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

The aim of the Polish Pilot Case was to find a way of effective post-production textile waste management. There is an urgent need to find solutions, e.g. recycling possibilities. The costs of waste storage and disposal are very substantial for the textile and clothing companies.

Polish Pilot Case comprised the following stages/steps:

- Different kinds of post-production textile waste were collected and were assessed in terms of their structure and the raw material composition.
- The potential possibilities of processing or other use of separated waste streams (polyolefins, natural fibers) were assessed and analyzed in cooperation with external experts.
- The possibility of obtaining needled nonwovens from collected post-production textile waste was tested in cooperation with recycling company.
- The possibility of obtaining ropes from selected post-production textile waste, produced according to KEMAFIL® technology, was tested in cooperation with research unit.
- The potential application areas for such manufactured products were proposed.

Two textiles companies delivered post-production textile waste. Experts on textile material engineering/processing were invited to cooperation, including textile waste processing plants. The developed solutions were tested in cooperation with processing plant in Tomaszów Mazowiecki and University of Bielsko-Biala.

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

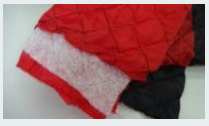
Within Polish Pilot Case scraps/waste collected from the production of traditional woollen carpets and artificial grass, based mainly on polypropylene and jute as well as from textile materials quilting, based mainly on polyester were used. Currently such textile wastes are mainly incinerated or landfilled.

Waste type	**Carpet selvedge with jute yarn**
Description 	Textile waste, solid, non-toxic. Flexible, no glue. Waste – partly woven fabric made of jute yarn in uniform natural colour, wool, polyamide and polyacrylonitrile – in different shades, white polyester/cotton yarn. Mass per unit area: 500g/m^2 Waste generated after: weaving **Current waste disposal**: incineration Waste storage: in carton boxes or packed cubes **The average annual costs of waste storage and disposal:** ca. 0.30 PLN/kg
Raw material	jute ; wool ; staple polyester/cotton yarn
Annual amount of waste	**ca. 1 000 kg**
Notes	*Size*: length 60 running metres, width 9 ÷ 14 cm *Frequency of disposal*: every 2-3 weeks
Transformation potential	**tearing - for nonwoven production**

Waste type	**Dust and short fibres**
Description 	Textile waste, solid, non-toxic, not transparent, containing dust and short fibres of: wool, jute, polyamide and polyacrylonitrile. Waste generated after: shearing process **Current waste disposal**: for cement or brick production Waste storage: in bags **The average annual costs of waste storage and disposal:** ca. 0.32 PLN/kg
Raw material	wool ; polyamide ; polyacrylonitrile
Annual amount of waste	**ca. 25 tonnes**

Notes	*Frequency of disposal:* every 2 weeks
Transformation potential	**- for cement or bricks production** **- for box training bags**

Waste type	**Selvedge of artificial grass, without glue (supple)**
Description 	Textile waste, solid, non-toxic. Waste - partly braided fibres, supple, without glue, not transparent made of polypropylene yarn in uniform beige colour. Mass per unit area: 230 ÷260 g/m^2 Waste generated after artificial grass production **Current waste disposal:** incineration Waste storage: in carton boxes and packed cubes **The average annual costs of waste storage and disposal:** ca. 0.30 PLN/kg
Raw material	polypropylene – fibrillated tape
Annual amount of waste	**ca. 400 kg**
Notes	*Size:* several meters / ca. 10 cm *Frequency of disposal:* every 2-3 weeks
Transformation potential	**- tearing - for nonwoven production ;** **- melting**

Waste type	**Cutting waste**
Description   (1)  (2)	Textile waste, solid, non-toxic. Waste - partly polyester woven fabric, flexible, without glue, not transparent, nonwoven filling made of siliconized polyester in uniform white colour. Mass per unit area: 550 g/m^2 (1), 330g/m^2 (2) Waste generated after: quilting **Current waste disposal:** disposal Waste storage: in bales **The average annual costs of waste storage and disposal:** NDA
Raw material	**Outer layer**: polyester woven fabric or polyester/cotton woven fabric, polyester threads (1) **Inner layer**: nonwoven - siliconized polyester (2)

Annual amount of waste	**~ 900 kg**
Notes	*Fequency of waste generation:* everyday
Transformation potential	**- tearing up - for nonwoven production**

3. Feasibility study

As a Polish Pilot Case result the first ideas of managing and processing of post-production textile waste from production of carpets, woven grass and quilted textile materials were developed.

The proposed solution for the post-production textile waste management comprises (Fig.1)**:**

- **Pre-treatment for recycling purposes** - waste cutting and then their defibering (mechanical recycling).

Requested technical parameters of waste to be accepted for pre-treatment: textile waste composed of one type of fibers or mixtures, not textile-polymer composites, materials with appropriate strength parameters, soft handle only, without the presence of resins and other stiffening agents, without perceptible polymer layers, without non-textile inclusions.

- **Needled nonwovens production**

Requested technical parameters of waste to be accepted after pre-treatment: the lowest proportion of short fibers (according to the AFIS system) with a length of less than 12.7 mm and dust - not more than 30% (m/m), the lowest proportion of threads and no fibrous elements, less than 50% (m/m).

To process textile waste into nonwovens requires no investments for textile companies. There are at least two recycling companies in the Lodzkie Region with equipment/machinery for mechanical processing of collected post-production textile waste to obtain needled nonwovens. These recycling companies are located within ca. 50 km of the textiles companies.

	Current costs of disposal	Costs of pre-treatment and needled nonwovens production
Carpet selvedge with jute yarn	0.30 PLN/kg	**9 PLN/kg***
Dust and short fibres	0.32 PLN/kg	**9 PLN/kg***
Selvedge of woven grass, without glue (supple)	0.30 PLN/kg	**9 PLN/kg***

*** -** maximum price for materials processed as part of the information / pilot batch below 500 kg; in the case of larger quantities, the price to be negotiated - it can be significantly reduced due to the time spent for preparing the machines for production and cleaning them after the production process into a greater amount of kilograms of the finished product – needled nonwoven.

- **Ropes production according to KEMAFIL® technology**

There is no need of investment for textile companies. There is a company in Poland with machinery for geotextiles production according to KEMAFIL® technology. The company is located in the Silesian Region, ca. 300 km of the textile companies.

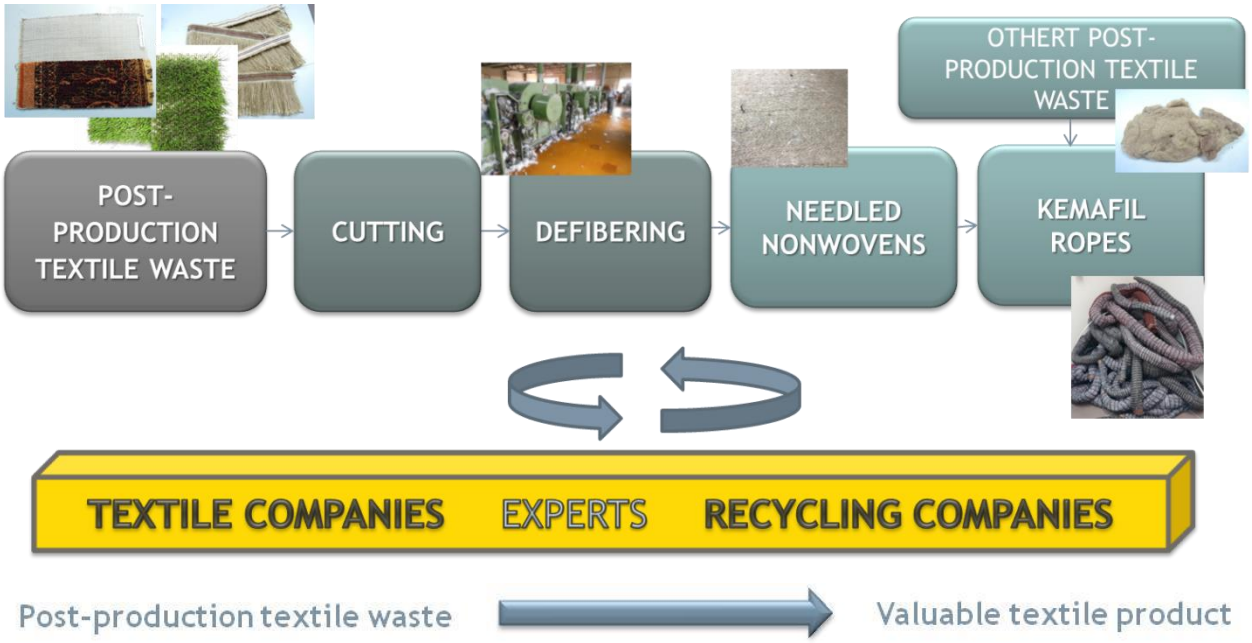


Fig.1 Scheme of developed solution for the post-production textile waste management

The developed solution within Polish Pilot Case is feasible in Poland with no need of investment plans. It enables to avoid the loss of resources which can be reused, such as natural fibres (jute, wool), since currently the large amount of textile waste, that have a commercial value, is incinerated or landfilled. As a result valuable textile product is obtained (ropes).

The geotextiles market and the nonwovens market are growing.

The usage of geotextiles in a wide range of construction applications such as roads, landfills, drainage structures, and harbours to enhance soil stabilization is increasing. According to Grand View Research such increased usage of geotextiles is anticipated to drive the market growth over the 2020-2027. The global geotextiles market size was estimated at USD 4.6 billion in 2019 and is projected to register a CAGR of 11.9% over the above mentioned period.[1] The market for Europe is led by Germany, UK, Italy and France.

According to EDANA, the European Disposables and Nonwovens Association, in 2008–2018 nonwovens production increased 5.7%, lead by growth in spunbond/spunmelt and drylaid hydroentanglement. Strong market demand for nonwovens materials is expected to continue.[2]

[1] https://www.grandviewresearch.com/industry-analysis/geotextiles-industry

[2] https://www.edana.org/about-us/news/new-report-forecasts-excellent-worldwide-outlook-for-nonwovens-through-2023

Environmental aspects

According to The Product Stewardship Institute textile manufacturing is the second largest polluting industry in the world after oil and gas. Cotton growing involves large amounts of water and pesticides, dyeing and finishing processes involve variety of chemicals.

Textile and Clothing (T&C) industry, which uses significant amounts of non-renewable resources as well as water and energy, is as a major contributor to global environmental pollution. Considering supply chain pressures (EU consumption perspective), clothing, footwear and household textiles is the fourth highest pressure category for use of primary raw materials and water (after food, housing and transport) and the fifth highest for greenhouse gas emissions. It is estimated that the production and handling of these goods purchased by EU-28 households in 2017 used an 1.3 tonnes of primary raw materials and 104 m^3 of water per person with emissions of 654 kg CO_2 equivalent per person, taking into account consumption[3]. It is expected that in 10 years the CO_2 emissions by T&C industry will increase by over 60% (~ 2.5 billion tonnes per year) with a 50% increase in freshwater consumption from 79 million m^3 in 2017[4]. Furthermore, during textiles production a large amount and variety of chemicals are used, e.g. the dyeing and finishing processes involve the addition of colourants, electrolytes, detergents, bleaches etc. amount to 20 % of global water pollution.

Hence, one of the key challenges facing T&C industry is more efficient management of raw materials, i.e. transformation towards Circular Economy. According to report titled "*Évaluation environnementale du recyclage en France selon la méthodologie de l'analyse de cycle de vie*" (2017) recycling a ton of textiles avoids the equivalent of 98% of CO_2 emissions needed to produce one ton of primary textiles as well as 98% of primary energy consumption of one ton of primary textiles.

No or little waste is generated during needled nonwovens and ropes production. Use of mechanical recycling allows for more sustainable resources consumption, with no water consumption. Weight loss is observed due to textile dust generation. But there is possibility to use such dust as core (filling) for rope production. In this context, developed solution for post-production textile waste management is environmentally friendly.

The advantage of proposed way of post-production textile waste management is:

- Solution to the problem of secondary raw materials (small quantities, no regular waste generation), i.e. management of several waste streams from various production plants,
- A different approach to post-production textile waste, i.e. managing of several waste streams similar in terms of their processing possibility, and not the raw material composition,
- Creation of new, regional value chains - the textile companies with similar waste streams, in terms of their processing possibility, recycling company and experts were involved.

[3] European Environment Agency (2019). Textiles in Europe's circular economy, Brief. No 10

[4] Le, Katherine (2018). Textile Recycling Technologies, Colouring and Finishing Methods

The potential application areas of new products obtained from post-production textile waste result mainly from their structure and the secondary raw material composition and thus they comprise for ropes - construction industry (e.g. roads, landfills, drainage structures) and for needled nonwovens: heavy industry (sorbents), forestry, transport, decorations, sealing used for construction of wooden houses.