



# WP T1 - TEXTILE WASTE & RECYCLING

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STRATEGIC AGENDA ON TEXTILE WASTE  
MANAGEMENT AND RECYCLING

Final Version

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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. Executive Summary

The Strategic Agenda (SA) is a practical document to translate the ENTeR partnership's vision on textile waste management into tangible elements.

The main EU regulations represent the legal underpinnings (base) of our Agenda. Indeed the Strategic Agenda stems from the analysis of the current technical and regulatory context, of the participating regions and from the consideration highlighted in the regional reports. It results from gathering the partners' experiences and helps to communicate the key focus areas related to waste management.

In order to address emerging issues in the European textile industry, the ENTeR's partnership has signed a Memorandum of Understanding (MoU) that defines the areas of interest to work on and a strategic collaboration aimed at improving the re-use of textile materials with a reduction of the economic and environmental burden.

The memorandum declares the intentions of the members of the ENTeR project to integrate part of their R&D efforts into a transnational program that will enhance and support the promotion of a joint offer of innovative services in order to link and drive the circular economy consideration and strategic actions.

Therefore, shared research in the textile sector can be improved by effectively combining resources between partner organizations and prioritizing the group's efforts on common issues of mutual interest.

The strategic agenda will guide partners in the implementation of the ENTeR project, aimed at strengthening research and innovation with the ultimate objective of improving the management of textile waste, encouraging economic growth and promoting the joint offering of new innovative services by the main local research centres and trade associations.

The model of collaboration envisaged will be like a "virtual centre", providing a common proposal on the management of textile waste in a circular economy optic.

In this context the partnership defined objectives, method of analysis (chapter 2 and 3) and five priority areas (lines of action), illustrated in chapter 2 and detailed in chapter 5. In Chapter 4, it describes the European textile industry and recycling.

The strategic agenda, defined jointly on the basis of problems relevant to the participating regions, provides a common vision and set objectives and priorities in a mid- to long-term perspective. The formulation of a transnational and / or regional strategy able to guide the ENTeR project in the next 2 years will be transformed during the project into an Action Plan.



## 2. Objectives of the Strategic Agenda

The Strategic Agenda aims to set the technical and scientific basis for developing knowledge and innovative solutions in order to favour the textile industry towards the Circular Economy.

It describes waste management strategy and action lines for obtain an improvement of material resources consumption and of environmental impact thanks to the application of circular economy in the companies.

In this framework five areas have been identified:

- **Legal and Policies**

At the macro level within the Legal and Policy area, in addition to monitor both local and EU policies, the necessity to thoroughly study the legislative framework has now become apparent, in order to constantly direct the Strategic Agenda. Specifically, the area intends to establish active interactions between the various stakeholders (companies, local administrations, governments) in order to verify the obstacles and problems to be submitted to the policy makers and, at the same time, verify how the policies orient new projects.

- **Waste management**

The prevention of waste production is the first objective provided by the European Waste Directive, 2008/98 / EC.

Waste management and prevention are a major challenge for the whole European community and for the Strategic Agenda of ENTeR project.

Textile waste is considered to be special waste and therefore cannot be placed in the bins of undifferentiated waste. This classification has impacted on the cost plan for companies - called to use a specific disposal system for textile waste, managed by authorized companies, traceable and paid.

- **Research trends and technologies**

The growth prospects of the European industry are mainly based on the capacity for innovation, aimed at increasing competitiveness in the context of sustainable development.

Product and process innovation goes through development and technologies with low environmental impact, which require integration and optimization of production processes with respect to the product and plant life cycle. Innovation conditioned by criteria of sustainable development represents therefore, in perspective, a competitive resource of the European industry.

Switching to a circular economy mind-set implies considering from the very early stages of product design recycling and reuse options for the end-of-life of products.

- **Communication**

The Circular Economy requires, together with new commercial strategies (markets) and new management of waste, the formation of new consumers and the adoption of sustainable lifestyles, therefore an investment in awareness for all citizens.



The ENTeR project wants to experiment a market system of secondary materials that, destined to become waste, can be reused and repositioned on the market, thus having a "second life".

- **Education**

The aim is to bring out the training needs of companies and the research world, identifying the conditions that favour the implementation of circular models with particular reference to industrial symbiosis.

It is necessary to ensure that the sector has access to the right technical skills. This is particularly important for companies that are pushing the boundaries of traditional applications to Circular Economy.

Collaboration with educational institutions will be required to ensure a new generation of workers and managers are prepared for successful careers in advanced EU-based textile production.

The Strategic Agenda will be the basic document for the development of an Action Plan to be developed at the end of the ENTeR project to effectively supporting the textile and clothing industries of the partner countries in transferring the findings and outputs from the project on textile waste management into the practice.

### 3. 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. The formulation of our transnational and regional strategy is carried out with involvement of relevant stakeholders (also targeting the policy level).

The elaboration of the SA was done in **two phases**, the **desk phase** and the **field phase**.

In the **desk phase** the state of the art of textile waste management and recycling in each partner region (Italy - Lombardy, Germany - Saxony, Poland - Lodzkie Region, Czech Republic, and Hungary) was studied and summarized in specific regional reports. Furthermore, the state of the art on textile waste management and recycling in other Central Europe (CE) regions (Austria, Slovenia, Slovakia and Croatia) was done. The regional reports show the legal, social and technical aspects concerning textile waste management. The strengths, weaknesses, opportunities and threats of the partner regions regarding textile waste management were elaborated and prepared in a SWOT analysis form, to identify individual and joint problems but also solution strategies.

In the **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, see Annex i "Template of Questionnaires for Interviews" and Template "Stakeholder interviews". The aim was to get a direct feedback from companies and stakeholders and to complement the desk phase studies with the experience and the handling of the current textile waste situation from everyday practice. Additionally, mutual visits to all partner regions were done. During this visit workshops on circular economy were organized. Local operators in the field of textile waste



management were invited or visited and informed about the project ENTeR and its main objectives.

The result of the desk phase and the field phase is a broad overview of project partner's mutual knowledge about the characteristics of materials and resources, the existing technical and regulatory context, already developed solutions and experiences.

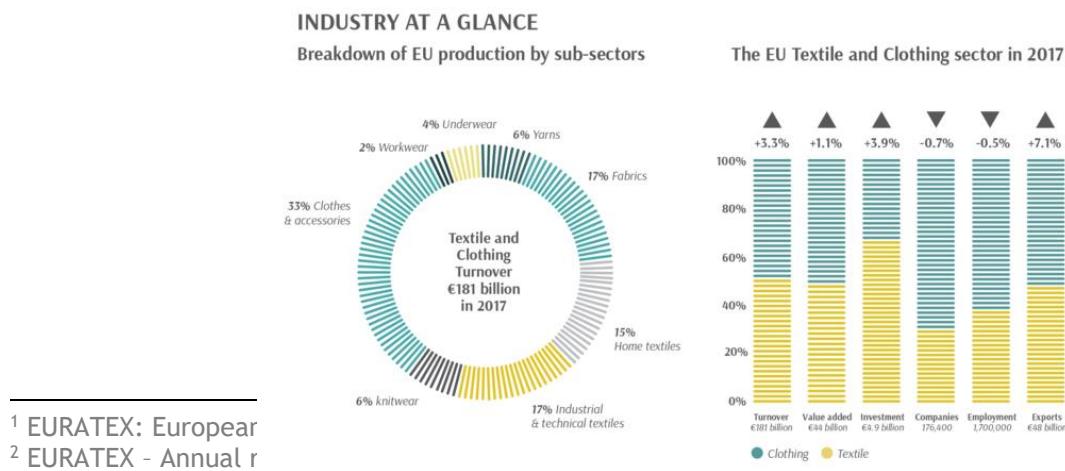
Based on these data the **Strategic Agenda** was prepared. Specific needs and unsolved problems in terms of textile waste management in the partner regions could be identified and are the basis for action lines deriving from the outcomes of the studies. The action lines shall represent the most appropriate ways to support textile and clothing companies in their waste management and to strengthen the expert network on textile recycling in Central Europe.

## 4. The European Textile Industry and Textile Recycling Sector

The textile and clothing industry represents a significant sector of economic activity in world trade and also within the European Union (EU). It is a highly diverse and heterogeneous industry which covers a wide variety of end products ranging from hi-tech synthetic yarns to wool fabrics, cotton bed linen to industrial filters, or nappies to high fashion. This diversity of end products corresponds to a multitude of industrial processes, enterprises and market structures.

### 4.1. The European Textile and Clothing Industry

The European textile and clothing industry (T&C) is a very diverse branch playing an important role in the European manufacturing industry. Around 1.7 million people are employed in 178,000 companies producing a turnover of EUR 171 billion (2016).<sup>1</sup> The T&C sector in the EU is based on small and medium-sized businesses. Companies with less than 50 employees account for more than 90% of the workforce and produce almost 60% of the value added.<sup>2</sup>



<sup>1</sup> EURATEX: European  
<sup>2</sup> EURATEX - Annual r



Figure 1: European production of clothing and textiles and main indicators<sup>1</sup>

**Characteristics of the industry:** The EU textile and clothing industry covers the entire textile value chain and therefore a wide range of activities from the processing of natural or synthetic fibres into yarns, the production of woven, knitted or non-woven fabrics, the treatment of textile materials (finishing, dyeing, coating) up to the production of a great variety of end-products such as high performance technical textiles for a lot of industrial applications as well as home textiles and clothing.<sup>3</sup> The retail & B2B sector is also an important part of the textile and clothing value chain and is essential for all textile and clothing products sold to the consumers.

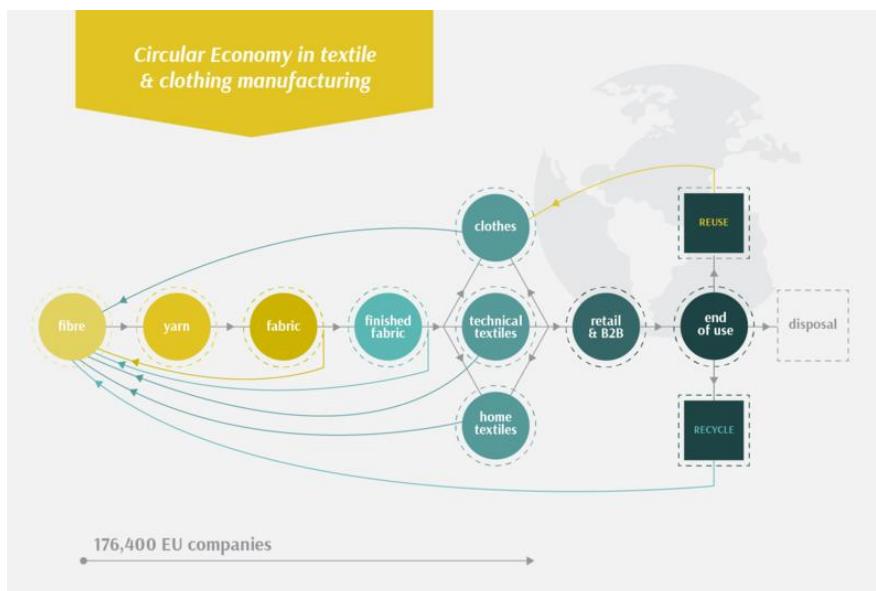


Figure 2: Textile value chain<sup>3</sup>

The biggest producers in the industry are Italy, France, the United Kingdom, Germany, and Spain. Together, these countries account for about three quarters of EU production. Southern countries such as Italy, Greece, and Portugal; some of the new EU countries like Romania, Bulgaria, and Poland; and, to a smaller share, Spain and France, are more involved in the clothing production. Northern countries such as the United Kingdom, Germany, Belgium, the Netherlands, Austria, and Sweden are focused more on textile production, mainly technical textiles.<sup>2</sup>

<sup>3</sup> <http://euratex.eu/pages/infographics/>

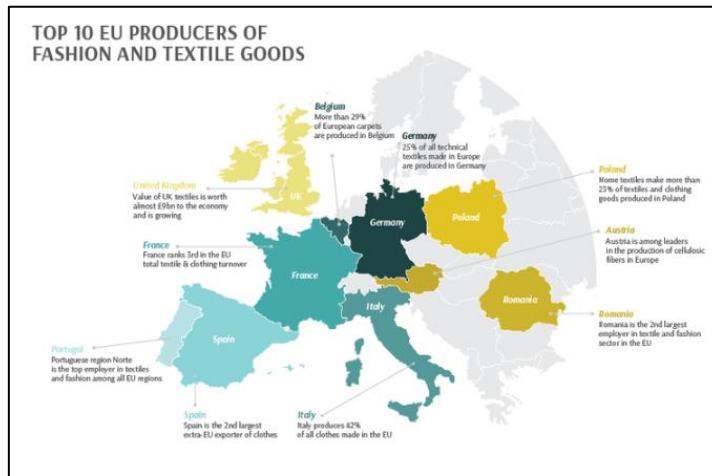


Figure 3: European main producers of textile goods<sup>3</sup>

## 4.2. The European Textile Recycling Sector

Textile materials are indispensable in everyday life. Clothing and textiles are needed, used and accordingly disposed by all people worldwide. In the last 15 years, clothing production has approximately doubled (see Figure 4), driven by a growing middle-class population across the globe and increased per capita sales in mature economies.<sup>4</sup> The total textile fibre production amounts to 100 million tonnes per year worldwide showing a growth rate of 3-4% each year. 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.<sup>5,6</sup>

Parallel the clothing utilization - the average number of times a garment is worn before it ceases to be used (Y-axis in Figure 4) - has decreased by 36% compared to 15 years ago.<sup>7</sup> Globally, customers miss out on USD 460 billion of value each year by throwing away clothing that they could continue to wear, and some garments are estimated to be discarded after just seven to ten wears.<sup>8</sup>

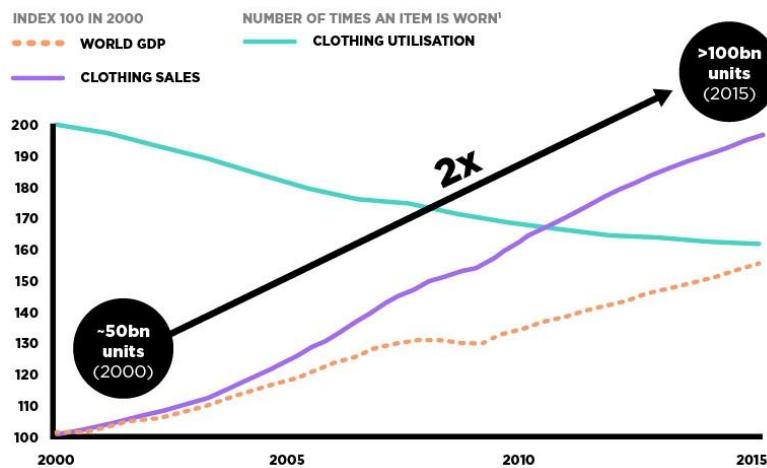
<sup>4</sup> Ellen MacArthur Foundation „A new Textiles Economy: Redesigning Fashion's Future“, 2017, <https://www.ellenmacarthurfoundation.org/publications/a-new-textiles-economy-redesigning-fashions-future>

<sup>5</sup> J. Conca. Making climate change fashionable - The garment industry takes on global warming. Available at <https://www.forbes.com/sites/jamesconca/2015/12/03/making-climate-change-fashionable-the-garment-industry-takes-on-global-warming/#e79b22379e41>.

<sup>6</sup> Nia C Bell, Peter Lee, Kate Riley, Steve Slater „Tackling Problematic Textile Waste Streams“, Oakdene Hollins Ltd, Aylesbury, UK, 2017

<sup>7</sup> Circular Fibres Initiative analysis based on Euromonitor International Apparel & Footwear 2016 Edition (volume sales trends 2005-2015).

<sup>8</sup> Morgan, L.R. and Birtwistle, G., An investigation of young fashion consumers' disposal habits (2009)



I Average number of times a garment is worn before it ceases to be used  
Source: Euromonitor International Apparel & Footwear 2016 Edition (volume sales trends 2005–2015); World Bank, World development indicators – GD (2017)



[tiny.cc/fibres](http://tiny.cc/fibres)

**Figure 4:** Growth of clothing sales and decline in clothing utilisation from 2000 to 2015<sup>4,9</sup>

Clothing represents more than 60% of the total textile market and is expected to remain the largest application field. Next to clothing, textile materials are used because of their technical and functional properties. Such so called technical textiles can be found in various branches and application scenarios, e.g. automotive, aerospace, medicine and hygiene products, architecture, living, energy sector, logistics and many more.

For the production, distribution and usage of textile materials large amounts of non-renewable resources are needed and used. The Textile and Clothing industry is all about transforming resources (materials, energy, water, chemicals) into value added products for business or private usage. Several textile production processes, such as dyeing and finishing, are very resource-intensive. The consumption of these resources is expensive. Therefore, companies have a natural incentive to use them as efficiently as possible. The tightening legislation on energy efficiency, CO<sub>2</sub> emission, water use, waste water quality and air pollution forces the industry to look for better technology to combine economic with ecological benefits while complying with the law.<sup>10</sup> Next to the efforts of the producing industry, the end user and customer behaviour has changed over the years. It is estimated that more than half of produced fast fashion produced is disposed of in under a year.<sup>4</sup> This also means that large amounts of used textile materials are accruing which show the potential to be used as raw material again. “Designed to be recycled” needs to become the norm in the future in the manufacturing of e.g. fibre composites and other textile-based products. The goals are closed recycling cycles in which resources are not consumed but used.

<sup>9</sup> Euromonitor International Apparel & Footwear 2016 Edition (volume sales trends 2005 - 2015)

<sup>10</sup> EURATEX - „Prospering in the Circular Economy“, Policy Brief, 2017



#### 4.2.1. Current situation in Europe

More than six million tonnes of clothing were consumed in the EU in 2015. The corresponding carbon footprint of clothing consumed in the EU in 2015 was 195 million tonnes CO<sub>2</sub> and the water footprint was 46,400 million m<sup>3</sup>.<sup>11</sup> Of the approximately 6 million tonnes of fabric waste Europeans discard every year, only 25 percent are recycled, according to a report released by Friends of the Earth Europe.<sup>12</sup> The EU textile industry generates waste estimated at 16 million tonnes per year. Much of this waste is thrown in landfills or incinerated, with a high environmental impact and at great cost. Valuable resources held within the waste are also lost.<sup>13</sup>

In general the textile waste can be divided in industrial waste coming from textile production sites and post-consumer waste. While the industrial waste often shows a good quality and large volumes of reproducible materials the post-consumer waste is often inhomogeneous and consists of large volumes of mixed textiles. Furthermore, textile waste can be divided in different waste streams that also vary for the different EU-Member States, see Table 1.<sup>14</sup>

**Table 1:** Residual textile waste streams produced by EU-Member-States<sup>6,14</sup>

Waste Stream	Total residual waste (million tonnes)	Top 3 EU-Member States
Clothing in sorters residuals	0,08	Germany, UK, Belgium
Clothing in municipal solid waste	5,80	Germany, Poland, Italy
Carpets	1,60	-
Mattresses	0,30	Poland, UK, Germany
Furniture	0,40	-
Uniforms	0,08	Germany, UK, France
End-of-life vehicles	0,19	UK, France, Italy
Manufacturing	0,90	Italy, Germany, Spain
<b>Total</b>	<b>9,35</b>	

Summarizing the eight different waste streams, the total amount of textiles being landfilled or incinerated in the European Union was quantified at 9,35 million tonnes per year.

Across the clothing industry, only 13% of the total material input is in some way recycled after clothing use (see Figure 5). Less than 1% of material used to produce clothing is recycled into new clothing.<sup>15</sup> Most of this recycling consists of cascading to other industries and use in lower-value applications, for example, insulation material, wiping cloths, and mattress stuffing - all of which are currently difficult to recapture and therefore likely constitute the final use.<sup>4</sup>

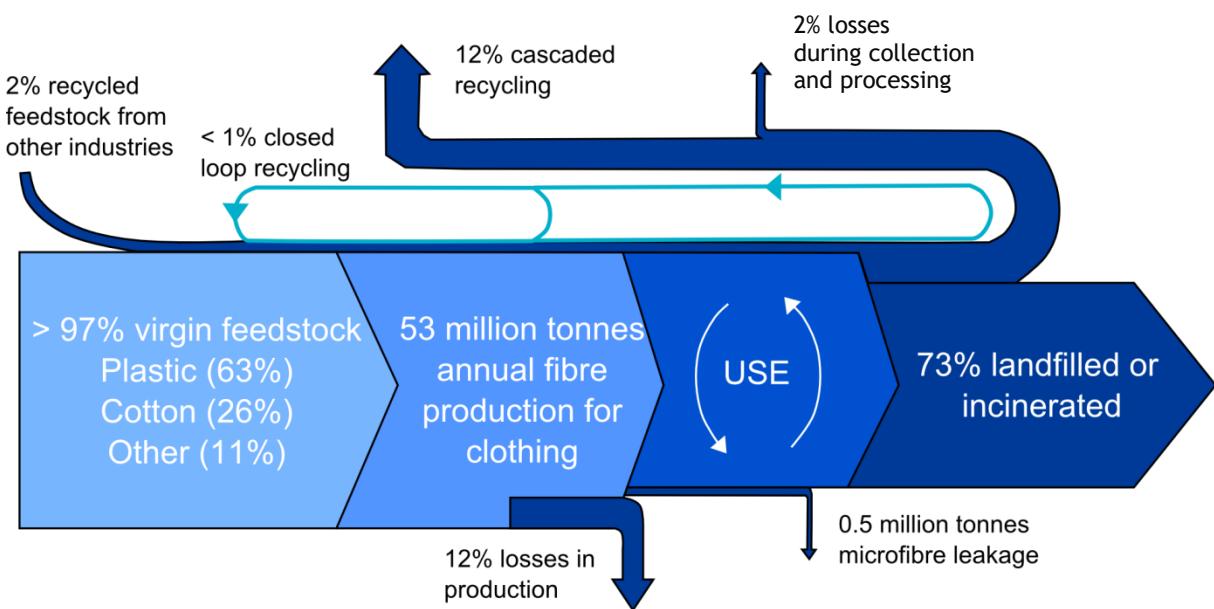
<sup>11</sup> Life Project ECAP - „Mapping clothing impacts in Europe: the environmental cost“, 2017; <http://www.ecap.eu.com/wp-content/uploads/2017/12/Mapping-clothing-impacts-in-Europe.pdf>

<sup>12</sup> Friends of the Earth Europe - „Less is more, Resource efficiency through waste collection, recycling and reuse of aluminium, cotton and lithium in Europe“; 2013

<sup>13</sup> <https://ec.europa.eu/easme/en/news/circular-economy-practice-reducing-textile-waste>; last visit 06.06.2018

<sup>14</sup> Oakdene Hollins Report „Textile Recycling Market Analysis“; <http://www.resyntex.eu/images/downloads/RESYNTEX-Leaflet-2018.pdf>

<sup>15</sup> Wicker, A., Fast fashion is creating an environmental crisis, Newsweek, 2016



**Figure 5: Global material flows for clothing in 2015<sup>4</sup>**



## 5. Lines of action

For Europe in general, structural changes of the T&C sector from the classical clothing production towards the production of technical textiles for high performance application fields are ongoing. Following this, the 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.

Technological solutions to treat conventional textile waste are sufficiently available and state-of-the art for Germany and Czech 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. In Italy technologies for sustainable manufacturing, that allow sustainable end-of-life processes, have been developing.

New methods/approaches to treat novel materials are required for all participating regions. 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).

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,
- the IT-based reduction of waste.

Production waste generated directly in the production process currently offers comparatively unknown potential in terms of volume (type and structure) and expandable potential in terms of recycling paths. Unlike used and old textiles, production waste is clean and defined in its composition and thus fulfils essential access criteria for successful recycling.

Enormous resources with high functionality can be made use of with waste from special fibers. Expandable value chains are to be established in particular in the areas of industrial and mobile textiles, but also in synergies with medical textiles and protective textiles.

According to EURATEX policy brief “Prospering in the Circular Economy” from 2017<sup>10</sup>, the need for a Circular Economy is becoming widely acknowledged across Europe and it is addressed by businesses, society and policy makers and specific initiatives. The analysis of the regional situation of textile waste management in the project ENTeR is showing a quite similar picture.

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

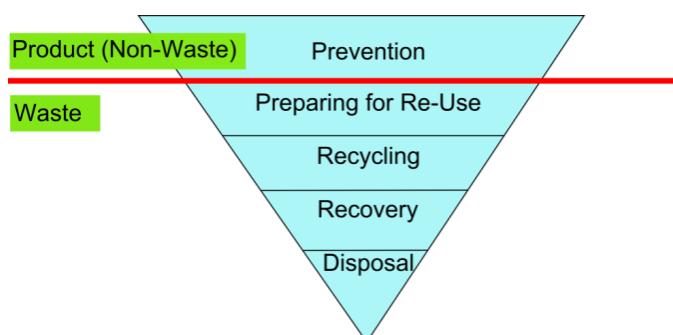


level for all regions and countries. These already existing solutions shall be consolidated and improved to profit from the opportunities of the Circular Economy.

## 5.1. Legal and Policies Area

A central concern of waste policy is to avoid and recycle waste. This is how natural resources are to be protected. The medium-term goal is to recycle all municipal waste in an environmentally compatible manner. This requires not only technical, social and political framework conditions but also legal decisions. Waste legislation is characterised by a large number of European legal acts. While regulations are directly applicable in the Member States, directives must be implemented into national law.

- **The European Waste Framework Directive (Directive 2008/98/EC)**<sup>16</sup> is one of the central directives in the field of waste management. It defines essential waste-related terms and defines, among other things, a five-stage waste hierarchy. It provides a general framework of waste management requirements and sets the basic waste management definitions for the EU. In the European Waste Framework Directive it is stated, that the primary objective of any waste policy is to minimise the adverse effects of waste generation and management on human health and the environment. Regulations for specific product waste can also be found in the End-of-Life Vehicles Ordinance, the Battery Act and the Electrical and Electronic Equipment Act.
- Directive 2008/98/EC sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling, recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risks to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. Waste legislation and policy of the EU Member States shall apply as a priority order the following waste management hierarchy:



**Figure 6:** Waste management hierarchy

<sup>16</sup> <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:32008L0098>; last visit 06.06.2018



The Directive introduces the "polluter pays principle" and the "extended producer responsibility". It incorporates provisions on hazardous waste and waste oils (old Directives on hazardous waste and waste oils being repealed with the effect from 12 December 2010), and includes two new recycling and recovery targets to be achieved by 2020: 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70% preparing for re-use, recycling and other recovery of construction and demolition waste. The Directive requires that Member States adopt waste management plans and waste prevention programmes.

- **Regulation (EC) No 1013/2006 of the European Parliament and of the Council<sup>17</sup>** of 14 June 2006 on shipments of waste. This Regulation specifies under which conditions waste can be shipped between countries.
- **Decision 2000/532/EC<sup>18</sup>** establishing a list of wastes. This Decision establishes the classification system for wastes, including a distinction between hazardous and non-hazardous wastes. It is closely linked to the list of the main characteristics which render waste hazardous contained in Annex III to the Waste Framework Directive above.
- On May 22, 2018, as recent action, the European Council approved and finally launched the new EU Circular Economy Package in Brussels. The aim of the package is to promote the circular economy, waste prevention and recycling Europe-wide. According to the German Environmental Assistance (DUH), this only partially succeeds with the approved recycling package.

### 5.1.1. Critical Factors

Although recycling rates for municipal waste and packaging are to be increased in the future, their calculation will be standardized throughout Europe. Separate collection of valuable materials such as bio-waste and used textiles should also be strengthened. However, specific targets for waste prevention and reuse are missing. Specifications on eco-design as well as economic steering instruments for the economical use of resources are also not provided. Despite its inadequacies, the circular economy package should be understood as a strong signal to all EU Member States to avoid waste and conserve resources. The package fixes new, binding targets and deadlines for more recycling and landfill reduction. It was also agreed that textiles must be collected separately across the EU starting from 2024.

### 5.1.2. Strategic objectives

Actions relating to policy/legislation are required, but also it is necessary to underpin recycling by developing innovative collection, reuse and recycling schemes, thus making recycling and reuse more efficient, easier to handle and transparent for consumers, industries and recycling companies.

Key components that will develop the strategic plan:

<sup>17</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528286329046&uri=CELEX:32006R1013>; last visit 06.06.2018

<sup>18</sup> <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:32000D0532>; last visit 06.06.2018



- to study ways to break down administrative obstacles and reporting to decision-making bodies: legal rules / guidelines (e.g. REACH or special certificates);
- supporting and promoting the use of financing to support investments (e.g. purchasing of technologies and machines);

## 5.2. Waste Management

The evolution of waste policies towards the circular economy is deeply transforming the waste management sector: the size of the business increases and the perimeter of the various supply chains widens ". It is a process that stimulates innovation and creates new markets.

With regard to textiles, the general system operates in a mainly linear way: large amounts of non-renewable resources are extracted to produce clothes, technical fabrics, furniture, after which the products are mainly sent to landfills or incinerated at the end of their life.

The objective of the area will promote the joint offer of new innovative services by the main local research centres and trade associations.

The expected collaboration model will be a "virtual centre", which provides a common proposal on the management of textile waste in a circular economy.

Used textiles are collected in many different ways. Textile waste as raw material for textile recycling has to be divided into production waste and used textiles. Therefore, also the collection and the further sorting and recycling are done differently.

- **Textile waste from industry and production**

Below we focus on material cycles for textile waste.

### Analysis of textile production waste

Main types of textile production waste are: fibre waste (also including dust and fluff), yarn residues, textile fabrics, pieces of textile fabrics (selvedges), cutting waste, defective products and other non-textile waste such as paper, cardboards, films, wood etc. The material composition of the textile waste comprises nearly all kinds of known natural and synthetic fibres.

### Waste treatment & recycling

Favourite option is to re-utilize the waste material by returning it directly into the production process to save raw material. Waste material from faulty production is sometimes used as cleaning wipes. The traditional method for the recycling of textile waste is the use of tearing and cutting processes to obtain reclaimed fibres. The material obtained is mostly used for manufacturing of fibre nonwovens (needle-punched or stitch-bonded) or for production of cleaning rags, filling material, insulation material, geotextiles, upholstery and automotive textiles which means a secondary use of waste. Further options used by the companies are physical or chemical recycling. Physical recycling is feasible for thermoplastic materials and the waste is re-granulated and can be used as raw material again. Chemical processes such as depolymerisation or re-polymerization are applied to re-cycle unmixed synthetic textile waste. Disadvantage of both recycling methods are high expenditure of time, energy and costs.

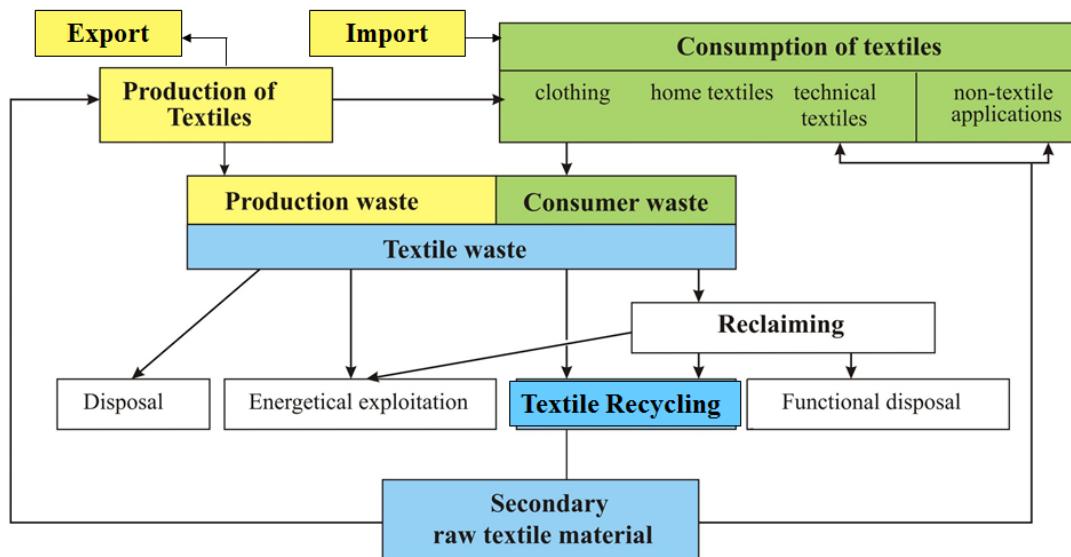


Figure 7: Material cycles for textile waste

If no re-utilization, no recycling or functional disposal (secondary use of textile products for another application, such as paper machine felts as geotextiles) is possible, the textiles waste becomes part of industrial waste or residential waste (cut pieces). Then a thermal/energetic exploitation is applied in public incineration plants or preferably in the producing companies. Finally, the waste is disposed in landfills.

#### Waste collection via disposal companies

In some EU-countries local disposal companies provide waste containers for the disposal of textile production waste as well as of non-textile materials (such as paper, cardboard...). The different types of waste are collected separately. Expenses occur for the rental of the containers as well as the collection/emptying of them.

The companies mostly carry out mechanical recycling and the reclaimed materials are re-utilized as described above. To save money, one important aspect for the textile companies is that the distances between textile companies are not too large. The collection of the textile waste is done on demand. To reduce the required space the textile waste is pressed into bales. The other types of waste like paper-board, films and packaging material are regularly collected by the municipal waste collection.

- **Textile waste from end-of-life clothing**

From the point of view of Circular Economy, all the end-of-life of textile products cannot be excluded in the evaluation.

Below we focus on the processes of recovery of textile waste from end-of-life garments:

#### Collection

In Europe each country has different success-levels of collection of end-of-life textiles and their further treatment. Used clothes are collected and redistributed by charity organizations but also by commercial collectors and municipal collecting points.

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 business. A part of the used textiles is sold afterwards sold to sorting companies for further processing. The remaining part finally goes the same way as residential waste and is end-up in incineration plants or landfills.
3. Further collection of used textiles and worn clothing is organised by private companies or charity organisations 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 under 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 will be again disposed.

### Sorting

The sorting of the collected goods determines which recycling path a garment goes through. The more accurately 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. According to a survey in Germany, sorters sort on average in 154 different fractions, with the maximum of 400 varieties.

It can be assumed that the time-consuming sorting service will contribute greatly to the added value within the used textile recycling chain and to the steady improvement in the recycling rate.<sup>19</sup> The sorters have sorting capacities in Germany, other EU countries and non-EU states. Overall, 93% of textiles are sorted in the EU (thereof 66% in Germany).

The proportion attributable to sorting facilities outside of Europe is currently comparatively low at 7%. Sorting companies acquire almost 65% of the input material for their plants with their own collection systems. The rest is purchased and comes up to 90% from national collections.

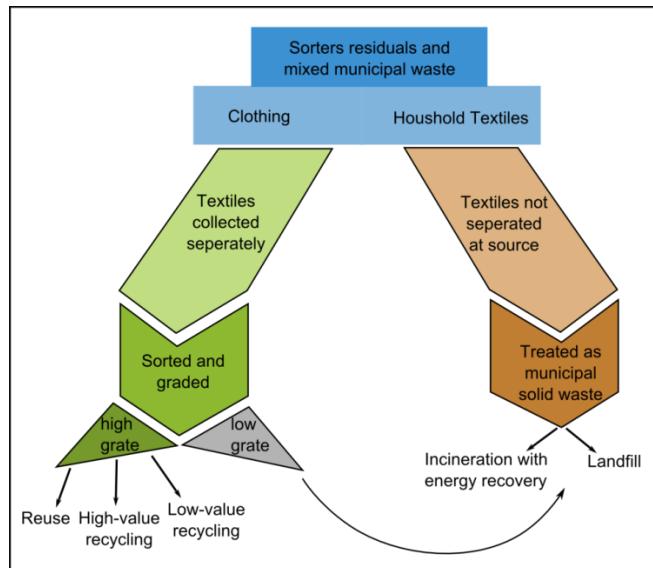
### Treatment

Clothing and household textiles are complex materials due to the variation in their composition, their quality at the point of disposal and the existence of alternative markets for textiles which have been recovered. Treatment options largely depend on whether the items have been segregated: if there has been no sorting and the items are mixed with non-textiles and are contaminated, there is the option to landfill or incinerate or to use classical mechanical recycling technologies. The traditional processing method for recycling of not wearable textiles

<sup>19</sup> German Association BVSE and FTR, Study „Consumption, need and reuse of clothing and textiles in Germany“, 2015



is the use of the tearing process to obtain reclaimed fibres. These reclaimed fibres are almost exclusively used in nonwoven products for insulation, upholstery and automotive textiles.



**Figure 8:** Flow diagram of end-of-life clothes and household textiles from source to treatment<sup>6</sup>

Currently, for ‘residual’ textiles which are contaminated, damp, ripped or stained and are no longer wearable, disposal commonly consists of landfill or incineration (without energy recovery) as there are no other valorisation routes available.<sup>6</sup> It is this type of waste for which research is being conducted to try to reduce or eliminate the disposal costs which are incurred and the environmental burden of landfill and incineration without energy recovery. It is important to find innovative solutions to valorise this waste to ensure that it does not add to the already significant environmental impact created by textiles.

### 5.2.1. Critical Factors

Several companies have problems in storing their textile production waste due to not sufficient storage space. Sometimes the disposal companies require textile waste bales which are assorted by colours. This causes even more problems concerning storage and also increases the time needed for waste collection. The companies prefer that disposal companies take high amounts of textile waste which has not to be assorted by colours.

Also the huge amount of old textiles from households disposed into the household waste is a critical factor.

Although there are the systems of separate container collection of old textiles provided by various charities, usually only the old textiles „fit for use“ is collected here. The huge amount of other old textiles (which is already too destroyed or contaminated to be offered to charities) goes to the bins becoming a part of household waste and usually is incinerated/landfilled without any sorting.

It is necessary to improve the separate sorting of this waste stream to divert it for further recycling.



### 5.2.2. Strategic objectives

Because of factors, such as the complexity of waste flows, volatility of material prices, rapid changes in business environment, lack of information about the availability and properties of waste streams, it is often very challenging to assess economic viability and sustainability of recycling and reuse of waste materials. In order to optimise the processes the potential for integration of various waste streams should also be considered. Understanding of synergies between sectors and value chains enables development of industrial symbiosis concepts, providing a great opportunity for approaches that will allow multiple industries to benefit simultaneously from cascading the material flows.

One of the challenges in estimating economic viability and sustainability of recycling and reuse of various waste streams, as well as in identification of raw material potential of waste streams, is the poor availability of up-to-date basic data. In addition, supply and demand do not meet because of lack of communication between waste producers and potential users. This calls for better means for information collection, management and transfer.

With the ENTeR project it will be possible to identify innovative solutions for the realization of a real local District of circular economy (consortium) in which to involve subjects in various capacities, engaged in the valorisation of materials and in the production of re-products, including: operators waste, small recovery platforms and SMEs.

Key components that will develop the strategic plan:

- to develop specialized databases and platforms for exchanging information, materials and technologies;
- to study a model for waste recovery (e.g. Local consortium for recovery);

### 5.3. Research trends and technologies

During the last decade, the sector has undergone a strong diversification process due to a combination of technological changes, an increase of production costs, the appearance of important international competitors, and the elimination of import quotas after 2004. To maintain the competitiveness, investment in innovation, creativity, advanced technologies, market enlargement and internationalisation became necessary. Companies have improved their competitiveness by reducing the mass production of simple products, and concentrating instead on a wider variety of products with higher added value.

European producers are worldwide leading in markets for technical and industrial textiles and nonwovens (applied as industrial filters, hygienic products, products for the automotive and medical sectors, etc.), as well as for high-quality clothing with a high design content. The trend towards higher value-added products needs to be continued in order to enhance the competitiveness of the T&C sector.

Globalisation and technological progress has caused a rethinking process in clustering strategies for the textiles and clothing industries. Cooperation only at local or regional level has increasingly proved insufficient to ensure that the production chain remains at the quite close geographical area of the European market. Therefore, clustering of diversified activities is now also based on a wider geographical area beyond the European borders.



Following the ongoing progress and development in the European T&C sector towards the 4th Industrial Revolution but also with respect to social factors like the rise in world population, higher life expectancy, an increasing proportion of leisure due to novel technological developments and more focus on health protection and prevention, the following research priorities for the coming years have been identified<sup>20</sup>.

The four innovation topics:

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

Within these thematic topics the focus is mainly given to high-performance materials and textiles, smart and multifunctional textile surfaces, new manufacturing technologies, digitisation, virtual modelling, new business models, high-tech recycling and circular economy concepts, sustainability of production and products, smart and functional wear products for health, sport and personal production, lightweight applications, and energy-efficient buildings.

### 5.3.1. Critical Factors

Essential innovations are not yet implemented on a large scale, due to uncertainties in the required investments and long-term economic viability of circular business models and the absence of long term commitments with retail and waste processors.

More than half of the companies do not see any problem to do waste collection and recycling. Main reasons why the interviewed companies do not recycle their waste are: the lack of technological or technical recycling solutions (11%). For 22% of the companies, the efforts for collection and treatment (separation, storage, logistics) are too high and also 22% mention that recycling of waste is not of economic interest for them.

### 5.3.2. Strategic objectives

New technologies and business models that could anticipate European industry with a view to competitiveness:

- to investigate treatment technologies for textile waste (e.g. mono-fraction, homogeneous and valuable waste);
- to investigate ways of re-using of waste coming from technical textiles especially by the technical character of such textiles (e.g. heavy coated or laminated, composites with latex, paper etc.);
- to study removal of chemical substances from textile waste;

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<sup>20</sup> Towards a 4<sup>th</sup> Industrial Revolution of Textiles and Clothing - A Strategic Innovation and Research Agenda for the European Textile and Clothing Industry.- Textile ETP, October 2016



## 5.4. Communication

We are in an era where the whole world is required, but in particular in Italy and Europe, radically different choices from those made in the past: far from the traditional production model, directed towards a new model of economy that respects the environment, oriented to a society that does not produce only waste but that knows how to create wealth and well-being with the reuse and regeneration of resources.

In order for this to happen, a profound change of mentality is required that involves institutions, businesses and individuals.

The Strategic Agenda promotes also a change of paradigm in waste management, which sees the industrial waste as a resource for sustainable economic growth. Therefore, attention is not limited to waste management, but it is shifted to the entire life cycle of goods, starting with the design phase.

In this context, change regulatory, production, organizational and distribution aspects, requires innovation and a new cultural approach with significant repercussions also on the consumer habits.

### 5.4.1. Critical Factors

The textile sector is by definition linked to the gratification of individual preferences, subject to the rapid change of trends (and consequently to the continuous replacement of goods) and is achieved through an extremely competitive industrial organization based on the most efficient economic exploitation of material resources.

In this context, the consumer is portrayed as a rational subject that makes his consumption choices in an efficient way: he tries to balance prices, personal gratification and the latest trends.

The direct consequence is the difficulty of products, which respect environmental standards, to establish themselves on the market as production is often more expensive and consequently the products will have to be sold at a higher price. This vision condemns eco-products to remain within a very narrow niche, reserved for the minority of consumers who perceive eco-compatibility or sustainability as positive elements within their utility function.

Therefore, the process of incentivising environmentally sustainable purchases sees on the one hand the institutions, with the task of educating and informing about sustainability issues, and on the other the companies that will have to generate an offer of quality products with low environmental impact.

Becoming sustainable will become more and more a necessity. For this reason, it is essential that a greater number of consumers and companies turn to a demand and offer of eco-compatible products.

### 5.4.2. Strategic objectives

Contributing to the development of future innovation skills capacity and culture.

Key components that will develop the strategic plan:



- to sensitize market demand and consumers for recycled products or made by recycled materials;
- to increase environmental awareness through educational campaigns;

## 5.5. Education

The aim is to bring out the training needs and the research world, identifying the conditions that favour the implementation of circular models with particular reference to industrial symbiosis.

It is necessary to focus mainly on the future generations of engineers, technicians and experts. The main impact will be to train professional figures connected to the circular economy. A side benefit, which is equally important, will be the communication of a culture of sustainability from the academic community to new professional figures.

The university world is asked to train experts in research and design in the textile sector able to design and manage technological development projects with innovative applications in the circular economy.

Collaboration with educational institutions will be required to ensure a new generation of workers and managers are prepared for successful careers in advanced EU-based textile production.

### 5.5.1. Critical Factors

The loss of skills because of an ageing workforce and the difficulty to find enough young professionals qualified in the new textile technologies is perceived as a major obstacle to the future development of EU textiles and clothing manufacturing.

### 5.5.2. Strategic objectives

Creating the right skills, knowledge, standards and mechanisms, to overcome traditional barriers between sectors and stimulate cross-sectorial, as well as value chain, collaboration to implement the ENTeR project and reach its targets.

Key components that will develop the strategic plan:

- to train professional figures to tackle problems and challenges coming from Circular Economy (e.g. waste recycling, up-cycling, industrial symbiosis).
- support translation and adaptation of technical courses to make them more broadly accessible and support sending employees from textiles companies away for extended periods of time to undergo extra training.
- support more vocational education programmes for textiles, at national or regional level;
- facilitate links between universities, trade schools and firms.
- to facilitate the transfer of know-how from the old generation to young textile workers.



## 6. Final consideration

The strategy agenda and the declination of the activity in the Action Plan will tend to operate the textile sector according to a globalised and efficient circular economic model that maximises the use of local resources, exploits advanced manufacturing techniques and engages in cross-sectorial collaborations.

Therefore, the individual lines of action declined in the five areas will improve the purpose of:

- Addressing the problem of managing, storing and transporting the textile waste to maintain the benefit of waste management
- Financial and administrative relief for managing textile waste would encourage the technical development in terms of textile waste treatments and the willingness to be active in the field of textile waste management and recycling
- Establishing well performing collection schemes and partnerships for producers of textiles (clothing, household and especially technical textiles) with focus on production waste
- Establish interregional expert networks and platforms for connecting stakeholders around Central Europe and build up a match making system for textile waste. To this respect one of the output of ENTeR is the textile waste database contained in the online platform developed in project Life M3P
- Cooperation between public authorities and regional textile industry is of high necessity for mandatory investments in sustainable textile waste management and technologies, especially SMEs need financial support from the regions
- Building up a knowledge pool for resource efficiency and eco design to encourage industrial stakeholders to implement such strategies in their production processes



## 7. Glossary

### Strategic Agenda

A strategy should be jointly defined on the basis of problems which are relevant for the participating regions. It should provide a common vision and set objectives and priorities in a mid- to long-term perspective. The formulation of a transnational and/or regional strategy should be carried out with involvement of relevant stakeholders (targeting the policy level) and aim at its subsequent implementation. Out of the findings coming from the Strategic Agenda the Action Plan has to be derived.

### Action Plan

An Action Plan is a sequence of steps that must be taken, or activities that must be performed well, for a strategy to succeed. An action plan must foresee: what will be done and by whom (tasks); when will it be done (time horizon); what specific funds are available for specific activities (resource allocation). An action plan should break down the strategy goals and objectives into specific tasks.

### Circular Economy

Looking beyond the current "take, make and dispose" extractive industrial model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimising negative impacts. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital. [Ellen MacArthur Foundation]

### Memorandum of Understanding - MoU

A memorandum of understanding (MoU) is a type of agreement between two (bilateral) or more (multilateral) parties. It expresses a convergence of will between the parties, indicating an intended common line of action. It is often used either in cases where parties do not imply a legal commitment or in situations where the parties cannot create a legally enforceable agreement. It is a more formal alternative to a gentlemen's agreement.

The MoU declares the Partners' interest to collaborate and common fields of interest to be explored.

### Interregional Advisory Board - IAB

It is an organism of consultation and support to the project. It's constituted by people named by the partners of the project, that are able to give feedbacks on problems encountered and strategies to address them for experience, competences and influence.



## 8. Bibliography

- [1] EURATEX - Annual report 2016;
- [2] EURATEX: European Textiles and Fashion: Facts & Figures, 2016;
- [3] EURATEX - „Prospering in the Circular Economy“, Policy Brief, 2017;
- [4] Ellen MacArthur Foundation “A new Textiles Economy: Redesigning Fashion’s Future”, 2017;
- [5] J. Conca - Making climate change fashionable - The garment industry takes on global warming, 2016;
- [6] Nia C Bell, Peter Lee, Kate Riley, Steve Slater „Tackling Problematic Textile Waste Streams“, Oakdene Hollins Ltd, Aylesbury, UK, 2017;
- [7] Circular Fibres Initiative analysis based on Euromonitor International Apparel & Footwear 2016 Edition (volume sales trends 2005-2015);
- [8] Morgan, L.R. and Birtwistle, G. - An investigation of young fashion consumers’ disposal habits (2009);
- [9] Towards a 4th Industrial Revolution of Textiles and Clothing - A Strategic Innovation and Research Agenda for the European Textile and Clothing Industry.- Textile ETP, October 2016;
- [10] M. Ricchetti, M. L. Frisa - Il bello e il buono. Le ragioni della moda sostenibile;
- [11] Sustainable Process Industry through Resource and Energy Efficiency - SPIRE Roadmap;
- [12] Euromonitor International Apparel & Footwear 2016 Edition (volume sales trends 2005 - 2015);
- [13] Life Project ECAP - „Mapping clothing impacts in Europe: the environmental cost“, 2017;
- [14] Friends of the Earth Europe - “Less is more, Resource efficiency through waste collection, recycling and reuse of aluminium, cotton and lithium in Europe“, 2013;
- [15] Oakdene Hollins Report “Textile Recycling Market Analysis”, 2016;
- [16] Wicker, A., Fast fashion is creating an environmental crisis, Newsweek, 2016.



## Annex

- i. Questionnaire and results of interviews
- ii. Summary of regional analyses (CZ, DE, IT, HU, PL)
- iii. EURATEX - Strategic Innovation and Research Agenda and Circular economy and resource efficiency
- iv. List of European projects in relation to textile waste and waste management