WP T2 – INNOVATION ON TEXTILE WASTE MANAGEMENT

ACTIVITY A.T2.3 PILOT CASES

D.T2.3.4 PILOT CASES FEASIBILITY STUDY

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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 is oriented to the management and optimization of waste, in a Life Cycle Design (or Ecodesign) perspective.

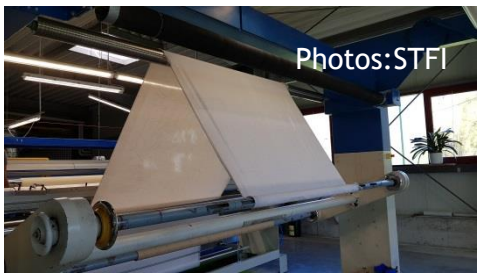
CONTENT

1. Pilot case description – aim and scope

STFI contacted the company Textilausrüstung Pfand GmbH, Lengenfeld (DE) as partner for the Pilot case.

Company Textilausrüstung Pfand GmbH offers contract finishing and functionalization of high-quality home textiles, household textiles and textiles for public areas, functional fabrics for clothing and technical textiles. Novel and innovative finishings for technical products, functional textiles and high-quality home textiles coming from own research and development activities are the basis for a steadily improving product range of the company. The services offered by Textilausrüstung Pfand GmbH include finishing and functionalization of textiles by means of chemical (wet), thermal and mechanical treatments. In detail, the following can be offered: optical whitening finish, rinsing, tentering, softening, fixation, flame resistant treatment, stain repellency, antistatic or antibacterial finishing, stabilisation against environmental influences (UV radiation). Multifunctional finishings, such as combinations of flame retardancy and stain repellency together with antibacterial finishing are more and more increasing. Pre-treatments as well as after-treatments for printing and embroidering processes and also thermosol dyeing are carried out.





The company produces different types of textile waste: selvedges (edge strips), end pieces / leftover pieces, mixed textile waste from products coming from customers for finishing, dust and pieces of thread and yarn waste. A part of the unmixed waste is taken back by customers to be reused again in the production process, but the major share is transported to disposal companies to be finally incinerated or landfilled; a fee has to be paid for the waste disposal (approx. 185 €/ton).

The following needs of waste management for the future were defined by the company:

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

2. Recycling of textile waste in the pilot case company - state of art

Company Pfand generates different kinds of textile waste during the production process: pure cut pieces and selvedges from different fabrics, mixed textile waste of different fibre types, yarn residues, coated and uncoated waste. The problems concerning the waste can be stated as follows:

- low amounts of waste, but a great variety of waste types occur
- a regular waste generation is mostly not given
- different waste types are collected jointly, no separation is done
- 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

Therefore, an effective waste management is quite difficult. The greatest part of the waste is transported to local disposal companies where a fee has to be paid for the waste disposal. Finally, the waste is incinerated or landfilled according to the regulations of the county.

Kind of waste	Description of waste	Current handling of waste
Selvedges (edge strips)	Generated within finishing processes from the treatment of woven or knitted fabrics Width of 2-3 cm Fibre material is PES, PA or blends Amount of waste: 200000 m/month (1t/month) Randomly laid	a) Taking back by customers if the waste is unmixed (reuse in the production process) b) Transport to a disposal companies, fee to be paid for the waste disposal 185 €/t → finally the waste is incinerated or landfilled according to the regulations of the county
End pieces/leftover pieces	Generated during the starting phase of finishing processes from woven or knitted fabrics Width of 160 cm Fibre material is PES, PA or blends	Transport to disposal companies, fee to be paid for the waste disposal 185 €/t → finally the waste is incinerated or landfilled according to the regulations of the county
Mixed textile waste from products coming from customers for finishing	Leftover pieces, strips from straight cutting of fabrics, torn pieces Material is unsorted (sorting only possible by colour) and cannot be separated Material mix contains grey, finished or coated pieces Fibre material is linen, silk, PA and others Amount of waste: 500-600 kg/month	Transport to disposal companies, fee to be paid for the waste disposal 185 €/t → finally the waste is incinerated or landfilled according to the regulations of the county
Dust, pieces of thread	Generated during shearing of fabrics Material is PES or viscose Amount of waste 200 kg/month Collected in textile bags	Transport to disposal companies, waste is sold to the companies → finally the waste is incinera-ted or landfilled according to the regulations of the county

Kind of waste	Description of waste	Current handling of waste
Yarn waste (pieces of thread)	Generated when fabrics are sewn together for finishing processes, afterwards the seams are ripped Length: around 3 m Thickness: 1 mm Crimped shape Amount of waste: 20 kg/month	Transport to disposal companies, waste is sold to the companies → finally the waste is incinerated or landfilled according to the regulations of the county
Residues from chemical finishing	Only chemicals/liquors are used which are not critical for the environment Two times per week the effluents are checked for quality (harmful substances)	Reusing of liquors in finishing processes by recirculation into the production cycle Discharging into the sewage plant

3. Feasibility study

For the activites done under the task "Pilot cases" STFI and project partner INOTEX (CZ) built up a consortium to work together on solutions for recycling and reuse of textile waste. The carried out activities are described below.

3.1 Activities done by STFI and INOTEX for company Pfand

Activity	Done by
Interview with the managing director of company Pfand at STFI to collect information about the company, waste amounts, waste profile and current waste management	STFI/Pfand
Elaboration of Pilot case description for company Pfand with the data collected during the interview (Deliverable D.T2.3.1 Pilot case list)	STFI
On-site visit at company Pfand to collect and record waste (see Result R1) and discuss the template "Technical and feasibility report"	STFI/Pfand
Testing trials for the textile waste at STFI (cutting unit) to proof the processability into textile shreds (see Result R2)	STFI
Recording the waste data (general data of company and waste, textile waste description, recycling potential) for the Textile Waste Database (see Result R3)	STFI
Sending the waste collected at Pfand to INOTEX for further processing	STFI
Search for companies in the Czech Republic able to process the sent waste material	INOTEX
On-site visit at INOTEX to discuss further cooperation, exchange experience concerning recycling	INOTEX/STFI/Pfand
Verification test of the waste samples processing	INOTEX/Green way

Activity	Done by
by company Green way recycling	recycling
Final report on processability of sent waste material (Result R4)	INOTEX
Sending of further material (pure white PES scraps) to INOTEX/ Green way recycling for further processing trails (Result R5)	STFI/INOTEX/ Green way recycling

3.2. Results

Result R1: **Collecting and recording waste (Photos: STFI)**

Company Textilausrüstung Pfand GmbH offers contract finishing and functionalisation of high-quality home textiles, household textiles and textiles for public areas, functional fabrics for clothing and technical textiles. The services offered by Textilausrüstung Pfand GmbH include finishing and functionalization of textiles by means of chemical (wet), thermal and mechanical treatments. The company produces **different types of textile waste**: selvedges (edge strips), end pieces, leftover pieces, mixed textile waste from products coming from customers for finishing, dust and pieces of thread and yarn waste. A part of the unmixed waste is taken back by customers to be reused again in the production process, but the major share is transported to disposal companies to be finally incinerated or landfilled; fees has to be paid for the waste disposal.

During an on-site visit at company Pfand the following types of waste could be detected and visually recorded:

Figure: Textile waste at company Pfand (Photos: STFI)

Table: Overview of textile waste at company Pfand

Textile waste company Pfand	
No.	Description
1	Artificial leather
2	Coloured selvedges (different composition)
3	Embroidery ground fabric made from PVA (polyvinylalcohol)
4	Hometextiles (curtains) made from PES
5	Selvedges from knitwear (plain, white)
6	Woven PPS selvedges with undefined finishing
7	Warp-knitted fabric made from PES
8	Yarn residues (material unknown)
9	Dust from finishing processes
10	Selvedges (from knitted PES fabrics), white, not chemically treated, slightly thermally fixed

Result R2: Testing trials for the textile waste at STFI (cutting unit) to proof the processability into textile shreds (Photos: STFI)

The waste material has been cut in a shredding unit (Pallmann Mühle) and the processability of the material could be proven in principle. An application for the textile shreds has to be found.

Figure: Shredded textile waste (Photos: STFI)

Figure: Shredding unit (Photos: STFI)

Result R3: Collection of waste data of company Pfand for the Textile Waste Database

Using the results from the interview and the on-site visit at Pfand a comprehensive overview of the textile waste types and composition as well as waste management issuses has been compiled.

General Infomation		
WASTE NAME	main description (max 5 words)	Mixed finished textile waste
EWC code	European Waste Catalogue	04 02 09 wastes from composite materials (impregnated textile) 04 02 22 wastes from processed textile fibres
Quantity	quantity of disposal per year in ton/y or equivalent units (l/y, m^3/y)	around 20 tons/year
Frequency	frequency of disposal (for example weekly, annual, occasional, seasonal)	monthly
Management	Actual disposal method (e.g. incenerition, sell, recycling)	incineration and landfill
Physical state	Solid, liquid, gas	solid
Appearence	Aggregate, Composite, Monomaterial, Bulk, Powder, Oil, Pellets, Fibres, Textile	dust, fibres, textile fabrics (coated and uncoated)
Toxicity	risk assessment form safety data sheet	not yet available
Outcoming Sector	indicate the main activity or factory sector that generate your waste	finishing unit
Tag	max 5	selvedges, end pieces, threads residues, mixed textile waste, dust, coated waste
Additional general info		
Material type	Glass, Polymers, Ceramics, Metals, Carbon-based, Naturals, Wood, Chemical products, Textile, CDW Cement-based, etc	textile waste
Composition 1	major component composition, with %	polyester, polyamid, viscoe, silk, linen (pure or blended)
Composition 2	minor component composition, with %, if any	
Composition 3	minor component composition, with %, if any	
Contaminants		
Size	particle size and description	selvedges are different metres long and randomly laid, end pieces have a fabric width of around 160 cm, mixed waste is mostly unsorted and contains grey, finsihed and coated pieces (undefined dimensions), dust comes form shearing processes
Containment	storage/disposal form (bags, bottles, etc)	bales, textile bags
Location	choosen from previous schedule (company - waste location)	local waste company nearby the company
Annual cost	Annual average cost for waste collection and disposal in €/y	4000-5000 €/year
Functional properties	tough/brittle, stiff/flexible	stiff and flexible, bulky
Tactile properties	hard/soft, smooth/coarse/texturized, warm/cold	hard, soft, smooth, coarse, fluffy
Visual properties	opaque/transparent, Solid colour, Gradient, Effects	coloured, unsorted (mixed colours)
Odour	if any	n.a.
photos	images in jpg or pdf format	not yet available
annexes	technical sheets, safety data sheet or other documents	not yet available
Other		

Textile material		
Composition	if multiple/mixed composition, list all	polyester, polyamid, viscoe, silk, linen
Fiber nature	natural, artificial, sintethic	fabrics made from natural and synthetic fibres
Kind of textile	woven, not woven, knitted, 3d knitted, net, lace, filling, feather, yarn, rope, leather	woven and knitted fabrics, coated fabrics, nonwovens, 3D structures
Kind of waste	scraps, selvedges, head/appending, fibers, powder	selvedges, end pieces, thread residues, mixed textile waste, dust, coated waste
Weigth	g/m^2 (if multiple, enter range)	250 - 600 g/m^2
Dimension	width and lenght (for textiles), main dimension (scraps or powder)	fabric width mostly 160 cm, selvedges different metres long, thread pieces around 3 m long
Yarn	thread count (dtex), mono/multifilament, staple, etc	sewing threads from 100 - 300 tex
Current application	clothes, fashion, technical textile, outdoor, furnishing, home textile, sport, workwear, healtcare, etc	home textiles, household textiles and textiles for public areas, functional fabrics for clothing and technical textiles
UV	UV performances (light resistance, UPF)	treatment of fabrics against UV radiation
Fire	Fire resistance (flammable, not flammable, etc)	non-flammable fabrics especially for home textiles and household textiles
Water	Hydrophobic, hydrofilic, hygroscopic	not applicable
Antibacterial	bacteriostatic, antibacterial, none	antibacterial treatment of fabrics
Finishing	Additional treatment products	stain repellency and antistatic treatment of fabrics
Other		

Result R4: Verifications test of the waste samples processing by Green way recycling - Final results

Most of the samples from textile waste produced by company Pfand were tested by company Green way recycling, s.r.o., Opava, Czech Republic, which has a rich experience in processing of various textile wastes.
According to the results, the majority of the samples cannot be processed by available mechanical methods as tearing at the TRÜTZSCHLER tearing machine or at the HAMSTER machine (special device constructed by Green way recycling for their own purposes) with specially modified ripping knifes.
According to the opinion of the company, the only processing technology which might be suitable for the textile materials which cannot be processed by tearing, is a milling (textile mill-shredder technology), where the textile fibres are milled and broken into very small particles. The resulting material can be used in building and automotive industry.
A summary of the test results from the mechanical treatment is shown below.

Summary of results:

Sample name	**ENTeR_GW19**
Date	**27 May 2019**
Material	**Artificial leather**
Picture	
Results	This type of material is not suitable for processing by tearing

Sample name	**ENTeR_GW20**
Date	**27 May 2019**
Material	**Coloured selvedges - different composition**
Picture	
Results	It It can be processed by tearing (common tearing technologies – TRÜTZSCHLER, LAROCHE) and used as a raw material for manufacturing of e.g. geotextiles, fillings, sound insulation, building

Sample name	**ENTeR_GW21**
Date	**27 May 2019**
Material	**Dust form finishing processes**
Picture	
Results	In Finland, they have a project on processing and use of the textile dust; the resulting material can be used for manufacturing of soundproofing and thermo-insulating boards. But in Central Europe, there is not such a type of production.

Sample name	**ENTeR_GW22**
Date	**27 May 2019**
Material	**Embroidery ground fabric PVA**
Picture	
Results	n.a.

Sample name	**ENTeR_GW23**
Date	**27 May 2019**
Material	**Hometextiles PES**
Picture	
Results	Material cannot be processed by tearing; when testing, there were a residual non-teared parts

Sample name	**ENTeR_GW24**
Date	**27 May 2019**
Picture	
Results	It can be processed by tearing (common tearing technologies)

Sample name	**ENTeR_GW25**
Date	**27 May 2019**
Material	**Warp-knitted fabric PES**
Picture	
Results	Not suitable for processing by tearing. It might be processed by the textile mill (Schredder technology)

Sample name	**ENTeR_GW26**
Date	**27 May 2019**
Material	**Woven PPS selvedges, finished (unknown)**
Picture	
Results	It was not suitable for processing by any available technology; when propcessed, the material is broken to the dust.

Sample name	**ENTeR_GW27**
Date	**27 May 2019**
Material	**Yarn residues**
Picture	
Results	It can be processed by tearing (common tearing technologies – TRÜTZSCHLER, LAROCHE) and used as a raw material for manufacturing of e.g. geotextiles, fillings, sound insulation, building

Result R5: Sending of further material (pure white PES scraps) to INOTEX/Green way recycling for further processing trails

In contrast to the above described waste material, the pure white PES scraps (unfinished, only slightly thermally fixed) are of great interest for the Czech company Green way recycling. Due to the untreated and smooth structure the material seems to be suitable for a use as underground in horse arenas and for the automotive industry. Currently, transfer activities for the waste material are planned between the companies Pfand and Green way recycling. The Czech company will carry out further testing and feasibility trials. If these trials achieve a positve result company Pfand will regularly deliver the textile material to Green way recycling.

Figures: PES scraps and storage in bales (Photos: Pfand & STFI)

3.3 Conclusions

a) Referring to waste

- Low amounts of waste are available, but a great variety of waste types occur, therefore a regular waste generation is mostly not given.
- Different waste types are collected jointly, no separation processes take place. This complicates a subsequent waste management.
- Non-textile waste (paperboard, bobbins) is also a problem. Large volumes are collected and have to be finally disposed.

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.
- 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 very small particles. The resulting material can be used in building (insulation material) and automotive industry (mats for car interior).

- Pure (made of only one fibre type) and untreated waste is easier to handle and can be cut or teared or given back to the production process.
- For those materials which can be teared or shredded applications of the recycled material have to be found.

Main output: Only for the pure PES scraps a reasonable solution for waste management could be identified. The selvedges from knitwear (white, nearly untreated and smooth structure) are of interest for the Czech company "Green way recycling" to use it as underground in horse arenas and for the automotive industry. Currently, transfer activities for the waste are planned by the involved companies.

Furthermore, to push the development of textile recycling, a regional network project (RE4TEX – New technologies for textile recycling) which is nationally funded has been established to find further solutions for waste management and application of recycled material. Company Pfand is one of the industrial network partners.

3.4 Activities done by STFI and INOTEX for company Pfand

STFI supported INOTEX with their two Pilot cases.

a) **Pilot case 1:** Generation of waste from manufacturing of technical textiles

INOTEX sent textile production waste from a Czech company they work with to STFI for processing trials. The waste material contained: selvedges from technical textiles (cotton waste coated), viscose waste backed with paper, abrasion fabrics (see Figure)

Figure: Textile production waste from a Czech company (Photos: STFI)

STFI did trials with a special winding technology called KEMAFIL®. The waste material is wrapped by a thread and is processed into ropes and strands (unfilled or filled). The processing of the waste material is technically feasible in principle, but applications have to be found.

Figure: Processing of Czech production waste at STFI machinery (Photos: STFI)

b) **Pilot case 2:** Reduction of the waste generation through prolongation of the service life of textile products

STFI got in contact with the German Textile Cleaning Association (DTV) to ask for support in completing a questionnaire of the Czech Laundry association. Discussion took place about the questionnaire content and how to collect the data from German laundries to provide the Czech partner also with data from Germany.

In summary, the creation of a consortium is advantageous for the implementation of Pilot cases. The contacts established in the ENTeR project should be extended. One possible scenario is to continue the work within the Pilot cases to find further solutions for textile waste management. This could be done in smaller consortia and in the framework of small R&D projects.