIZON2020, research and innovation EU programme

# List of European Projects with relation to textile waste and waste management approaches

- **UPCYCLINGTHEOCEANS**

  Boosting the potential of small businesses for eco-innovation and a sustainable supply of raw materials. High quality clothes made from marine plastic litter

  Duration: 01.06.2015 – 30.11.2015

  Funding programme: HORIZON2020, research and innovation EU programme

- **INSUWASTE**

  Boosting the potential of small businesses for eco-innovation and a sustainable supply of raw materials. Recycling of hard-to-treat, post-consumer textile wastes and conversion to insulation material for construction industry using a novel conversion technology.

  Duration: 01.11.2014 – 30.04.2015

  Funding programme: HORIZON2020, research and innovation EU programme

# List of European Projects with relation to textile waste and waste management approaches

- **URBANREC**

  New approaches for the valorisation of URBAN bulky waste into high added value RECycled products

  Duration: 01.06.2018 – 30.11.2019

  Funding programme: HORIZON 2020, research and innovation EU programme

- **IDENTITEX**

  Innovative technologies for the economically sound identification and sorting of post-consumer textile

  Duration: 01.02.1999 – 30.04.2001

  Funding programme:

# List of European Projects with relation to textile waste and waste management approaches

- **RECAM**

  Sustainable Closed Loop System for Recycling of Carpet Materials

  Duration: 01.12.1995 – 31.05.1999

- **EcoSign**

  Eco – Innovating skills development to reduce enviromental impact of goods during their life - cycle

  Duration: 01.11.2015 – 31.10.2017

  Funding programme: co-funded by the Erasmus+ Programme of the EU

# List of European Projects with relation to textile waste and waste management approaches

- **CRESIM**

  Carbon Fiber Recycling Through Special Impregnation

  Duration: 01.12.2012 – 31.01.2016

  Funding programme: supported by LIFE funding

- **ECAP**

  Life Programme, European Clothing Action Plan – reduce clothing waste, embed a circular economy

  Duration: 01.09.2015 – 31.03.2019

  Funding programme: supported by LIFE funding

# List of European Projects with relation to textile waste and waste management approaches

- **INSUL-ECO**

  Eco-innovative insulating thermal and acoustic panels made with recycled textile fibres

  Duration: 28.08.2014 – 27.08.2017

  Funding programme: Eco-innovation Initiative of the European Union

- **RESET**

  RESearch centers of Excellence in the Textile sector

  Duration: 01.04.2016 – 31.03.2021

  Funding programme: Interreg Europe

**European projects data base:**

https://cordis.europa.eu/projects/en

**EUREKA projects data base:**

https://www.eurekanetwork.org/eureka-projects

**Polish data bases of projects:**

https://polon.nauka.gov.pl/opi/aa/pn?execution=e2s1

http://www.funduszeeuropejskie.gov.pl/

# CONTACT INFO

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ENTER – WP T3 Approach & Validation / Task A.T3.1

**High Level Training Modules - Training Path 5: Technical and economic findings from the pilot cases and professional profiles**

ENTeR Project Partners INOTEX and ČTPT (CZ)

# CONTENT OF TRAINING PATH 5

Pilot cases - overview

Professional Profiles

Pilot case by STFI

Pilot case No.1 by INOTEX

Pilot case No.2 by INOTEX

Pilot case by CENTROCOT, UNIVA

Pilot case by IW

Pilot case by INNOVATEX

Pilot case by PBN

# FOREWORD

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# ENTER PILOT CASES

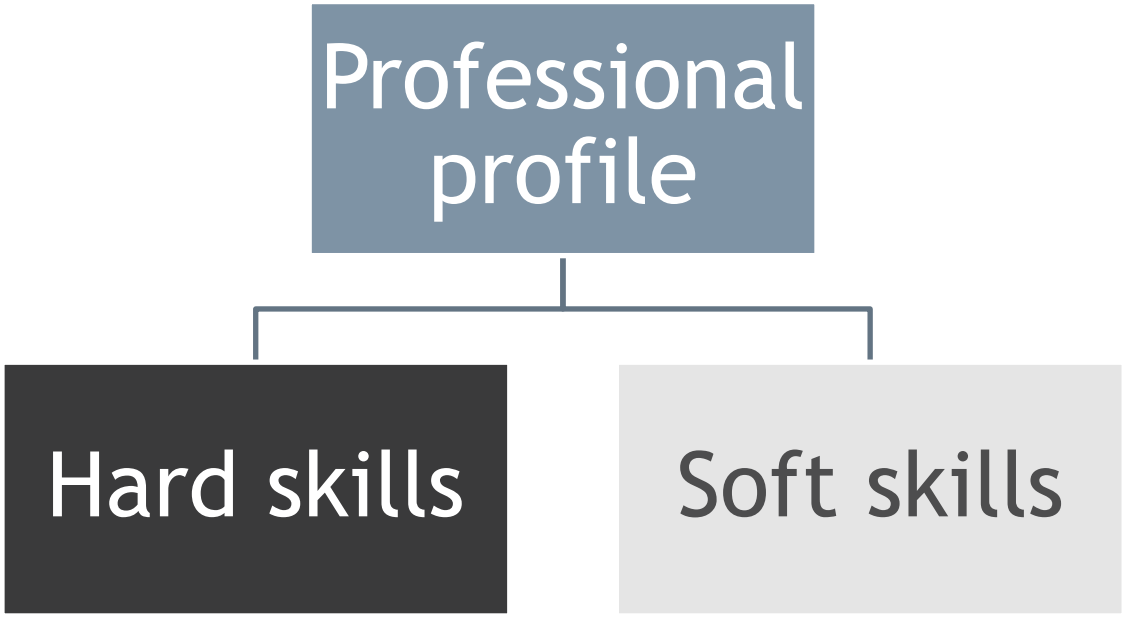
- Within the ENTeR project, 7 pilot cases from 5 countries were identified

- Aim:
  - to demonstrate realistic needs and problems of companies in the field of textile waste management
  - in-depth study of the pilot waste streams
  - to identify best practices and technologies, share this know-how among partners
  - to promote consortium to enhance recycling

# ENTER PILOT CASES

| No. | Title of the Pilot Case | Partner |
|---|---|---|
| 1 | From residues to raw material – New recycling approach to handle textile waste from a finishg company | STFI (Saxony) |
| 2 | Generation of waste from manufacturing of technical textiles | INOTEX (Czech Republic) |
| 3 | Reduction of the waste generation through prolongation of the service life of textile products | INOTEX (Czech Republic) |
| 4 | Recollection, recycling and waste management of stock post-industrial and used post-consumer workwear finished garment | Centrocot, UNIVA (Lombardy) |
| 5 | System of segregation and preparation of postproduction waste | IW (Poland) |
| 6 | *"Wool Waste"* raw material development | INNOVATEXT (Hungary) |
| 7 | Development of the waste management related in-house logistic system | PBN (Hungary) |

# PROFESSIONAL PROFILES




## Hard skills – based on requests from Strategic Agenda

- Research Trends and Technologies
- Legal and Policies
- Waste management
- Communication

# PROFESSIONAL PROFILES

## Hard skills

| | |
|---|---|
| Legal and Policies | • Knowledge about actual legislation (kinds of waste, rules for waste management, EU and national directives…)<br>• overview of upcoming legislation |
| Waste management & Research Trends and Technologies | • Technical knowledges about textile (materials, treatments, technologies, innovation trends, composition of the textile waste …)<br>• Chemical knowledges (chemical substances in textile waste, LCA – Life Cycle Assessment, …)<br>• Technical knowledges about recycling technologies<br>• Information about recycling companies<br>• Logistic skills<br>• Economical skills |
| Communication | • Marketing strategies |

# PROFESSIONAL PROFILES

## Soft skills

- communicativeness
- English/ other foreign language
- „business negotiation“ skills
- unconventionality
- analytical thinking

# PILOT CASE BY STFI

## 1. From residues to raw material – New recycling approach to handle textile waste from a finishing company

### *The company needs to be solved*

| | |
|---|---|
| **Technological needs** | Shredding/cutting of waste directly at the point of origin (online processing)<br>Technical development of such a shredding unit<br>Find solutions where such chopped pieces can be used<br>Finding solutions for the use of shearing dust (airlaid method, papermaking) |
| **Economical needs** | Economically reasonable solutions for waste disposal<br>Disposal of unmixed (pure) waste free of charge |
| **Logistical needs** | Regular disposal/take away of waste by external providers to save storage capacities<br>Easy and non-bureaucratic handling of waste |
| **Environmental needs** | Reduction of waste amounts to be disposed |

# PILOT CASE BY STFI

1. From residues to raw material – New recycling approach to handle textile waste from a finishing company

   *Waste streams:*

   - Yarn residues (20 kg/month)
   - Selvedges (1t/month)
   - End pieces/leftover pieces
   - Mixed textile waste from products coming from customers for finishing (500-600 kg/month)
   - Dust with pieces of thread (200 kg/month)
   - Residues from chemical finishing
   - Material: polyester, polyamide, viscose, silk, linen
   - Material is pure or in blends

# PILOT CASE BY STFI

## 1. From residues to raw material – New recycling approach to handle textile waste from a finishing company






(Photos: STFI)

# PILOT CASE BY STFI

## 1. From residues to raw material – New recycling approach to handle textile waste from a finishing company

*Main activities done:*

- Meeting with company Pfand at STFI and interview on the current situation on waste generation (types of waste, waste streams/waste amounts, waste management)
- On-site visit at company Pfand and collection of waste material for testing and recycling trials
- Establishing a consortium with project partner INOTEX for exchange of experience in waste processing
- Visit of INOTEX together with Pfand and discussion of recycling possibilities for the waste material
- Trials with waste material at Czech companies as well as at STFI

# PILOT CASE BY STFI

## 1. From residues to raw material – New recycling approach to handle textile waste from a finishing company

*Results and conclusions achieved:*

*a) Referring to waste*

- Low amounts of waste available, but a great variety of waste types, therefore a regular waste generation is mostly not given
- Different waste types are collected jointly → no separation
- Non-textile waste (paperboard, bobbins) is also a problem

*b) Referring to waste processing*

- Most of the waste cannot be processed by available mechanical methods such as tearing, since the material is coated or the material structure is not suitable for such treatments.
- Pure (made of only one fibre type) and untreated waste is easier to handle and can be cut or teared.

# PILOT CASE BY STFI

## 1. From residues to raw material – New recycling approach to handle textile waste from a finishing company

*Results and conclusions achieved – technical approaches/solutions:*

- A processing technology which might be suitable for the textile materials which cannot be processed by tearing, is milling (textile mill – shredder technology), where the textile fibres are milled and broken into small particles. The resulting material can be used in building (insulation material) and automotive industry (mat for car interior).
- Pure PES scraps (selvedges from knitwear; white, nearly untreated and smooth structure) are shredded into smaller pieces and can be used as underground material for horse arenas.
- A regional network project (RE4TEX) nationally funded has been established to find further solutions for waste management. Company Pfand is one of the industrial network partners.

# PILOT CASE *NO.1* BY INOTEX

## 2. „Generation of waste from manufacturing of technical textiles“

*Coated textiles – CZ market significance:*

- **Steady rising market: technical. textiles, barrier textiles, (multi)functional membranes, carpets, terpaulins, large volume products**
- **Extensional use od waterbased systems (AC,PU,EVA, PVC .., new biobased polymers launched)**

# PILOT CASE *NO.1* BY INOTEX

## 2. „Generation of waste from manufacturing of technical textiles“

*The company needs to be solved:*

- To find solution for use of produced waste: coated fabrics with thermoplastic, water based polymers, paper etc.
- an efficient processing supporting their valorization within CE

*Waste streams:*

- Pieces / selvedges of fabrics, threads, yarns (PES, PA, cotton, viscose, blends)
- Dyed, laminated, coated, backed with paper, …




# PILOT CASE *NO.1* BY INOTEX

## 2. „Generation of waste from manufacturing of technical textiles“

*Results achieved:*

- *First survey*: coated fabrice almost non-acceptable for conventional textile waste processing devices (mechanical - tearing)
- *Contradiction*: high resistivity - adhesion of coated layers in long term use x efficient separation of coating film from various textile carriers
- *Optimum*: waste less utilization of both - coating and textile part (first R&D activities recognised)

# PILOT CASE *NO.1* BY INOTEX

## 2. „Generation of waste from manufacturing of technical textiles“

*Results achieved:*

- Potential use for cutoffs of coated fabrics as raw material for design products – *testing still ongoing*
- No solution for small cuttings or strips

# PILOT CASE *NO.1* BY INOTEX

## 2. „Generation of waste from manufacturing of technical textiles“

*Conclusions:*

- **To proces this waste by conventional mechanical technologies to get textile fibres not possible: not suitable for procesing by mechanical recycling technologies (tearing)**
- **The only processing technology which might be suitable for small strips is millling (shredder technology):** chopping and grinding, cutting, shredding of textile scraps, the resulting material could be used for manufacturing of insulations, fillings, in automotive industry, horse arenas etc.; **but in practice, the coating on the fibres may be an obstacle for use**

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Hospital textiles -raw material sustainability*:

- large volume textiles with daily harsh use and intensive laundry maintenance (95*C, chemo-thermo disinfection)
- well localised, with almost known material and processing (dyes, textile auxiliary agents)

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Hospital textiles - raw material sustainability*:

1.1 Dematerialization

1.1.1 New more durable constructions can be used

- blends PES/Co (50/50) witrh min 2,5x longer service life against 100%Co (prooved in real clinical and industrial laundry condititons)

1.1.2 Reactivation of functional finishing (AMB,FR...)

- new processes and auxuliary systems for industrial laundry services in development

Remark: Introduction of blends (Co/PES) vs. Recycling - number of methods for regeneration of both fibre parts in development

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Hospital textiles - raw material sustainability*:

1.2 Towards CE

- recycling of used health service textiles

1.2.1 Separation and recovery od fibre conponents

- production of regenerated fibres ( Co, PES...)

1.2.2 Non-textile use

Remark: **Recycling of (bio)contaminated textiles - hazardous waste don't exist. Laundry after last use is obligatory.**

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*The needs to be solved:*

- Study of the influence of a prolongation of the textile products service life thanks to changed material composition on reduction of textile waste and of the raw materials consumption

*Waste streams:*

- End-of-life medical rental laundry

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Results achieved*

- Questionnaire survey to get data for a study (11 laundries with leasing service of textiles for medical sector / 5 responded)

Based on this data:

- Study focusing on
  - material composition used in leasing medical textiles
  - lifespan of medical textiles depending on material composition
  - methods and parameters of decommissioning

# PILOT CASE *NO.2* BY INOTEX

## 3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Results achieved*

- **Parameters for decommissioning:**
  - ways of decommissioning textiles **often part of the contract**
  - decommissioning takes place **in the laundry**
  - parameters: **visible damage, stains, shade change, basis weight reduction**
  - **laundry repairs - 4 respondents** (3 – by own staff, 1 – external)
- All 5 respondents discard **67 762 pieces** of textile/year **(~35 t/year)**
- **Disposal: a) use for own needs (rags - cleaning, maintenance)**
  **b) selling to recycling company**
  **c) landfill (1respondent)**

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Results achieved*

- **Material composition of leasing medical laundry:**
  - only **25% of laundry - 100% cotton**
  - **bedlinen** - usually **80% cotton / 20% PES**
  - **staff´s apparel** - usually **35% cotton / 65% PES**
  - **patient apparel** - usually **50% cotton / 50% PES**

- **On a contrary - hospitals operation own laundries (not leasing) and hotel sector** prevailing use of **100% cotton laundry**

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Results achieved*

- Maintenance technology
  - almost the same for 100% cotton as well as for blended materials
    - reasons – processing of large batches of laundry
      - transition from thermal disinfection to chemo-thermo disinfection at a lower bath temperature
  - steps: washing (continuous tunnel washing machine, 60°C)
    chemothermo disinfection
    pre-drying
    ironing, finishing

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Results achieved*

- Monitoring of leasing laundry
  - HF or UHF chips
  - 3 respondends – use chips on almost the entire range
  - must be removed from the textile before disposal

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Results achieved*

- Service life of leasing medical laundry:
  - 100% cotton ……..  75 washing cycles (max. 103)
    blends ……  106 washing cycles (max. 147)

Use of blended material can extend the service life by almost 30%

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Conclusions*

- laundries renting textile for medical facilities
  - **use blended materials in their practice**
  - **blended textiles** with a chemical fibre content have **a life cycle up to 1/3 longer than 100 % cotton products** = reduction of textile waste production
  - **discarded laundry – further use = circular aproach already applied**

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Conclusions*

- Hospitals operating own laundries
  - 100% cotton linen prevailing
  - purchase of laundry – main parameter is mosty favourable price
  - quality – is not the main parameter

*Our study provides strong arguments for the purchase of blended textiles in hospitals.*

*Education of the staff of the hospital laundry purchase department is necessary.*

*Service life (number of wasing cycles) as a main parameter in public procurements (x now - the lowest price)*

# PILOT CASE *NO.2* BY INOTEX

3. „Reduction of the waste generation through prolongation of the service life of textile products“

*Conclusions*

- Hotels and other accomodation facilities
  - **usually 100% cotton linen (bed linen, terry textiles)**
  - generally have high demands on the look and handle of used textile; but …

*… use of blended materials with a predominant share of natural fibres could extend the service life of the material without noticing by consumers*

# PILOT CASE CENTROCOT, UNIVA

## 4. „Recollection, recycling and waste management of stock post-industrial and used post-consumer workwear finished garment“

### *Brief summary of the pilot case aims:*

Grassi producers of work and protective garments and uniforms. The problem of waste management addressed by the company deals with the management of old (and expired) garments stocked in their storehouse, and with the used garment recollected from their customers after use. From the technical point of view, the company needs to find a method to recycle the disposed garment (disassembling method, recycling techniques for some components with special finishing or associated composites). The proposed solution need to be verified from the economical and logistical point of view. Special consideration has to be taken into account in case of garments intended for military applications.

# PILOT CASE CENTROCOT, UNIVA

## 4. „Recollection, recycling and waste management of stock ~~post-industrial~~ and used post-consumer workwear finished garment“

*Activities done:*

| Action lines | Support from the Italian team (Centrocot, UNIVA) |
|---|---|
| 1 | Law interpretation<br>Support on document preparation and approval by competent public authority |
| 2 | Support on defining logistics, for instance collection boxes |
| 3 | Recognition of any dangerous substances present on the garment used<br>Support on finding recyclers or technologies to recycle |
| 4 | Life Cycle Analysis, Life Cycle Cost Analysis, Social-LCA, PEF - Product Environmental Footprint |
| 5 | Support on finding materials and technologies to facilitate disassembling |

# PILOT CASE CENTROCOT, UNIVA

## 4. „Recollection, recycling and waste management of stock post-industrial and ~~used post-consumer~~ workwear finished garment“

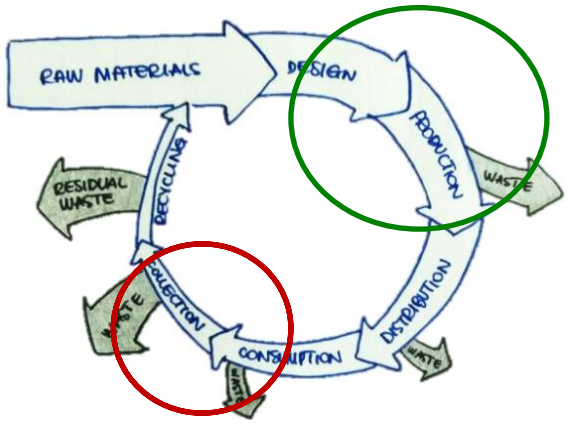
*Activities done:*

| Action lines | Support from the Italian team (Centrocot, UNIVA) |
|---|---|
| 1 | |
| 2 | |
| 3 | Support on finding new users |
| 4 | Life Cycle Analysis, Life Cycle Cost Analysis, Social-LCA, PEF - Product Environmental Footprint |
| 5 | Support on finding materials and technologies to be easily removed |

# PILOT CASE CENTROCOT, UNIVA

4. „Recollection, recycling and waste management of stock post-industrial and used post-consumer workwear finished garment“

*Current state, achieved results:*




We worked on two points in the Circular Economy

GREEN Circle: identified 2 types of waste:

- cuttings in aramid fibers→ Yarn
- piece of cloth → company that creates limited edition clothing and accessories.

RED Circle: selected garments for 2 types of use (recycling and reuse)

Recycling: company creates a clothing line starting from the finished garment (workwear).

Reuse: created a partnership to distribute clothing to needy populations.

# PILOT CASE BY ŁUKASIEWICZ RESEARCH - NETWORK - TEXTILE RESEARCH INSTITUTE

## 5. „ System of segregation and preparation of postproduction waste“

*The company needs to be solved:*

Economic: disposal costs reduction

Logistic: the amount of the storage waste reduction

through

Technological: solution for recycling and re-use, including waste analysis, segregation, labelling, pre-treatment for recycling, staff training

*Waste streams:*

- **carpet selvedges with yute yarns,**
- **polypropylene selvedges of woven grass,**
- **quilted textile waste, based mainly on polyester**




# PILOT CASE BY ŁUKASIEWICZ RESEARCH - NETWORK - TEXTILE RESEARCH INSTITUTE

## 5. „ System of segregation and preparation of postproduction waste“





*Results and conclusions achieved:*

- Characterization of textile waste
- Catalogue of waste
- Identification of Polish textile companies with similar waste streams
- First ideas of managing and processing of post-production textile waste
- Identification of the potential application areas
- Identification of market available technologies for waste pre-treatment in Poland and textile waste recycling technologies tested in Polish companies
- Feasibility study

# PILOT CASE BY ŁUKASIEWICZ RESEARCH - NETWORK - TEXTILE RESEARCH INSTITUTE

5. „ System of segregation and preparation of postproduction waste“

Needled nonwovens from collected post-production textile waste


**Nonwoven manufactured from 100% defibrated jute selvedges**

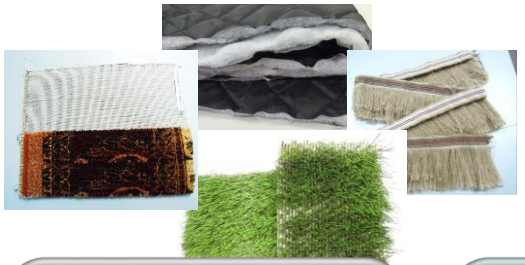


**Nonwoven manufactured from:**
- 50% defibrated jute selvedges
- 50% polypropylene selvedges

**Nonwoven manufactured from:**
- 33% defibrated jute selvedges
- 33% polypropylene selvedges
- 34% shredded polyester from quilted textile waste

# PILOT CASE BY ŁUKASIEWICZ RESEARCH - NETWORK - TEXTILE RESEARCH INSTITUTE

## 5. „ System of segregation and preparation of postproduction waste“



OTHERT POST-PRODUCTION TEXTILE WASTE

POST-PRODUCTION TEXTILE WASTE → CUTTING → DEFIBERING → NEEDLED NONWOVENS → KEMAFIL ROPES

separated waste streams

TEXTILE COMPANIES EXPERTS RECYCLING COMPANIES

# PILOT CASE BY INNOVATEXT

## 6. „“*Wool Waste*” raw material development“

***The company needs to be solved (1):***

Solution for recycling and use of wool felt waste

- Economic - Solution should be economically profitable – from the wool felt waste, product with high added value
- Mapping greatly marketable products with high added value
- Logistic - actually the majority of waste is only stored in bags and in own storage room. It means minimum/no cost for waste collection and disposal, however there are capacity constraints (storage room) and no revenue.
- Environmental - Minimalisation of communal waste - previous practice used to be the transportation to landfills. Actually the company of pilot case plans to do it only in the case of the unusable, dirty, long-standing waste
- Technical needs – need for proper tool/equipment to prepare the felt waste for reuse

# PILOT CASE BY INNOVATEXT

## 6. „“*Wool Waste*” raw material development“

*The company needs to be solved (2):*

Technical needs – need for proper tool/equipment to prepare the felt waste for reuse

Labour force – the actual staff is reuse a limited quantity of felt waste for decoration purposes

Economics of scale - Lack of enough felt waste in factory to produce the felt waste product in big quantity

# PILOT CASE BY INNOVATEXT

## 6. „“*Wool Waste*” raw material development“

*Waste streams:*

- waste generated from cutting the edges, small cuttings of felt
- 2 types of waste: felt for industrial and felt for decorative purposes
- Waste has good quality: 100% wool felt and felt blends wool (80%) with viscose
- In case of painted felt waste paintings meet the STANDARD 100 by OEKO-TEX requirements
- 1,3-1,5 tons felt waste/year

## 6. „“*Wool Waste*” raw material development“

### *Results and conclusions achieved (1):*

*a) Low recycling and/or reusing capacity – lack of proper equipment and labour force.*

Actually, the majority of the waste is not reused or recycled within the factory, taking part in the pilot project. It is simply stored.Only a small part of the decoration felt waste is reused for decoration purposes.

*b) Highly valuable but reduced quantity of waste at disposal*.

The waste (100% or 80% wool felt) is highly valuable raw material but is available in reduced quantity and small cuttings.

## 6. „“*Wool Waste*” raw material development“

### *Results and conclusions achieved (2):*

c) In case of finding the right way and technology the owner of pilot project company is willing to increase the actual producing capacity of the factory (it considers investing in equipment) and even *to buy more waste* and/or use the regular (new) raw material for these purposes.

d) Actually, the *unit price* of the *reuse* (some miscellaneous products for decoration) or simply the handling (storing in bags) of the available felt waste *is insignificant*.

e) The positive attitude of the new owner to circular economy generated the *search for high value added solutions* to deal with waste, in a win-win basis. It is an environmentally friendly and at the same time profitable solution, which results a high-value, innovative and easily marketable product.

# PILOT CASE PBN

## 7. „Development of the waste management related in-house logistic system“

*Brief summary of the pilot case aims:*

**Problems, where the company is looking for solutions:**

- solution for recycling and use
- logistic (minimalization of the storage cubage, support the handling and moving the waste inside/outside company)
- reduction of company’s communal waste quantity

## 7. „Development of the waste management related in-house logistic system“

*Activities done :*

- PBN contracted with an expert for a study to help the in-house logistic system for the chosen company (BioTextima Kft.)
- Arranged about the study, which needs to be delivered December 2019
- 2 studies will be done
- Study 1 will be about the current state of the in-house logistic system in the Biotextima company, with 4 offered options to develop (0,A,B,C) their company
- PBN, the external expert and the CEO of the Biotextima Kft. had meetings and found the best possible option for the development
- Development started, the company invested and purchased the needed systems

## 7. „Development of the waste management related in-house logistic system“

### *Activities done :*

PBNs contents of studies:

1.

Introduction

1. Executive Summary

2.Introduction of Bio-Textima Kft.

2.1.Former developments at Bio-Textima Kft.

2.2. Placing the development in the Bio-Textima Kft.'s strategy

3. The background of the investment

3.1.Waste management in the textile industry

3.2. Law and policy background

4. Specifying investment objectives

4.1.Waste management at Bio-Textima Kft.

4.2. Objectives of development, expected results and outcomes

5. Solution alternatives

1.1. The methodology for choosing the best possible alternative

1.2. Identification of viable alternatives

1.3. „0" Solution – continuing without development

1.4. „A" Solution alternative

1.5. „B" Solution alternative

1.6. „C" Solution alternative

1.7. Choosing the best possible solution

6. Development of an implementation proposal

1.8. Presentation of technical content

1.9. Operational proposal

1.10. Action plan

7.Financial plan

1.11. Estimation of investment costs

1.12. Operational costs

1.13. Summary of financial charges and incomes

1.14. Financial performance indicators for development

8. Waste balance

2. Valuation of the investment (under process)

# PILOT CASE PBN

## 7. „Development of the waste management related in-house logistic system“

*Current state, achieved results :*

- The expert identified the current situation and offered 4 options to Biotextima (1.study)
- The best and most cost-effective chosen
- Development started, the company invested and purchased the needed systems
- The expert and PBN will analyse how the company‘s waste management is developing (2. study)

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# ENTeR – WP T3 Approach & Validation / Task A.T3.1

## High Level Training Modules - Training Path 6: ECO DESIGN - Applications and Challenges for Fashion and Textile Industry

ENTER Project Partner INNOVATEXT (HU)

# CONTENT OF TRAINING PATH 1

Interreg CENTRAL EUROPE
European Union European Regional Development Fund
ENTeR

- Goin' green!
- Sustainability in the textiles and fashion industry
- Circular economy
- Eco-design
- Areas of action in eco-design
- Eco-attitude in making fashion
- Organizations, projects & collaborations
- Bibliography

# FOREWORD

## Interreg Central Europe Programme

(https://www.interreg-central.eu/Content.Node/home.html)

This course has been developed within the ENTeR project (CE 1136) thanks to the funding received from the European Union under the Interreg Central Europe Programme (2nd call 2016).

The training course reflects only the authors' view and neither the European Commission nor the Interreg Central Europe Managing Authority are responsible for any use that may be made of the information it contains.

# GOIN’ GREEN!

Photo by Nikola Jovanovic on Unsplash

Going green is an environmentally conscious approach to living and thinking by making responsible choices to reduce imprint left on the environment.

It is considered a gradual process of changing the lifestyle by reusing and recycling products whenever possible and making choices that will help preserve the earth’s non-renewable resources instead of destroying them.

# SUSTAINABILITY IN THE TEXTILES AND FASHION INDUSTRY

Sustainable fashion refers to the processes by which fashion products are designed and manufactured responsibly, considering the environmental and social impact of clothing. As a trend of sustainability in the textile and fashion industry, it aims to reduce the environmental footprint of the industry in the long term by supporting initiatives in the field of environmental protection and social responsibility. As a movement and process that promotes change at all levels of the industry, it is helping to transform the entire system of textile production and the fashion industry towards significant environmental integrity and social justice.

In this approach, the social, cultural, ecological, and financial aspects of the production of goods need to be addressed in a holistic approach, considering the context in which they are produced.

## Why sustainable?

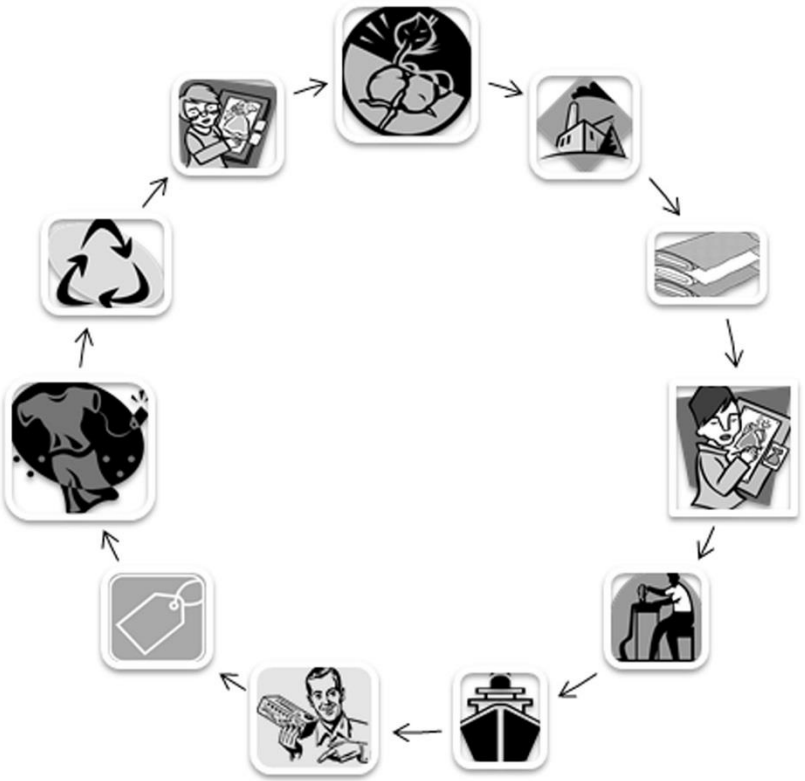
The textile industry is one of the oldest sectors in the world in the production of consumer goods. It is a diversified and heterogeneous sector that covers the entire production chain and converts natural and chemical fibers (such as cotton, wool, and oil) into end-user goods, including clothing, household textiles, and industrial textiles. In terms of trade intensity, textiles and clothing are the second-largest economic activity in the world.

One of the most prominent reasons for the unsustainable state of the fashion industry is the constant flow of new goods on the market. The term "fast fashion" refers to the supply of cheap, fast-access trendy clothing over the global production and distribution chains. Slow fashion is an alternative approach to fast fashion.

## Why sustainable?

Garment, like any product, has its key phases of the life cycle: design, production, distribution, use, and end-of-life-cycle stage. The sustainable approach can be integrated into all these phases.

All actors of the supply chain play important role in reducing the environmental footprint of textile products.



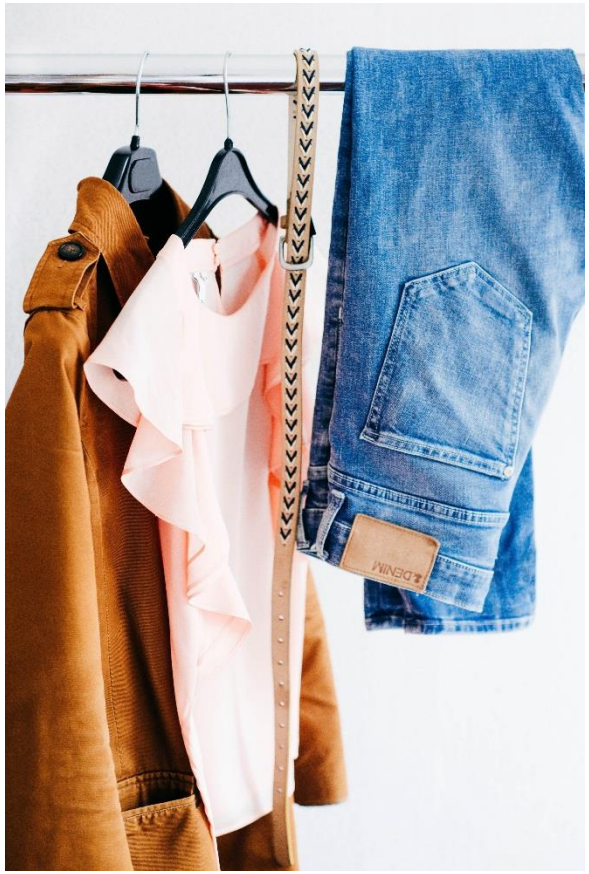
The flowchart of the supply chain and lifespan of the garments

## Why sustainable?

The textiles and fashion industry is among the leading industries that have an impact on the environment. Other products are also responsible for damaging the environment. Textiles are particularly significant because of their wide range of use. Considerable impacts might be generated during fiber production, dyeing, printing, and finishing. However, also considerable environmental impacts occur during the use phase since every individual consumes and disposes of many products daily.

Globalization has made possible the producing of clothing at increasingly lower prices, and with the spread of consumerism, many consumers consider this clothing to be disposable, which adds to pollution and generates potential environmental hazards.

## Why sustainable?



The sustainability movement dates back in the late 1990s. From 2013 the global movement is consistently spreading the idea by establishing public campaigns, professional events, fashion fairs and training. More and more people are agreeing that sustainability is the only way forward for the fashion industry. Consumers pay more attention to their purchasing. The pressure on manufacturers will increase as the effects of global warming become even more evident.

Photo by Alexandra Gorn on Unsplash

## Why sustainable?

The paradigm shift towards sustainable fashion brings new challenges.Taking an active stance on social issues, as well as meeting the criteria of transparency and sustainability, also become a confident expectation of the new generation consumers addresed to fashion brands. The responsibility of textile and fashion designers integrating the concept of sustainability into production processes is indisputably important.

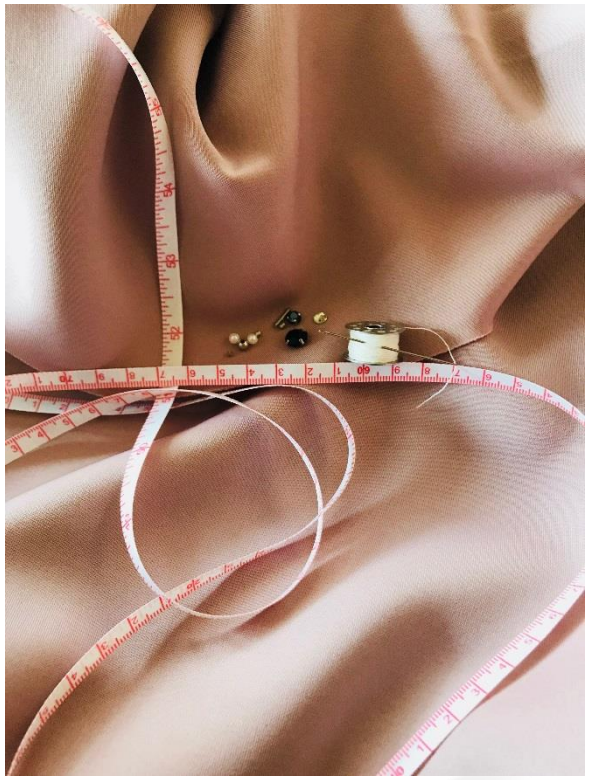


Photo by Pina Messina on Unsplash

# CIRCULAR ECONOMY

The circular economy is an economic system designed to eliminate waste and the continued use of resources, which aims to redefine growth, in contrast to the current take-make-waste extractive industrial model.

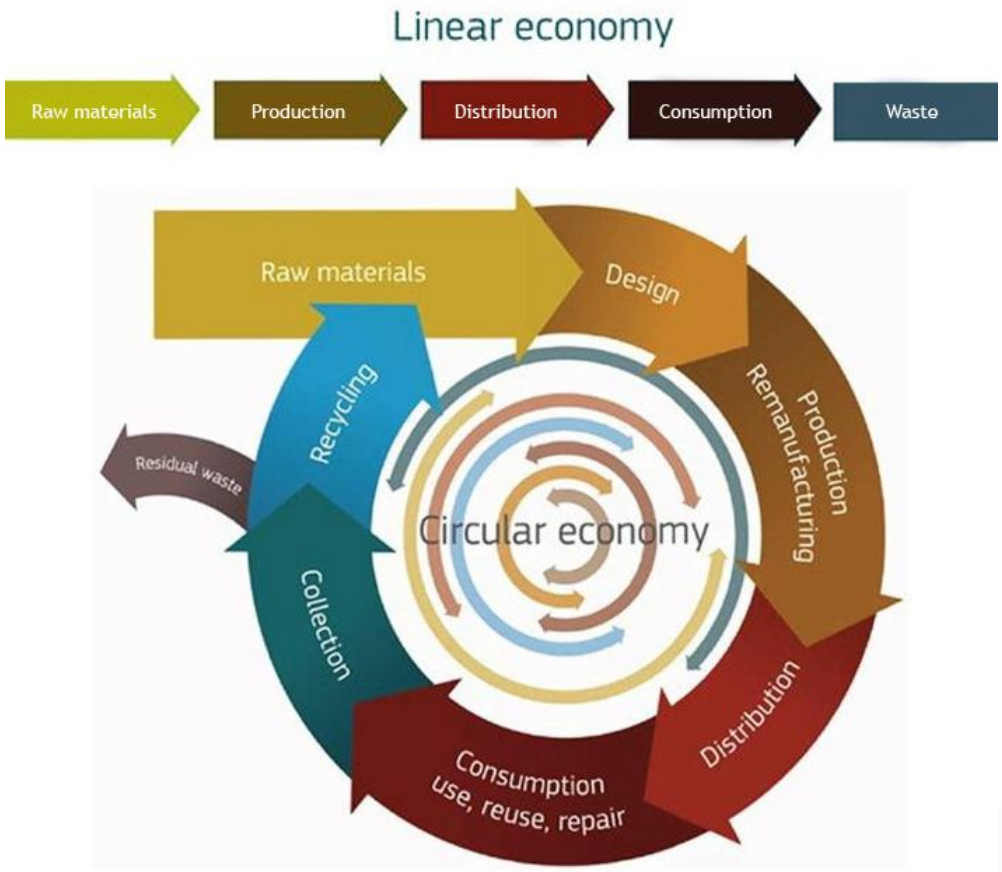
Its further aim is to keep products, equipment, and infrastructures in use for longer, thereby improving their productivity by focusing on positive social benefits. Relying on renewable energies, the circular model builds economic, natural, and social capital. Reducing the resources used helps to reduce environmental pollution. It bases on three key principles:

- Plan waste and pollution
- Keep products and materials in use
- Regeneration of natural systems

## From the linear to circular systems

The circular economy is a system more sustainable than the linear economic scheme. All 'waste' should become 'food' for another process. Features:

- System-oriented concept
- Durability and recyclability
- Continuous renewal and restoration
- Maintains human needs and considerations



## From the linear into circular systems

The textile industry is one of the industries that has adopted the circular economy principle. Within the textile and fashion industry, the circular economy means the constant recycling of clothes and fibers, in response to the current linear model where raw materials are extracted, manufactured, purchased, used and subsequently discarded by consumers. Following the circular economy model, the textile industry can be transformed into a sustainable business, returning textile waste to the economy as much as possible.

The textile industry has a long way to go to achieve a sustainable future. The circular economy can be the answer to the social and environmental issues created by the current linear, fast fashion model.

## Fashion business models inspired by the circular economy


The Ellen MacArthur Foundation is at the forefront of efforts to reap the benefits of the circular economy.

The Make Fashion Circular initiative, launched in May 2017, brings together leaders of the fashion industry, with aim to stimulate the level of cooperation and innovation needed to create a new textile economy, in line with the standards of the circular economy.

Jeans Redesign project, sponsored by the Make Fashion Circular initiative

# ECO-DESIGN


**A product can be called "green" if it has a low environmental impact during its life cycle and has a low or zero environmental impact at the end of its life.**

## What is ‘eco-design’?

Ecological design or popularly, eco-design is an integrative, environmentally sensible design discipline within the sustainability trend. It is an approach to designing products concerning the environmental impacts of the product during its full lifespan.

Eco-design is concerned *„any form of design that minimizes environmentally destructive impacts by integrating itself with living processes.”*

Areas of design are clothing and accessories, household appliances, furniture, and toys. Further, it is present in architecture design, light and energy design, and transportation.

## Why the ‘eco’?

The natural world has always inspired fashion designers over time. However, the fashion industry's relationship with nature has been overwhelming over the last few hundred years as it has discovered animals, birds, plants and natural resources. As the time has come to change our attitudes, practices and beliefs by transforming the perception of the world, it is not enough to refer to the inspiration of nature and to reject the use of wildlife and the treasures of nature for dressing. We desperately need to find less destructive, healthier and truly sustainable ways of communicating with the world while remaining "well-dressed" according to environmental and climatic conditions, keeping pace with civilization and reflecting our individuality.

# What is ‘eco-fashion’?

Photo by Volha Flaxeco on Unsplash

Eco-fashion is considered a form of eco-designing of clothing and accessories. Eco-fashion is an approach to making clothes considering the environment, the health of consumers and the working conditions of people who make them.

## Eco-conscious aspirations in fashion design

Eco-fashion products are made:

- using organic raw materials, grown without pesticides
- avoiding fabrics treated with harmful chemicals and bleaches
- often from recycled and reused textiles, or recycled fibers
- to last, so that people keep them for longer
- under the conditions of „fair trade”.

Photos by Ethan Bodnar, Mel Poole, and Lisa Woakes on Unsplash

# AREAS OF ACTION IN ECO-DESIGN

Improving the life quality by maximizing the potential of ecosystems in the long term by using relevant technologies is a fundamental objective of the sustainable development model, based on the principle of a circular economy.

The new paradigm requires us to look at things differently.

Textile and fashion industry uses large quantities of water and energy; the two of resources of major concern worldwide. Both the production and the consumption of fashion and textile products are a significant source of pollution.

Eco-design has more solutions to their solving.

## Application of the ‘Cradle to Cradle’ concept

Cradle to Cradle (C2C) design is a sustainable, biomimetic method for designing products and systems that model industry through the processes of nature and consider raw materials as nutrients that circulate in the industry's metabolism. In contrast to the cradle-to-grave concept, where these "grave" in the same generation where they were born, the C2C models the processes to go from one generation's "cradle" to the next, from birth to death.

The model is applied in industrial design, manufacturing, urban environment, social system, and many more.

## Application of the ‘Cradle to Cradle’ to fashion

The creation of closed-loop-collections, where the clothes consist of recycled fibers, is an application of the Cradle to Cradle, providing the increase of sustainability in the supply chain of the fashion industry. The application of the model starts with the design which is using carefully chosen fabrics. Further, the energy consumption is also considered during manufacturing. To create value, the designer should take not only the economic but also the environmental and social aspects into account from the beginning of the process.

Interactive and collaborative approaches and cooperation with other designers and companies in the chain are a way to greater sustainability and to achieving more significant benefits.

## End-of-life management of textile products

Textile waste management is a challenge for the textile industry. There are many ways to use a product at the end of its life. These may include:

- reuse for primary and secondary purposes;
- recycling (open and closed loop types);
- landfills (disposing of textile products in the traditional sense)
- firing.

One of the many right solutions is partnering with textile recycling programs. These initiatives operate on the principle of the circular economy, and their mission is to bring all collected clothing and shoes that people can no longer wear into the recycling process, this way creating a closed-loop.

## Waste management solutions: Re-design

In other respects, there is much we can do to protect the environment by re-designing, re-cycling and refurbishing existing but useless goods.

The first recycling concepts were born in the hippie-era of the ’60-s. In vintage stores many designers find inspiration for re-design.

Photo by Jeff Wade on Unsplash

# AREAS OF ACTION IN ECO-DESIGN

## Waste management solutions: Re-sell & Clothing as a service

Extending the life of clothes by resale or rental is a growing trend in the fashion market. Many clothing companies introduce a resale/second-hand business model to their profile. The traditional solution is to depose them However, 'Clothing as a service' also becomes an essential business model in the fashion industry.


Photo by Alice Pasqual on Unsplash

# AREAS OF ACTION IN ECO-DESIGN

## Waste management solutions: Re-pair

The repair culture is back in fashion. As a part of the slow fashion trend, many companies offer repair services to their clients for the clothing purchased in their shop-chain. Repair and mending have been lost for decades, but the new generation is picking up with the new trend.

Photo by Annie Spratt on Unsplash

## Waste management solutions: Recycling

Recycling is the action or process of converting waste into reusable material. Different fibers in the garments present a challenge for recycling. Some materials, such as cotton and flax, are easy to recycle, but artificial fibers, such as polyester, and blended fiber have little chance of being reused.


Photo via Shutterstock

# ECO-ATTITUDE IN MAKING FASHION

Eco-fashion is a complex and multifaceted relationship with the environment, often rooted in the environmental movement and the hippie styles of the 1960s. Seeds of eco-fashion in the modern sense were sown in the early '90-s when the use of environmentally friendly fabrics began to grow.

From the beginning of human civilization, the use of natural (animal, plant) raw materials was clear, as was the fact that people made as many garments as they used. With the introduction of synthetic fibers since the mid-twentieth century, when the textile and clothing industry has been able to meet mass demand with relatively cheap quality, the situation has changed.

# ECO-ATTITUDE IN MAKING FASHION

**Re-think, first!**

Anyhow, rethink first; *what we are willing to design, for who, and with which purpose?* Creation without knowing the final goal of the work is wasting of time, energy and resources! Let it be your main principle for the future sustainability in fashion!

And thereafter select the right material and technology…

Photo by Kenny Luo on Unsplash

## Ecological textiles vs manufactured fibers

Scientific models for evaluating different textile fibers in terms of their environmental impact and ecological sustainability are incredibly complex; however, they exist, and they are in use.

Factors influenceing the sustainability of a Fábri: renewability and source of fiber, the process of converting crude fiber into textiles, the impact of fiber preparation and dyeing, energy used in the production process.

Furthermore: working conditions of people who manufacture the materials, total carbon footprint of the material, transportation issues, care and washing of the product, and what happens to it at the end of life.

# Eco-friendly materials and processes

Photo by Waldemar Brandt on Unsplash

A common question when discussing the environmental effects of textile products is whether synthetic fibers or natural fibers are more environmentally friendly?

## Natural fibers & Eco-friendly materials

Natural fibers are fibers that are naturally occurring. They can be categorized into two main groups: cellulose or plant fiber and protein or animal fiber. These fibers are biodegradable.

Photos by Trisha Downing (left) and Judith Prins (right) on Unsplash

## Natural, plant fibres

Cotton is one of the most used natural fibers. Organic cotton is grown without being genetically modified, avoiding the use of fertilizers, pesticides and other synthetic agrochemicals that are harmful to the land.

Apart from cotton, the most common vegetable, cellulose fibers are jute, flax, ramie, abaca, soy, corn, banana, pineapple, beech.

Alternative fibers such as bamboo and hemp are increasingly used in eco-fashion.

Photo by Marianne Krohn on Unsplash

## Protein fibres

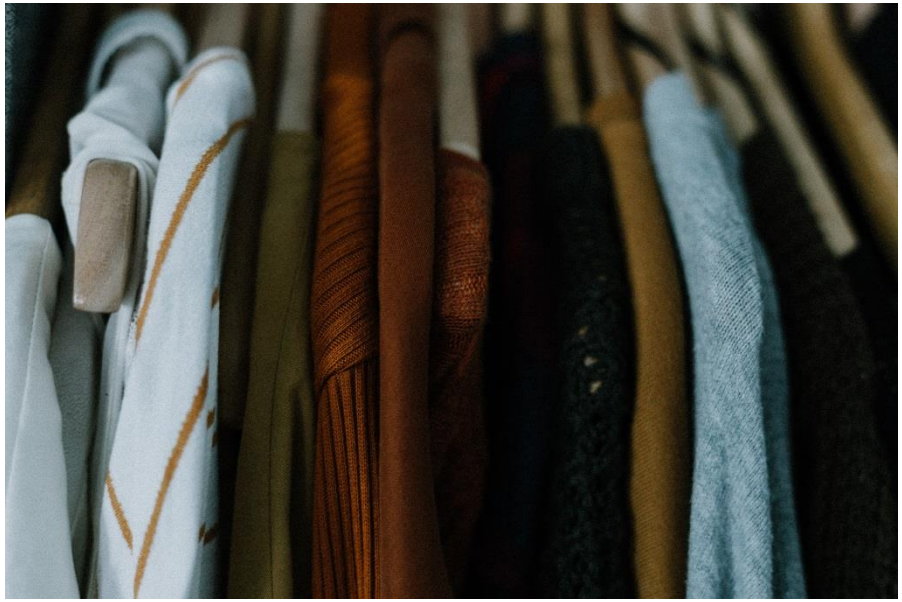
Fibers that originate from animal sources are called protein fibers, which consist the basic elements of the protein molecules: carbon, hydrogen oxygen and nitrogen.

Natural protein fibers include wool, silk, angora, camel, alpaca, llama, vicuna, cashmere, and mohair.

Photo by Ciprian Boiciuc on Unsplash

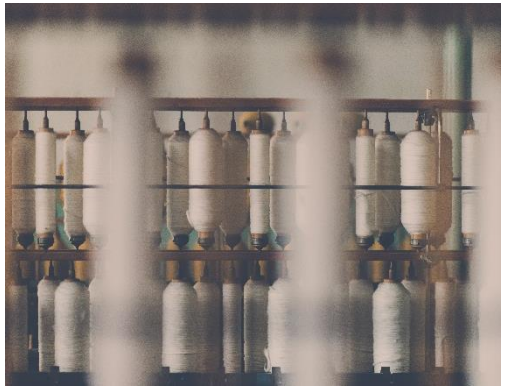
## Manufactured fibers

Manufactured fibers sit within three categories: manufactured synthetic fibers, manufactured protein fiber and manufactured cellulosic fibers. These are not biodegradable; must be recycled.



Photos by Priscilla Du Preez on Unsplash

## Synthetic fibers



More than half of the world's clothing is made of synthetic fibers. Synthetic fibers are criticized for the environmental effects caused: they are obtained from non-renewable sources and requires significant amounts of chemicals in the manufacturing process.

Synthetic cellulosic fibers are modal, Lyocell (or Tencel), rayon made from bamboo, or wood. Acryl, Nylon, Polyester, polyethylene, polypropylene and spandex are manufactured synthetic fibers, while azlon is a manufactured protein fiber.

Photo by Janko Ferlič on Unsplash

## PET plastic recycling & new fibres

PET plastics is responsible for 12% of the total amount of waste we produce. Their recycling reduces air, water, and ground pollution, as one of the many steps towards sustainably.

New types of fibers and processing technologies open new possibilities. A new generation of fibers and processing technologies allow low-energy and water-intensive recycling of clothing, thereby achieving a net positive impact on the environment during processing and maintenance.

Photo by Ciprian Boiciuc on Unsplash

# Sustainable and transparent manufacturing

Photo by Nigel Tadyanehondo on Unsplash

Wide environmental awareness has made companies aware that reputation, transparency and environmentally friendly manufacturing are the new „state-of-art" of the industry.

## Conscious and sustainable manufacturing processes

Photo by Devin Edwards on Unsplash

Key players in the fashion industry are collaborating to deliver industry-wide sustainable solutions. The worldwide introduction of extended producer responsibility in the fashion industry requires fashion companies to reduce their waste and apply fair and equitable living wages to their employees as a worldwide standard.

# ECO-ATTITUDE IN MAKING FASHION

## Transparency of the supply chain

Many fashion companies acknowledged that lousy reputation costs more than the investments. Transparency of the textile supply chains should become a universal objective maintained by highly detailed sustainability reporting. In achieving of this goal training, education, networking and associations play crucial role.

Photo by Pieter on Unsplash

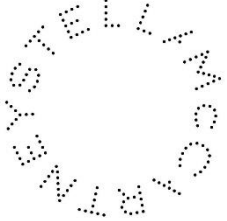
# ORGANISATIONS, PROJECTS & COLLABORATIONS











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