ETP
Fibres Textiles Clothing
EUROPEAN TECHNOLOGY PLATFORM

Textiles of the Future

PARTNERSHIP UNDER HORIZON EUROPE

Strategic Research & Innovation Agenda

July 2024

Executive summary

Following publication of the ***EU Strategy for Sustainable and Circular Textiles***[1] by the European Commission in 2022, the EU textile ecosystem was called upon to implement significant changes in the way it designs, produces and places textile products on the EU market. Research and innovation is an important tool to realise these changes, as highlighted in the Textile Transition Pathway[2]. To support the textile sector, especially its many SMEs in the implementation of the necessary research and innovation programme, the launch of the **European Partnership Textiles of the Future** (in short 'the Partnership') was announced by the European Commission in March 2024. The Partnership is expected to be formalised before the end of 2024 and will implement a **Strategic Research and Innovation Agenda** (SRIA) as described in the present document.

The SRIA's strategic objectives are aligned with the major challenges of the ongoing green and digital transition of the textile sector, addressing the needs arising from upcoming regulation and global market trends while making use of new knowledge and key enabling technologies.

The central Vision of the Partnership is the **development and demonstration of new technologies and innovative business models for competitive manufacturing of safe and sustainable textile products (and related services) made from low-impact functional materials and by clean and digitally connected processes in regional, circular and fully traceable supply chains for quality jobs, industrial competitiveness and responsible consumption in Europe.**

In a collaborative exercise involving several hundred experts representing the entire European textile ecosystem, the following three main Priority Areas and 13 Strategic Topics were identified and validated:

- **Priority Area I: Sustainable materials & clean processes**
  - Strategic Topic 1: Sustainable bio-based feedstock
  - Strategic Topic 2: Sustainable fibres
  - Strategic Topic 3: Sustainable textile chemistry
  - Strategic Topic 4: Resource efficient processes
  - Strategic Topic 5: Efficient end-of-life sorting, separation & recycling
- **Priority Area II: Digital supply chains & new business models**
  - Strategic Topic 6: Digitalisation of the textile value chain
  - Strategic Topic 7: Sustainability & Circular Data Management

[1] European Commission, *EU Strategy for Sustainable and Circular Textiles*, 2022
[2] European Commission, Textiles industry transition pathway, 2023

    - Strategic Topic 8: Design for sustainability & circularity
    - Strategic Topic 9: Circular business models & value-added customer and end-user services
- **Priority Area III: Advanced manufacturing & high-performance textiles**
    - Strategic Topic 10: Automated and AI-supported smart manufacturing
    - Strategic Topic 11: On demand digital and networked manufacturing
    - Strategic Topic 12: Safe & sustainable materials for technical applications
    - Strategic Topic 13: (Multi)functional materials for technical applications

Following the signature of a **Memorandum of Understanding between the European Commission and Textile ETP**, as lead organisation of the private stakeholder community, in late 2024, **dedicated calls for proposals will be launched under Cluster 4 of the Horizon Europe programme in 2025-2027**. The specific scope, objectives and expected impacts of these call topics will be inspired by the priorities identified in this SRIA and will be approved by the Partnership Board composed of representatives of the European Commission and the private stakeholder community.

The resulting co-financed collaborative projects will involve industry, with a focus on SMEs, research and technology organisations, universities and other ecosystem stakeholders. Research and innovation activities will primarily focus on higher Technology Readiness Levels (TRL) to ensure rapid deployment of the developed solutions at industrial scale by European companies of the sector.

In the initial phase of the Partnership (2025-27) at least **€60 million** should be spent by public and private stakeholders on the core research and innovation actions mutually agreed upon. These funds will be supplemented by additional public and private funds raised from various EU, national and regional programmes and investors for accelerated exploitation actions such as demonstration, pilot testing, new manufacturing facility set-up, early market replication and start-up creation.

Additional community building, project and technology brokerage as well as communication and dissemination activities coordinated by Textile ETP will ensure that project results, new technologies, knowledge and best practices are rapidly diffused with the EU textile ecosystem and beyond. The ultimate objective is to enable the European textile sector to perform in compliance with the regulatory requirements relating to sustainability and circularity that are expected to enter into force towards the end of the decade, while successfully facing the challenges of global competition and realising attractive growth opportunities in existing and new markets in the EU and around the world.

01

The role of textiles for people, planet and the economy

Textiles are everywhere

Fibres and textiles are among the oldest, most versatile and most broadly used materials known to mankind. Plant or animal-derived natural fibres have been used for millennia to make clothing, to build shelters, to dress and decorate interiors, to protect and carry goods, to fabricate tools or transportation systems (rafts, sailing boats etc.), to farm and fish, to conduct ceremonies or to play games and sports.

In the late 19th century, the production of man-made cellulosic fibres made from wood pulp was invented and in the 1930's to 1950's petrochemical inventions massively enlarged the spectrum of available textile fibres synthesized from fossil fuel based polymers such as polyester, polyamide and polyolefin fibres, which due to their functionality and industrial production efficiency have now come to dominate the global textile fibre market with an approximate 65% market share. However, cotton remains a highly important fibre with a market share of about 22%. All other natural fibres such as wool, linen, silk, jute as well as man-made cellulosic fibres collectively make up the remaining 13%.

Globally some 116 million tonnes of textile fibre are produced per year[3] with an average annual growth rate of about 2-3%. This growth is primarily caused by global population growth, rapidly growing consumption in emerging economies and a more wide-spread use of textile materials in technical end markets, while textile material consumption growth in the European Union (EU) is well below the global average.

Slightly over half of textile fibres are used for apparel (clothing and footwear), some 20% for home and interior textiles (incl. carpets) and close to 30% for a very wide range of technical end markets, the most important of which being construction, automotive, furniture, personal protection, hygiene and healthcare as well as sports.

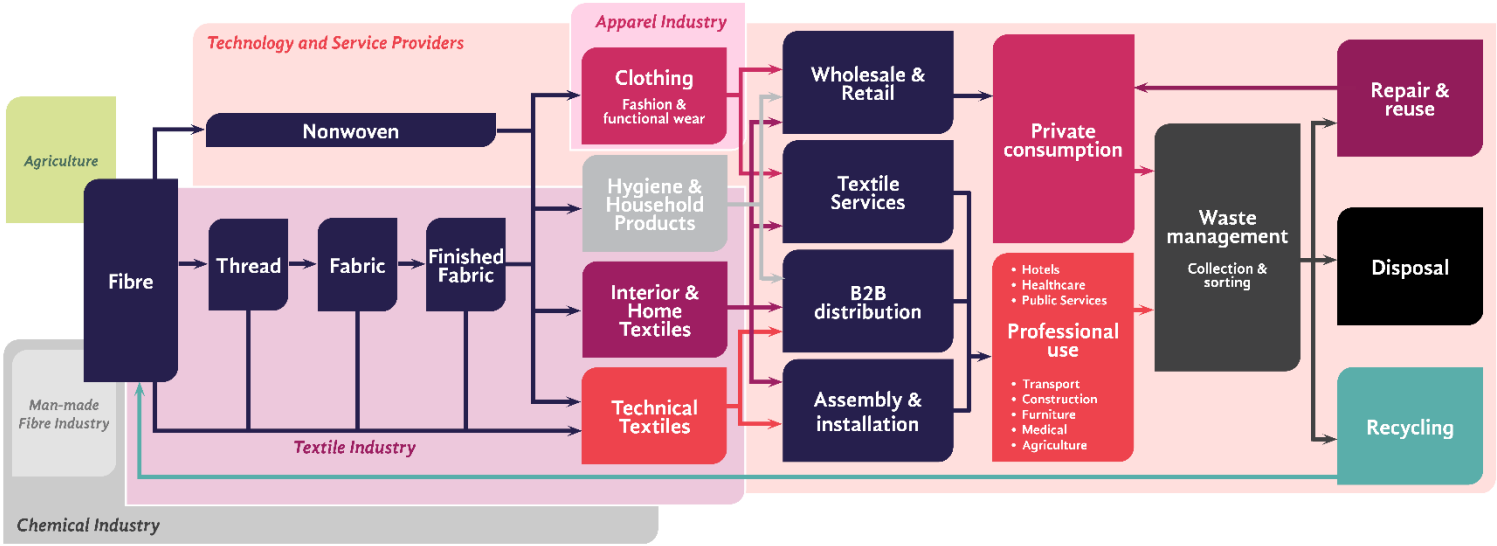


Figure 1: The world of fibres and textiles – Source: Textile ETP.

The use of different fibre types for different end uses is heavily dependent on the required material properties as well as economic factors. The vast majority of cotton, due to its softness and moisture absorption capacity is used for clothing and home textiles that are in close contact with the human skin such as underwear, night wear, shirts and t-shirts, pants and tops, bedding or bathroom textiles. Synthetic fibres on the other hand due to their durability, low cost, hydrophobicity or quick drying are predominantly used for technical applications, furniture, carpets, sports and outdoor gear. In recent decades textile fibre use for technical applications including non-wovens and composites has grown faster than clothing and home textile use.

Most textile products are durables and remain in constant or repeated use for years or decades such as carpets, bedding, seating furniture, automotive interiors, tents, bags, household linen and a significant share of clothing and footwear. A relatively small share of textile fibre-based products is designed for short term or even single use predominantly in the healthcare and hygiene market (wipes, diapers, face masks etc.). Also, a growing share of clothing products typically referred to as 'fast fashion' is made in such a way that long-term use is compromised due to the low quality of material or assembly, or due to the fleeting nature of its design. Other textile-based articles with typically short use lives include merchandise and marketing products such as printed t-shirts, caps, tote bags, flags, banners, carpets etc. made for special occasions and events.

[3] Textile Exchange, *Materials Market Report*, 2023.

The impact of textile production and consumption

The farming of natural fibres, the extraction of raw materials for synthetic fibre making, the processing of fibres into yarns and fabrics, the assembly of fabrics into finished products as well as their distribution, use, maintenance and end-of-life treatment consumes resources and creates a multitude of environmental and social impacts.

Due to the highly dispersed nature of textile material use across many end markets and related different production processes, no reliable figures exist for the greenhouse gas emissions of the entire global or EU textile sector. Recent studies of the global apparel industry showed about 1.85% of total global greenhouse gas (GHG) emissions[4] for the entire production and distribution value chain of clothing and footwear and slightly over 2% when the use and end-of-life phases are included. The vast majority of these emissions are linked to energy-intensive wet processing steps in textile production such as dyeing and finishing which use a significant share of primary fossil fuels such as coal, oil and gas to heat water or generate steam. Most other textile processing and assembly steps such as spinning, weaving, knitting or confection are electrically powered, and their CO2 emission are largely dependent on the sources of electric energy production that feeds the local grid.

In addition to energy use, fibre and textile production also uses significant amounts of water, a very broad spectrum of processing and functionalising chemicals as well as agricultural land and crop protection chemicals in fibre farming. Inefficient, incompetent or outright illegal management of these resources can be linked to many negative environmental impacts from soil degradation to freshwater scarcity or pollution that negatively impact human health and biodiversity in the concerned areas. According to a European Environment Agency (EEA) study the textile sector ranks 3rd in land and water use.[5]

The farming of textile fibres, the industrial processing of textile materials and the manufacturing of garments is very widely distributed across the globe, but also includes many countries and regions with political instability, limited legislation concerning environmental or social protection or poor enforcement thereof, which enables the violation of human rights, the exploitation of workers, vulnerable communities and the environment.

The consumption of textiles creates obvious user and societal benefits. Clothing and fashion provides protection as well as ways of self-expression. Home and interior textiles provide comfort, safety, light and temperature management in addition to decoration. The list of benefits of technical textiles is too long to exhaustively provide, but protection and safety of people and goods, energy-efficiency and light weight advantages are the main aspects. But consumption of textiles is also generating negative impacts. The main ones are GHG emissions related to energy use for washing, drying or ironing, the shedding of microfibrous particles during wash and wear as well as waste generation at the end of a product's useful life. Total EU post-consumer textile waste generation amounts to 11 million tonnes, 52% from technical and home textiles and 48% from clothing and footwear. 75-80% of this waste is incinerated or landfilled after its first use cycle[6], with the rest being similarly disposed of after one or two re-use cycles. Globally, less than 1% of post-consumer textile waste is recycled back into fibres and textiles.

[4] Apparel Impact Institute, *Taking Stock of Progress Against the Roadmap to Net Zero*, 2024.
[5] European Environment Agency (EEA), *Textiles and the environment*, 2022.
[6] Joint Research Centre, *Techno-scientific assessment of the management options for used and waste textiles in the European Union*, 2023.

Generally, the consumption of apparel in volume has been stagnant in the EU over the last 20 years fluctuating between 4 to 5 million tonnes annually since 2005, following a relatively rapid rise in the years between 1995 to 2005 when the import quota system of the Multifibre Arrangement (MFA) was successively dismantled.[7] At the same time consumption of textile fibres for technical applications including non-wovens and composites is steadily increasing. This also impacts the material mix, with a rapidly increasing share of synthetic fibres in the global textile fibre mix, while natural fibre production and consumption remains relatively constant.

The European and global textile industry

The design, production, distribution and after-sales service of textiles and textile-based products incl. the farming of natural fibres is one of the largest sectors of the global economy, providing occupations and income to hundreds of millions of people around the world. The production of clothing, home textiles and footwear consumed in the EU alone is estimated to provide employment to some 13 million full-time equivalent workers around the globe.[8]

The textile and clothing industry is also one of the most globalised industries. While over 80% in volume of all clothing, home textiles and footwear consumed in the EU is imported, the EU textile and clothing industry exports close to 40% of its production to non-EU markets amounting to € 64 billion in 2023[9]. Because textile products are easy to transport over long distances due to their light weight and non-perishable nature, businesses can easily exploit comparative competitive advantages such as access to raw materials and lower cost resources especially labour in developing and emerging economies or the high level of design and engineering competence in the EU.

This specialisation led to a highly diversified and differentiated profile of the EU textile and clothing industry with an extraordinarily high and steadily rising labour productivity and a concurrent decline of employment in labour-intensive manufacturing and otherwise low value adding activities. The annual turnover of the EU textile and clothing industry has been largely stable over the last 10 years (€ 170 billion in 2023)[10], fluctuating with economic cycles while total manufacturing employment has slightly declined by a cumulative 10% over the same period.

*Figure 2: EU textile and clothing industry key figures 2023, turnover and employment: estimates. imports and exports: extra-EU trade, *companies and investments in tangible assets: 2022 - Source: EUROSTAT, In: EURATEX, 2024.*

[7] Joint Research Centre, *Preparatory study on textiles for product policy instruments (draft)*, 2024.
[8] EEA, 2022.
[9] EURATEX, *Facts & Key Figures*, 2024.
[10] EURATEX, 2024.

Dominant segments of the EU industry are premium level fashion and home textile products with a high design component and as well as highly engineered and strictly quality-controlled advanced technical textiles. EU textile exports are dominated by premium fashion and workwear garments (60%) and high-quality woven and other technical textiles (25%). The EU also has a world-leading textile technology industry, providing machines, equipment, tools, software and services to textile and garment manufacturing operations around the world. The physical and cultural proximity to these outstanding industrial engineering and technology development capacities combined with a European-wide network of dedicated research centres, technical universities and universities of applied sciences with a focus on textile and fashion, has ensured that Europe still generates the majority of textile innovations, while other parts of the world excel in rapid adoption, replication, and scaling of these innovations.

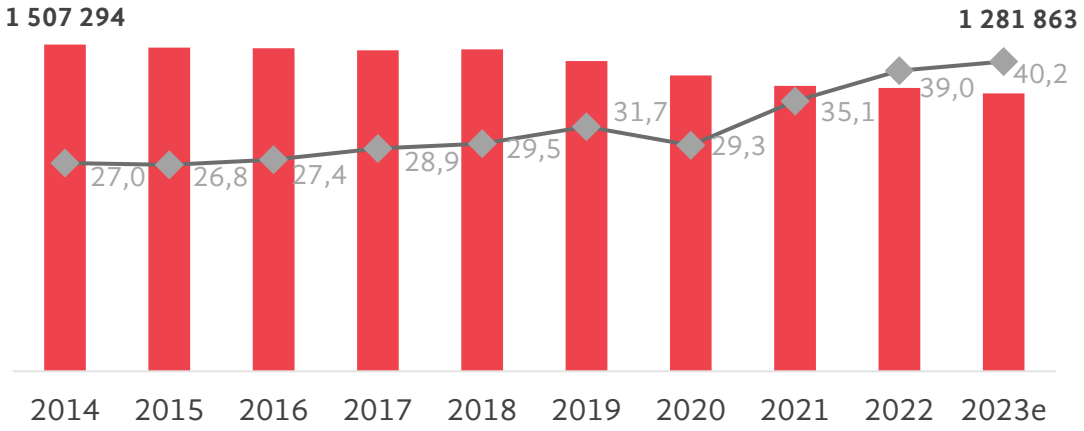


Figure 3: EU-27 Evolution of labour force and labour productivity in T&C industries between

Traditionally textile production has been locally concentrated in clusters or districts distributed across the EU. Major production clusters continue to exist in Italy, Germany, France, Spain, Portugal, Poland and Romania, with the biggest one in terms of employment, the Norte region in Portugal, counting over 100,000 direct job being. Hence while the textile sector represents a relatively modest share of total EU manufacturing, it remains a strategic provider of jobs and economic income in many cities and regions across the EU. These existing local production clusters can also serve as a springboard for the (re-)emergence of regional supply chains in which products can be more easily manufactured on demand and end-of-life materials can be recycled and fed back into the industrial processing chain without excessive long-distance transportation.

02

Industry transformation & policy context

Industry transformation challenges and opportunities

The economic, technological, geopolitical and societal transformation processes that the European textile ecosystem is confronted with have never been more multifaceted and fast-changing than today. They represent a complex mix of challenges and opportunities and will lead to many disruptive shifts in global textile production and consumption. Below the most impactful trends are shortly described.

Sustainability

Competitiveness impact: very high
Research & innovation impact: very high

Sustainability in all its facets is generally considered the most pressing and holistic challenge for businesses in all sectors of the economy, including the textile industry. GHG emission, resource consumption, pollution, waste generation and other negative externalities affecting human health, economic development, social justice and cohesion, environmental integrity and biodiversity are expected to be actively reduced by all businesses. The knowledge, economic incentives, financial resources and technical capacities to do so vary from company to company and are particularly scarce among small and micro-enterprises that make up 98% of textile and clothing businesses in Europe[11]. Impactful investment in sustainability while maintaining economically viable business operations in the face of fierce global competition and average low profit margins is undoubtedly the most formidable challenge for the European textile ecosystem.

[11] EURATEX, 2024.

Digitalisation & AI

Competitiveness impact: very high
Research & innovation impact: high

The pervasive digitalisation and partial virtualisation of all economic and societal systems also affects all aspects of textile production and consumption. The massive gains in productivity, efficiency or speed of operations that result from successful business process digitalisation make the digital transformation of the textile sector an inevitable trend. Information & communications technology (ICT), software, databases, digital platforms and most recently artificial intelligence have become indispensable tools for all textile business functions from design and product development to production, supply chain management, logistics, distribution, marketing and customer service. However, the investment in such technology is not without risks and challenges. IT experts or employees with sound digital skills are often in short supply especially in smaller textile companies. Software implementation projects often disrupt existing business processes, require reorganisations and reskilling of staff. The need to securely store, process and exchange digital data exposes companies to cybersecurity risks. Still, enterprises that fail to digitise rapidly are at high risk of being overtaken and outcompeted by more nimble rivals or digital-native start-ups.

Distribution and consumer engagement

Competitiveness impact: medium-high
Research & innovation impact: medium

Textiles are material-based goods which often also require customers to physically touch, feel or fit the product. Therefore, the textile and clothing sector was not a first mover in digital distribution. However, by now, online sales of clothing, home and professional textiles are a significant and rapidly rising share of the total market. Omnichannel capacities are becoming the norm, which allow the customer to engage with the product both on- and offline and where the experience of touching and trying the product can be separated from the process of purchasing and delivering it. Social media platforms and mobile applications are further important tools to reach and engage with the customer, to collect feedback on the user experience and to create customer loyalty. Efficient last mile international logistics also enable competitors without any local manufacturing or even physical business presence in the country of sale to reach customers around the globe.

New business models

Competitiveness impact: high
Research & innovation impact: medium-high

For a long time, the textile and clothing business was a traditional product driven business where economic value creation ended when a customer had purchased the good and walked out of the store or the warehouse. Growing the business meant increasing production and extending distribution to reach more customers in more locations or to generate accelerated replacement demand through planned obsolescence, the hallmark of the fashion business, to entice the consumer to discard products often well before they were physically worn out. Some exceptions existed in professional textile business lines such as workwear, protective clothing or bedlinen, towels and table wear in the hospitality or medical sector where service business models were common and economic value creation also included logistics, care and maintenance operations. Digitalisation now allows service-based business models including those that advance circular economy principles such as rental, resale, repair etc. to also be extended to the consumer market. Such servitisation has the double benefit of differentiating the supplier's offer against a pure product price-based competition and allows to decouple economic value creation from material consumption, which has obvious sustainability benefits. Such service-based business models are expected to become more pervasive in the textile and fashion business.

Regulation

Competitiveness impact: very high
Research & innovation impact: medium-low

Apart from some specialised textile business niches such as personal protective equipment or textiles used in the healthcare or construction sector, most textile-based products where not subject to extensive regulation, apart from some labelling and consumer safety requirements. This is about to change quite dramatically, especially in the EU single market where a raft of regulation is in various stages of preparation and implementation. Other countries around the world are closely monitoring this European agenda and may decide to adopt similar strategies in the years to come. The specifics of the key legislative initiatives impacting the textile business are detailed in the following chapter. It is clear that regulatory compliance including the knowledge and resources to correctly deal with data collection, verification, information, reporting and other requirements will become an important factor for survival and success of textile businesses serving the EU market.

Supply chain integration and on-demand production

Competitiveness impact: medium-high
Research & innovation impact: medium

The fact that the assembly of textiles into garments and other complex products has remained a labour-intensive process and that global transportation of textiles is cost-efficient, has over several decades led to a geographical disintegration of the manufacturing value chain. While knowledge-based high added value business functions such as design, product development, branding, marketing and merchandising as well as distribution and retail was maintained in Europe, most manufacturing operations where outsourced to independent suppliers and manufacturers, mostly based in Asia. The complexity and inflexibility of these global supply chains forced most textile brands and retailers to adopt a forecast-based production model, even for fashion products with highly volatile and unpredictable demand patterns. This systematically leads to overproduction of items for which no buyer can be found (or only after heavy discounting in end-of-season sales) and an inability to serve unexpectedly higher demand for popular items. It also complicates supply chain optimisation, transparency and legal compliance efforts. For this reason, a stronger push toward reintegration of supply chains and at least a partial reshoring or near-shoring of production, based on higher levels of automation and digital connectedness can be expected to reap the benefits of an on-demand production model and to facilitate regulatory compliance.

Regional supply chains

Competitiveness impact: medium-high
Research & innovation impact: medium

Such reintegration of textile supply chains and reshoring trends could lead to a renaissance of stronger regional supply chains within Europe which have the additional benefit of facilitating circularity and service-based business models. European countries with existing textile and clothing production clusters are expected to be early beneficiaries of these trends while in countries where traditional textile and clothing manufacturing capacities had been almost entirely lost, the rebuilding of regional manufacturing capacities will require greater capital and human resource investment. Since the launch of the Smart Specialisation concept in EU regional policies and related funding programmes, EU textile regions have been brought together under the RegioTex initiative to exchange best practices and accelerate smart investments into regional textile innovation and manufacturing capacities. Also, neighbouring countries in Eastern and Southeastern Europe and Southern and Eastern Mediterranean countries could be important beneficiaries of nearshoring trends, facilitated by the recently revised Pan Euro Med Convention on rules of origin.

Raw materials

Competitiveness impact: high
Research & innovation impact: high

Textile fibres are generally not considered critical raw materials, because while most of their production takes place outside Europe, they generally have been in abundant, diversified and price-stable supply. However, in the drive towards sustainability and circularity, textile businesses including consumer facing brands and retailers are forced to take a more engaged role in ensuring not only the quantitative and economic supply of their raw materials, but also the sustainability and responsibility in which they are produced and sourced. Cotton and other natural or man-made cellulosic fibres must be sourced from producers that are engaged in responsible land, forest and water use and legal and non-exploitative labour practices. Over a longer time horizon, fossil-based textile fibres need to be replaced with functionally equivalent alternatives from renewable feedstocks. Information about resource utilisation and emissions from the fibre production stage must be collected for all fibre types for reliable product footprint calculations. In addition, recycled materials should be increasingly integrated into textile products, while their supply is currently very limited and technologies and industrial capacities to provide such recycled fibres in the necessary quantities and qualities must be actively developed.

Resource costs

Competitiveness impact: high
Research & innovation impact: medium

In addition to fibres, the textile industry also uses significant quantities of energy, water and chemicals throughout all production and use stages. The cost for these resources can fluctuate, sometimes rapidly and widely, such as during the war-induced energy crisis in Europe in 2022-23. Also, resource availability, especially water is not always guaranteed. Many fibre and textile production regions in Europe and around the world suffer from seasonal or permanent water scarcity. The cost and availability of process-critical chemicals can also be compromised, either by market or geopolitical factors such as the concentration of production of certain dyes, chemicals or intermediates among very few suppliers or their location in a single country or world region. Also, regulatory restrictions of hazardous textile chemicals can disrupt their supply, at least in the countries where the restriction applies, without any functionally equivalent or economically suitable substitute available.

Resilience

Competitiveness impact: medium-high
Research & innovation impact: medium

A series of global crises in recent years have shown that the smooth functioning of global trade and ready availability of all types of imported primary resources and products cannot be taken for granted at all times. Strong dependencies from suppliers in single countries or world regions can create sudden vulnerabilities for otherwise well-functioning industries or sectors of the EU economy. Textiles are no exception, e.g. the shortage of face masks during the Covid-crisis, or the supply of dyestuffs originating from just one country. When individual companies or subsectors of an industry cannot ensure sufficient diversity and stability of supply, governments may have to step in to create alternative supply sources and routes within Europe or allied countries or create resource price conditions that do not put EU companies at massive disadvantages against global competitors. Diversified and economical raw material, energy and chemical supply conditions are critical for the long-term health and competitiveness of the EU textile industry and the necessary investments and geopolitical agreements should be put in place to guarantee them.

Global Markets

Competitiveness impact: medium-high
Research & innovation impact: medium-low

The textile industry is one of the most globalised industries and without free global trade the textile and clothing business as we know it today would collapse. In 2023, the EU imported € 115 billion worth of fibres, textile materials and final products while exporting € 64 billion of mostly processed textile materials and final products, corresponding to almost 40% of the EU industry's turnover.[12] Imports are highly regionally concentrated. The 7 largest countries of import origin are all Asian, jointly representing 75% of all EU textile imports. EU exports on the other hand are far mor diversified with countries from 4 different continents to be found in the top ten expert destination list. The EU textile industry needs open markets especially because consumption growth is much faster in emerging economies with healthier demographics and a higher need to catch to levels of prosperity and quality of life that are common in the highly industrialised world. Still this global trade not only needs to be free but also fair, so that similar rules and procedures apply to allow companies wherever they are based in the world to compete on a level playing field.

New Textile Applications

Competitiveness impact: medium-high
Research & innovation impact: medium-high

By 1990 almost 90% of all fibres produced were used for apparel and home textiles. This share is expected to drop to close to 70% by 2030. This means that close to 30% of all textile fibres produced are used for a broad range of technical end markets such as transport vehicles (ground, sea and air), construction, landscaping and agriculture, protection, healthcare, sports and outdoor equipment and several others. The EU industry is a global leader in highly engineered technical and functional textiles, non-wovens as well as fibre-reinforced composites and most of these markets are expected to show steady growth rates within Europe and globally for decades to come. Also, major societal challenges and innovation trends such as the renewable energy transformation, climate change adaptation and mitigation, electromobility and the care for a growing elderly population will offer interesting opportunities for textile-based solutions. Many of these markets are highly performance, quality and innovation driven which plays into the strength of the EU textile industry and should make them a prime destination for intensified investment.

Workforce and skills

Competitiveness impact: high
Research & innovation impact: medium

Compared to many other manufacturing sectors, textile and clothing has traditionally been one with an outsized workforce due to highly labour-intensive operations, especially in garment making. With the accelerated offshoring of these labour-intensive processes to lower labour cost non-EU countries, especially during the Agreement on Textiles and Clothing (ATC) phase out period after the end of the Multifibre Arrangement in the 1990's and earlier 2000's, the EU textile and clothing industry rapidly lost close to 2 million employees. By the early 2010's this process had largely played out and since then employment reductions are rather limited and more in line with other stable manufacturing industries where labour trends are more influenced by automation and digitalisation than disruptive global competition. In 2023, the EU textiles and apparel sector employed 1.3 million workers[13].

The situation has actually reversed to a point where many companies struggle to find qualified staff and attract young talent to replace a rapidly ageing workforce. In 2022 42% of the sector's

[12] EURATEX, 2024.
[13] EURATEX, 2024.

employment in the EU was 50 years or older. The related skills shortage doesn't only concern conventional material, manufacturing and general business skills, but especial digital and sustainability-related skills that are in high demand in many sectors of the economy.

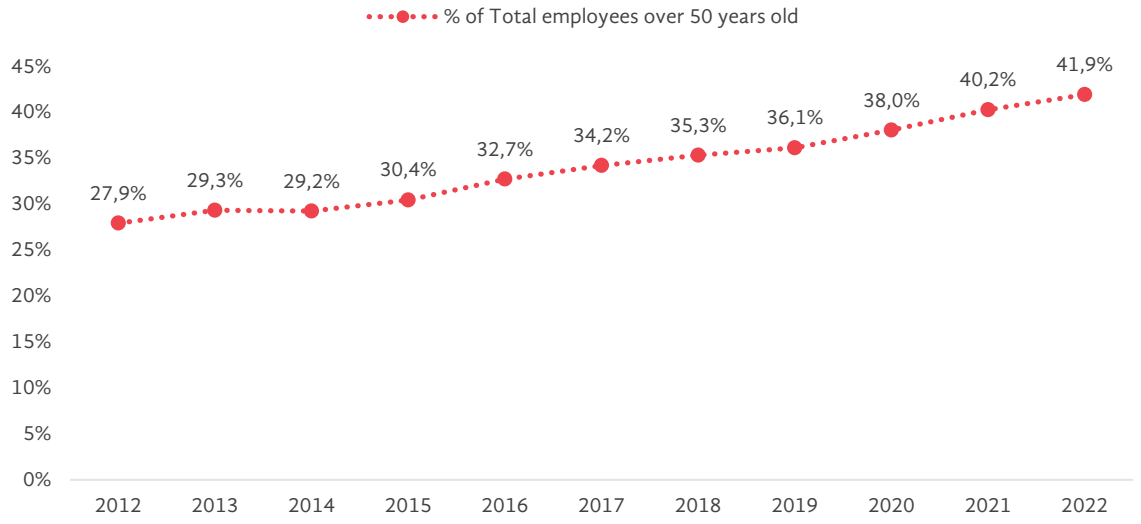


Figure 4: Evolution of workers over 50 in T&C - Source: EURATEX, 2024.

Education and training

Competitiveness impact: high
Research & innovation impact: medium-high

To address the shortage of skilled labour and young professionals equipped and ready to enter the textile workforce, the sectoral education and training provision needs to be upgraded, modernised and professionalised. While design schools face no shortage of students, technical universities, universities of applied sciences, technical colleges and professional schools offering textile-related curricula have a much harder time to fill their programmes. Persistently low student numbers led to underinvestment in or outright closure of such programmes or schools with resulting declines in quality and availability of higher and professional textile education.

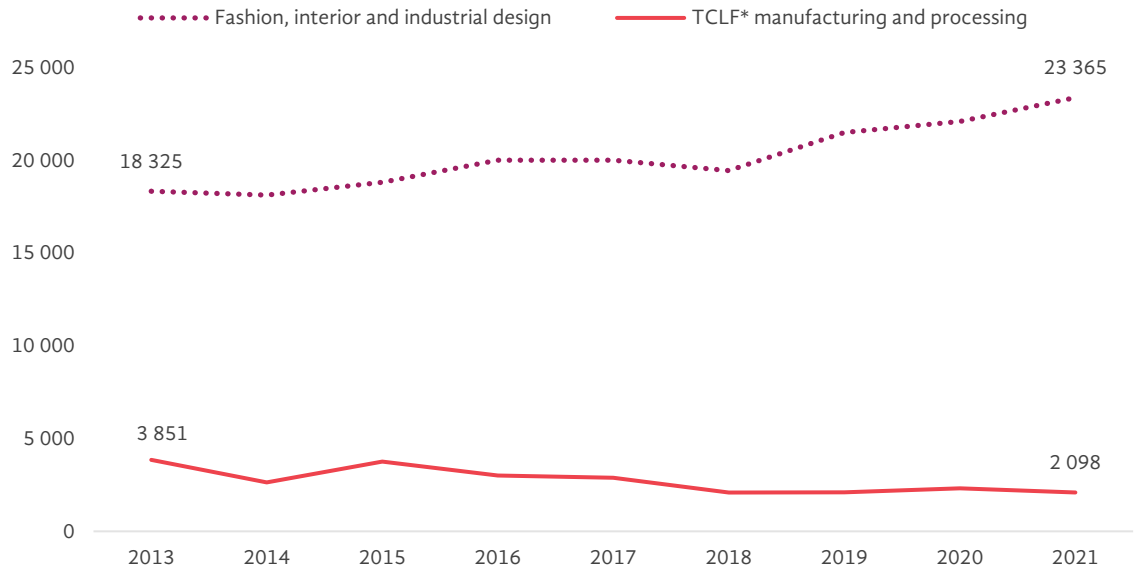


Figure 5: Evolution of graduates (masters & bachelors), by programme orientation - Source: EURATEX, 2024.

To address this EU-wide problem, the Textile, Clothing, Leather and Footwear industries (TCLF) Skills Alliance was launched in 2023 and several funding programmes mostly under the ERASMUS+ scheme and the Single Market Programme have since been initiated. These programmes focus on modernisation of curricula, teaching and learning methods and tools, the exchange of best practices and more active collaboration between industry, the professional education sector and public authorities at regional level. Apart from improved initial education and training provision, also life-long learning, continuous workplace training and generational knowledge and skills transfer within companies need to be intensified to ensure the EU textile and clothing industry can maintain its competitive position as a maker of innovative high-quality products.

Policy and regulation

Latest when the European Commission published its communication *EU Strategy for Sustainable and Circular Textiles* in early 2022, it became clear that the policy and regulatory landscape for this industry was fundamentally changing. Never before had the textile and clothing sector been so directly and comprehensively targeted by such a comprehensive set of policies and upcoming regulations that would redefine how textile products are made, sold and consumed in the EU. The textile sector was in the process of becoming a regulated industry, here in Europe, but with wide repercussions on global textile value chains.

Figure 6: EU legislations that will impact textile and clothing companies – Source: EURATEX, 2023.

Below the main policies and legislative initiatives are shortly outlined

Ecodesign for Sustainable Products

Designing and making textile products, notably clothing, with clearly defined and objectively verifiable sustainability attributes is expected to become the norm in the EU when the textile-specific requirements of the broader *Ecodesign for Sustainable Products Regulation* (ESPR) becomes legally binding later in the decade. A special delegated act will describe which product characteristics at what performance levels will be required for each type of textile product covered by the regulation. Attributes such as durability, repairability, recyclability, recycled material content or the overall environmental footprint of the product may be in the scope. A mandatory digital

product passport (DPP) should reveal product information to consumers, authorities or value chain participants.

Supply Chain Due Diligence and Traceability

Companies that manufacture or place textile products on the EU market will not have to ensure that those products comply with product-specific regulations, but also need to monitor, anticipate, mitigate and address social and environmental risks across their supply chain. According to the *EU Corporate Sustainability Due Diligence Directive* (CSDDD) which is expected to enter into force in 2027, large companies must undertake due diligence to guarantee that own production processes or those of suppliers respect recognised standards and for instance do not involve violations of workers' rights, including forced labour or environmental degradation. Transparency and traceability provisions in CSDDD and in ESPR could lead to a global level of supply chain control that is way beyond today's common practice, relying primarily on voluntary audits, certification and other self-regulatory measures.

Circularity and Waste Management

In its revision of the *EU Waste Framework Directive* (WFD), proposed in 2023, the European Commission specifically targets the textile sector, highlighting the high volume of post-consumer textile waste generated, its low level of separate collection as well as its virtually non-existent material recycling. The introduction of mandatory separate collection across the EU as of 2025 and harmonised *Extended Producer Responsibility* (EPR) schemes across all 27 EU member states over the following four years should address this problem. The stricter rules for exporting textile waste outside the EU, set under the Waste Shipment Regulation, may further increase the amounts of textile waste in need of processing and recycling. This means that collection, sorting and recycling infrastructure needs to be scaled up rapidly across Europe, ideally in-sync with a growing capacity of the EU textile manufacturing supply chain to absorb and process recycled materials.

Chemicals

Since 2007 the *Registration, Evaluation, Authorisation and Restriction of Chemicals* (REACH) regulation comprehensively regulates how chemicals are manufactured, placed on the market and used in the EU with the main aim to improve the protection of human health and the environment from the risks posed by chemicals. This means that all chemicals need to be registered to be evaluated based on the risk they pose. In cases where risks cannot be sufficiently mitigated, chemicals maybe restricted to certain use cases only or banned altogether. Many classes of chemicals conventionally used in the textile industry were subject to such restrictions or risk becoming subject in the coming years as revisions to the current REACH regulation are being adopted. To ensure that important textile processing options or product functionalities are not lost due to such restrictions, a constant quest for the development of functionally equivalent but less hazardous substitutes is needed. To further ensure that chemical and material innovation processes do not result in novel environmental or human health hazards, the EU has developed a voluntary framework called Safe-and-Sustainable-by-Design (SSbD).

Pollution & microplastics

GHG and emission of other pollutants into air, water and soil are negative externalities of the production and use of textile and clothing products. The release of such emissions is regulated in the EU through the *Industrial Emissions Directive* (IED) which defines and regularly updates best available technology reference documents (BREFs) specific to industrial sectors including textiles. BREFs provide the reference for setting emission limit values and issuing operating permits for

industrial installations in the EU. The latest BREF document for the textile sector was published in 2023.

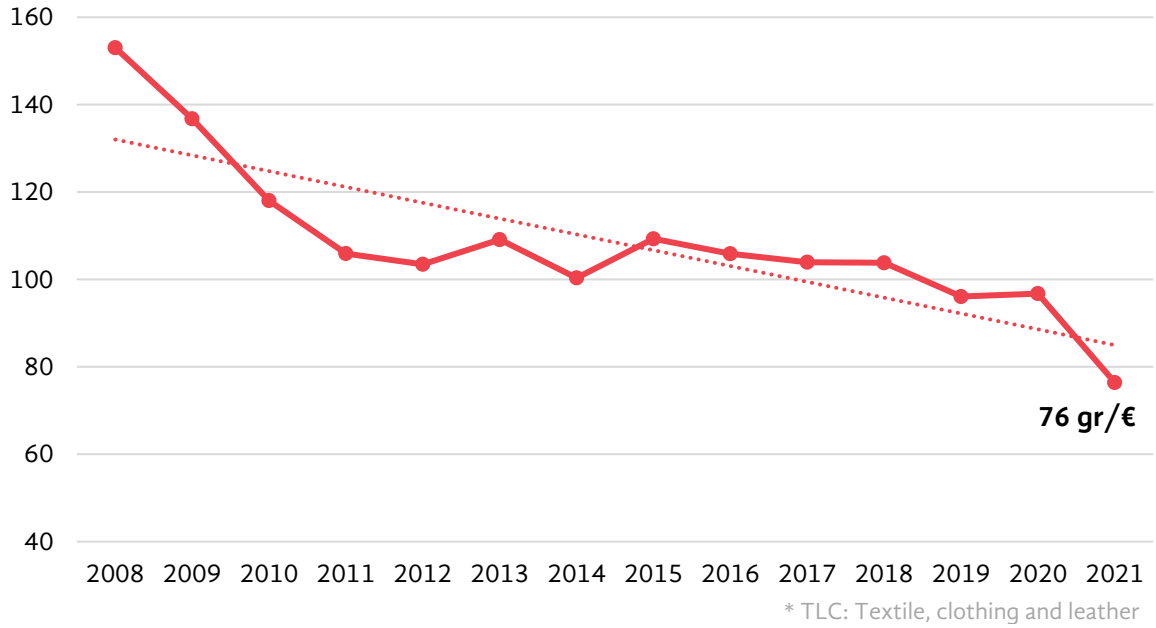


Figure 7: Evolution of the CO2 emission intensity in the TCLF sectors 2008-2021 (unit: Grams/€) - Source: EURATEX, 2024.*

A special case of pollution from textile products is the release of micro-fibrous particles, often also referred to as microplastics, although such particles can also be shed from non-plastic natural fibres. While research on release, distribution, accumulation and potential harm for human health and the environment is ongoing, no specific regulation is in place for unintended microplastic release from textiles. The subject is currently addressed as part of the *Green Claims Directive* (GCD), and it may also be addressed as part of ESPR in the future. Research into prevention and reduction of microplastic shedding during textile production and use as well as a better understanding of the potential harmful effects of their dispersion or accumulation in the environment or absorption by living organisms including the human body is needed.

Sustainable Marketing aka. green claims

To prevent confusing or misleading communication by companies about the sustainability credentials of their products the European Commission in 2023 proposed an *EU Green Claims Directive*. This legislation attempts to eradicate greenwashing and make green claims reliable, comparable and verifiable. To ensure that their claims are accurate and substantiated companies will need follow approved lifecycle assessment (LCA) methodologies and need to be able to disclose the data and sources thereof on which their claims are based. This should reward companies that make genuine investments in the sustainability profile of their materials, processes and end products.

ESG finance via EU taxonomy

The EU taxonomy is a cornerstone of the EU's sustainable finance framework. It aims at directing investments to the economic activities most needed for the sustainability transition to reach the EU's climate and environmental objectives. Following the principles laid down in various delegated acts adopted between 2021 and 2023, banks and other public and private financial institutions and investors will be able to evaluate investments all over the world and proposed by EU-based

companies to support those that will objectively contribute to climate and environmental objectives. Criteria specific for the textile sector are expected to be proposed at some stage.

Market surveillance and international level playing field

The list of regulations provided above are applicable to companies operating in the EU including those that place textile products on the EU market that were manufactured elsewhere in the world. As the EU market is one of the largest and most attractive end markets for textile products, many companies outside Europe will indirectly be affected by the changing rules or will have to adapt their operations according to the standards if they wish to continue to serve customers in the EU. To ensure that this is effectively the case, EU member states will have to significantly step up their market surveillance capacity to prevent non-compliant products to enter the EU market or to remove them promptly from circulation should they have entered the EU.

Many global, multi- and bilateral efforts are underway to align regulations internationally through United Nations (UN) bodies, the Organisation for Economic Co-operation and Development (OECD) or bilateral governmental collaboration. Many voluntary private sector initiatives, sometimes in collaboration with governments, non-governmental organisations (NGOs) and other civil society organisations contribute to the levelling of the international playing field by setting industry standards, adopting voluntary commitments, accelerating diffusion of innovative technologies, exchanging best practices, organising information and education campaigns.

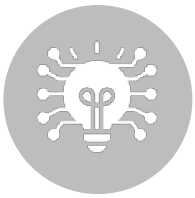
Key technologies

Digital technologies

Competitiveness impact : high

1. Big data and AI

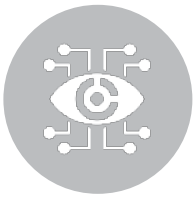
Textiles are among the most complex materials. The combinations of fibres, structuring, processing, shaping, colouring, pattering etc. are practically infinite. For this reason, many product development and manufacturing processes in the industry are guided by experiential heuristics or simple trial-and-error. The emergent ability to capture massive datasets and simulate, analyse and optimise in rapid iteration through high performance computing and artificial intelligence (AI) models can revolutionise many traditional paradigms in the design, production, distribution and customer interaction.



Competitiveness impact : medium-high

2. Virtualisation & digital twins

Creating realistic virtual representations of materials, products, processes, production lines, factories or full supply chains can speed up development processes, make production planning and scheduling more agile, reduce unnecessary inventory, resource consumption or waste generation. It can also support value-adding services at the use stage such as product care, repair or appropriate end of life management.



Competitiveness impact : medium-high

3. Sensor and vision technology

Capturing data as materials and products flow through production, logistics and distribution is indispensable for process optimisation, rapid human or machine-based decision making, quality assurance and maintenance, inventory management, cost and footprint simulation and calculation, regulatory compliance information and much more. Sensor and machine vision systems linked to networked databases, expert and machine learning systems are expected to play a much more important role in the future textile industry.

Competitiveness impact : medium-high

4. Robotics & digital microfactories

Due to the complexities of flexible material handling, the level of automation and robotisation, especially in the confection and related processes in garment making has traditionally been low. With new generations of robots, co-bots and advanced material handling technology, this expected to change. Combined with highly digitised and integrated workflows comprising processes such as printing, cutting, sewing, piece-dyeing, folding, pressing and packaging, the emergence of highly automated microfactories for efficient local on-demand production comes within reach. Such automated processes can also greatly benefit professional care, repair or remanufacturing as well as used textile sorting and disassembly.

Competitiveness impact : medium-high

5. Internet of things (IoT) and wearables

Textile-materials due to their light-weight, flexibility, drapeability and softness are an interesting carrier medium for smart components and micro-systems such as sensors, actuators, conductors, energy harvesters or storage media, light emitters etc. on irregular, moving, shape-changing and large-area surfaces including the human body. Thanks to rapid technology advances in micro- and nanoelectronics, miniaturisation, power efficiency, flexible integration technologies, computing and data processing the potential of smart or e-textiles and wearables is expected to rapidly advance and offer a multitude of market opportunities for smart textile-based systems in healthcare, sports, personal protection, smart interiors, soft robotics, consumer electronics and gaming.

Competitiveness impact : high

6. Traceability & DPP technology

No efficient, sustainable and responsible management of a complex industrial supply chain is possible without detailed measurement and monitoring of all inputs and outputs of all systems and processes that are involved in the value creation process. This applies to material, energy and information flows as well as all human labour and knowledge contributions. Due to the highly complex and geographically fragmented nature of the global textile value chain and the absence of legal requirements to collect and report such data, supply chain transparency and traceability was rather limited so far. This is about to dramatically change due to upcoming legislation, including the requirement to equipment textile products placed on the EU market with digital product passports that must contain a wealth of information for consumers, public authorities and authorised supply chain stakeholders. Methods, technologies and standards to enable the secure and efficient collection, processing, exchange and display of such data and information is therefore a key innovation building block.

Materials and process technologies

Competitiveness impact : very high

7. Sustainable chemistry and biotechnology

With a strong drive to phase-out chemicals and related processes that are potentially hazardous to humans and the environment or lead to difficult to treat waste or effluents, softer and gentler textile processing and functionalisation approaches are expected to be in high demand. Robust chemistry, biotechnology and process engineering innovations are needed to achieve solutions that maintain high levels of performance and functionality, while lowering hazards and impact.

Competitiveness impact : high

8. Next generation fibres and biosynthetics

About two thirds of all fibres used in the global textile value chain today are fossil-based synthetics. While the first priority is to phase out fossil fuel burning for energy generation, over the medium term also chemical and material production from fossil resources should be significantly reduced. It is possible to synthetise chemical fibres from a broad range of renewable feedstock from agriculture, forestry, marine and waste resources, even captured CO2. The processes of doing so need massive material and process innovation to yield fibres at comparable levels of functionality and cost to conventional alternatives. Also, natural fibres from European origin have a significant potential if agricultural and industrial innovation can be aligned.

Competitiveness impact : very high

9. Recycling

In addition to bio-based materials, fibre-to-fibre recycled textile waste also holds significant potential to phase out a certain share of fossil-based virgin fibres and reduced the environmental impact of their extraction. The biggest feedstock source for such recycling operations is post-consumer textile waste, which currently finds little valuable use. To refine and scale both mechanical and chemical processes, including all preceding steps such as efficient collection, reverse logistics, sorting and separation, that maximise recycling rates while minimising process inputs and unrecoverable waste outputs is a core challenge for the industry, especially for the typically complex material mixes present in post-consumer waste. And as in the case of bio-based material, the challenge to generate new fibres that are functionally and economically competitive to virgin material is as high.

Competitiveness impact : very high

10. Resource-efficient process technologies

All usage of energy, water and chemicals represents both an economic cost and an undesirable environmental impact. Therefore, any technological or organisational innovations that can safe either primary inputs or recover and reuse outputs are a very welcome contribution to both competitiveness and sustainability of the textile industry. Important focus areas are low water or water-free processes, better fixation of dyes, inks and other functionalising chemicals for reduced washing and drying as well as heat recovery and waste water treatment processes. Also reduction of material waste such as off-cuts at the textile or garment making stages is an important lever to reduce overall impact.

Competitiveness impact : medium-high

11. Electrification & renewable energy

Today 55% of primary energy demand in the EU textile, clothing, leather and footwear industry is fossil-based, primarily gas[14]. To maximally reduce greenhouse gas emissions from the textile manufacturing supply chain, the electrification of all processes is mandatory. This concerns especially wet processes where gas boilers are still commonplace to heat water or generate steam. Once all textile production processes are electrified, GHG emissions can be radically reduced when factories are powered by CO2-neutral grid energy, that is becoming increasingly available across Europe, supplemented where appropriate with local renewable energy generation and storage.

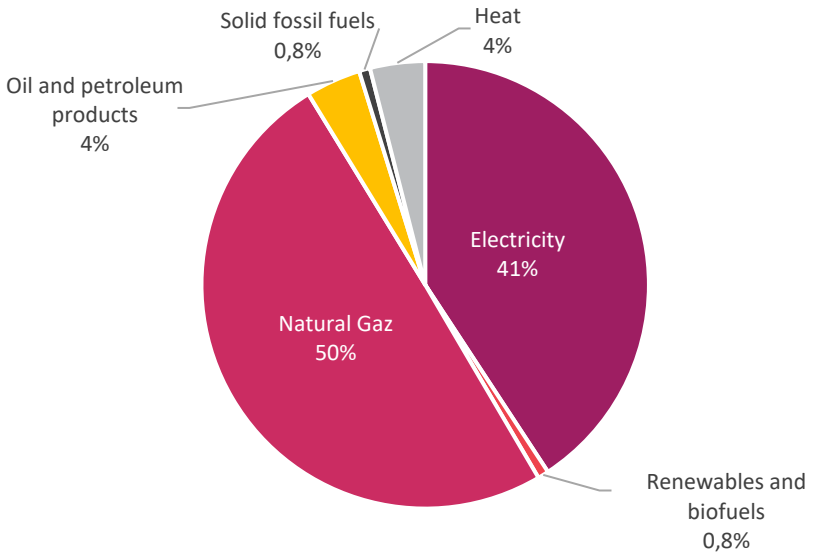


Figure 8: Energy consumption in the TCLF sector, by fuels - Source: EUROSTAT, In: EURATEX, 2024.

Competitiveness impact : high

12. Ecodesign & LCA tools

Given the great complexity of textile products, the materials and production processes used as well as use and end-of-life scenarios it is highly challenging and costly to carry out comprehensive life cycle assessments (LCA, Social-LCA, lifecycle cost…) and hence their use is relatively limited in the industry today. To reliably and efficiently design textile-based products that can meet clearly defined environmental performance criteria, such as those to be set by ESPR, there is a need for accessible expert support systems and tools drawing on relevant, current, validated and interoperable data. In many cases such necessary data is incomplete, non-existent, proprietary, outdated or otherwise lacking. For this reason, there is a great need for more open data, standardised methods and cost-effective small and medium enterprise (SME)-friendly tools to make ecodesign a common practice in the industry.

[14] EURATEX, 2024.

03

Textiles of the Future Vision and guiding principles

The information provided in the following chapters 3 and 4 was developed in an iterative co-design process within the European stakeholder community, supporting the Partnership and consisting of industry and research experts with a broad scientific, technological and industrial background covering many European countries. Textile ETP consulted its members, consisting of 52 associations, 43 industry representatives and 61 research & development organisations. Textile ETP offered the opportunity to provide input to the SRIA via an online survey, in which 147 experts participated, and sought opinion of a member and non-member expert audience during a public conference in May 2024 and a follow-up survey, in which 195 individuals engaged. The final results were validated in a further expert feedback process in which 94 experts provided written input.

The analysis of these expert inputs resulted in the list of R&I priorities and their corresponding shared public-private Research and Innovation Objectives of chapter 4.

Vision for 2030

The Vision and central objective of the Textiles of the Future Partnership is:

> *The development and demonstration of new* ***technologies*** *and innovative* ***business models*** *for competitive* ***manufacturing*** *of safe and sustainable textile* ***products*** *(and related services) made from low-impact functional* ***materials*** *and by clean and digitally connected* ***processes*** *in regional, circular and fully traceable* ***supply chains*** *for* ***quality jobs, industrial competitiveness & responsible consumption in Europe****.*

The starting point for achieving this Vision lies in robust applied **research and development** focused on **innovative technologies** across several multidisciplinary domains.

These include developing, demonstrating and rapidly commercialising:

- **low-impact functional materials** that maximise societal benefit and minimize hazards for human health or the environment,
- **clean and efficient processes** that reduce resource use and emissions,
- **digital technologies** that ensure flexibility and agility, and
- **innovative business models** that promote sustainability and economic value creation uncoupled from resource consumption and negative impact generation.

These innovative technologies will be applied in Europe first by **industrial innovators and entrepreneurs** for **competitive manufacturing**, ensuring that the EU remains at the forefront of textile product and process innovation.

By focusing on **regional supply chains**, the Partnership seeks to strengthen local economies and reduce the carbon footprint associated with long-distance transportation.

Additionally, the creation of **sustainable products** and **value-adding services** will cater to emerging consumer demand for eco-friendly and high-quality textiles.

The envisioned societal benefits of advancing in these strategic research and innovation domains are manifold.

Firstly, they will maintain existing and create new **high-quality jobs in the European textile and clothing industry**, providing stable and rewarding carrier opportunities both for young job starters and experienced professionals.

Secondly, they will enhance **industrial competitiveness**, ensuring that European textile manufacturers can successfully compete in an open global market by leveraging high productivity based human ingenuity, advanced technologies and resource-efficient sustainable practices.

Lastly, they will promote **sustainable consumption** by offering consumers products that are of high added value, lasting quality as well as environmentally friendly and ethically produced.

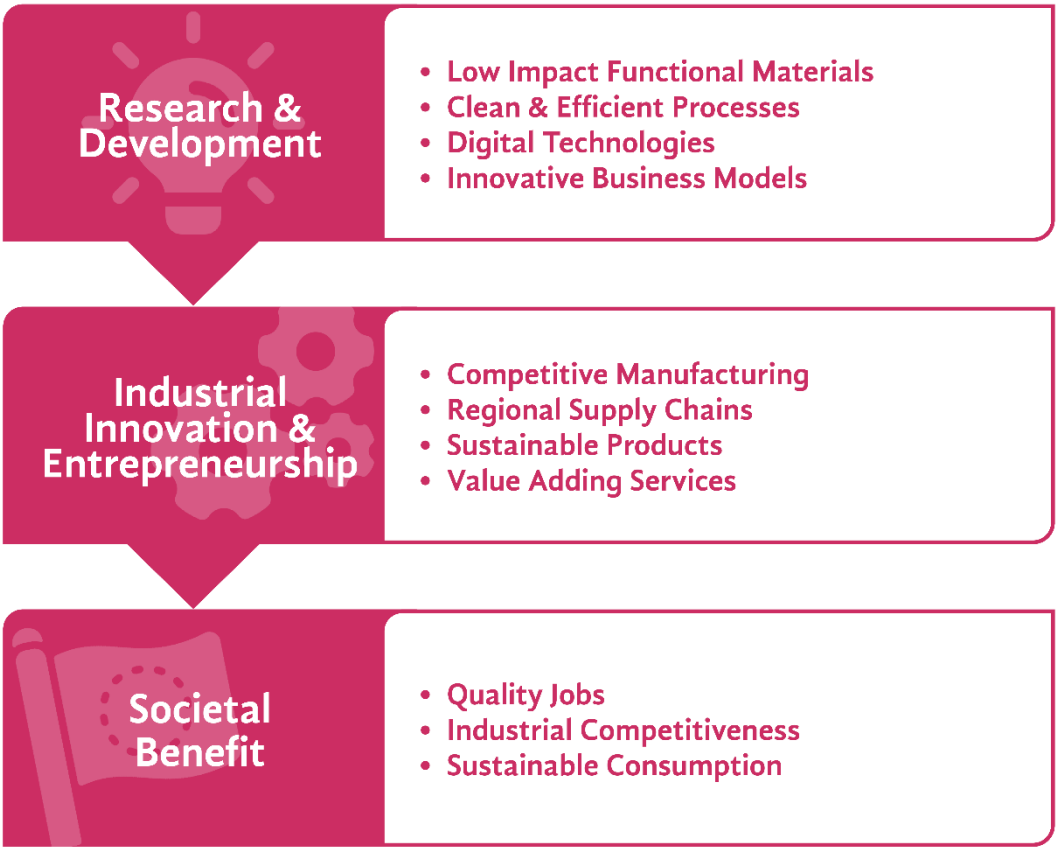


Figure 9: Textiles of the Future Vision explained - Source: Textile ETP.

In summary, the Textiles of the Future Partnership envisions a transformative shift in the European textile, clothing and related industries towards sustainability, competitiveness, and social responsibility, anchored by cutting-edge research, industrial innovation, new technologies and a strong focus on regional and circular supply chains.

It is crucial to invest in industry-relevant research and innovation at this critical juncture of the green and digital transition of this industry to strengthen the European textile manufacturing value chain as a strategic provider of economic added value, quality jobs and successful model to be adopted around the globe.

Strategic guiding principles for research topics

The following strategic guiding principles informed the process of identifying research and innovation priorities that form the basis for the development of specific call topics for the EU's framework programme for research and innovation Horizon Europe, during the initial operational period of the Partnership (2025-2027).

The research topics are focused on addressing the **main industry transformation challenges**. These include **sustainability and circularity**, **digitalization**, **and the growth of new and existing markets**. By targeting these areas, this agenda aims to ensure that the European textile and clothing industry can successfully adapt and thrive in a rapidly changing global landscape.

This agenda **strategically supports the competitiveness of the European textile and clothing manufacturing industry,** while also generating knowledge and advanced technologies that can be diffused around the world for the benefit of a more responsible and sustainable textile sector at the global level. This is achieved through promoting competitive manufacturing practices that emphasize resource efficiency, reduced time-to-market, and smart automation. Additionally, there

is a focus on strengthening regional supply chains to enhance local economies and reduce environmental impacts linked to long-distance transportation, complex untransparent global supply chain management and long-range forecast-based production. The development of **service-based business models**, which create more economic value with less reliance on growth of production and sales of physical goods, is also a key component.

Special attention is given to the innovation and technology adoption needs of small and medium-sized enterprises (SMEs). SMEs are crucial to the industry, and supporting their ability to innovate and adopt new technologies ensures a more resilient and diversified textile ecosystem in Europe.

Furthermore, the research topics are **aligned with the strategic priorities of Horizon Europe, specifically within Cluster 4**: **Digital, Industry & Space**. This alignment focuses on the green transition, the digital transition, and building a more resilient, competitive, inclusive, and democratic Europe. The expected impact is to achieve global leadership in climate-neutral, circular, and digitized industrial and digital value chains.

However, the strategic scope as well as the time horizon of the research and innovation priorities identified go far beyond the thematic limitation of Horizon Europe's Cluster 4 and the remaining 3 years of programme operation. They are meant to inform all policy makers and programme managers at EU, national and regional level concerned with the establishment of sustainable textile production and consumption and the incentivisation of industry practices than can deliver on this objective.

In summary, the strategic guiding principles ensure that the research topics not only address current industry challenges but also support long-term sustainability, competitiveness and resilience, with a particular focus on the needs of SMEs and their successful operation in manufacturing supply chains involving larger and smaller businesses, in full alignment with broader EU strategic goals.

04

The Partnership's Research and Innovation Priorities

This chapter is organised in three sections, representing the following three priority research and innovation areas:

Each *Priority Area* is closely linked to **societal challenges** as well as the **competitiveness of the European industry** in meeting those challenges.

The three *Priority Areas* and their corresponding *Strategic Topics* and *Research & Innovation Objectives* provide the input for the preparation of future work programmes. It should be noted that one *Strategic Topic* can be relevant for more than one *Priority Area*. In these cases, *Strategic Topics* and corresponding *Research & Innovation (R&I) Objectives* are listed under the *Priority Area* with highest relevance.

Priority Area I:

Sustainable materials & clean processes

The Research & Innovation Priority Area I includes the following Strategic Topics, which were assessed for their potential positive sustainability impact.

This impact would be realised if research results and new material or technology solutions in this particular field were effectively deployed at an industrial scale:

Strategic topics	Sustainability impact
Efficient end-of-life sorting, separation & recycling	Very high
Sustainable textile chemistry	Very high
Sustainable fibres	High
Resource efficient processes	High
Sustainable bio-based feedstock	Medium-high

Table 1: Strategic Topic sustainability impact assessment of Priority Area I

Strategic Topic 1 Sustainable bio-based feedstock

General objectives and scope

The general objectives of this strategic topic are to develop and promote alternative sustainable feedstocks to replace fossil fuels and non-sustainable natural resources currently used for the production of textile fibres and chemicals. This entails harnessing renewable sources such as agricultural and forestry side streams or residues and sustainably produced biomass, which offer a lower environmental footprint compared to traditional petrochemical feedstocks.

The scope of this strategic topic extends to building connections and fostering industrial symbiosis between bio-based resources, waste flows, and the textile value chain. By integrating diverse sectors, such as agriculture, forestry, food, feed or wood processing or biofuel industries, with textile manufacturing, the partnership aims to create a circular economy preferentially at local or regional scale. This holistic approach ensures that waste products and by-products from one sector are efficiently repurposed as raw materials for another, enhancing resource efficiency and sustainability.

Furthermore, valorising un- or underutilised side and waste streams from food, feed, biofuel, and other biotechnological processes can also enhance the economic viability of such operations. The textile sector can significantly benefit from converting these waste materials into valuable inputs. This not only minimizes waste but also creates economic value from previously discarded materials, promoting sustainability and innovation.

This Strategic Topic includes the following **Research & Innovation Objectives:**

- **R&I Objective 1.1 Development and utilisation of (local) bio-based materials (from side streams and waste).** *This objective seeks to promote the development and utilisation of (locally sourced) bio-based materials and aims to innovate the conversion of locally or regionally available side streams from other bioprocessing operations (e.g. biorefineries) as well as waste of the textile and other industries into valuable bio-based fibre materials or their precursors.*
- **R&I Objective 1.2 Development and utilisation of sustainable agricultural, forestry and marine feedstocks.** *This objective focuses on advancing the development and use of renewable, bio-based raw materials from agriculture, forestry and marine sources, specifically grown, harvested and processed for the use in textile applications.*
- **R&I Objective 1.3 Development and utilisation of living organisms.** *This objective focuses on advancing the development, cost-efficient production and effective processing of sustainable, bio-based feedstocks and chemicals derived from living organisms like fungi, yeast, algae or bacteria.*
- **R&I Objective 1.4 Digitise bio-based waste and raw material flows.** *This objective aims to leverage digital technologies to track, analyse, and optimize the use of sustainable bio-based feedstocks such as their local or seasonal availability, enable the emergence of competitive markets and dynamic pricing for such resources.*

Key technologies and enablers

Sustainable chemistry and biotechnology

Next generation fibres and biosynthetics

Ecodesign & LCA tools

Big data & AI

Strategic Topic 2 Sustainable fibres

General objectives and scope

The overarching objective of this strategic topic is to reduce the textile industry's reliance on fossil-based fibres and fibres derived from unsustainable or inefficiently managed agricultural and forestry practices. This transition is crucial for creating a more environmentally responsible and resilient textile sector.

One of the key strategies involves improving the use of locally available natural fibres and bio-resources across Europe. By building robust local value chains, the initiative aims to strengthen the connections between agriculture, the industrial value chain, and end users. This not only supports local economies and reduces transportation emissions but also ensures a more sustainable and traceable fibre supply.

The scope of this strategic topic includes improving the processing, economics, and functionalities of bio-based fibres for both large-scale conventional applications and higher added-value niche markets. This involves advancing the technologies and methods used in the extraction and refinement of natural fibres, such as flax, hemp, and wool, to ensure they meet the quality and performance standards required by modern textile applications. Enhancing the cost-effectiveness and versatility of these fibres will enable their broader adoption and competitiveness against traditional synthetic fibres.

Furthermore, the industry seeks to enable the adoption of both novel fibre types and conventional synthetic fibres derived from bio-based feedstocks. This dual approach encourages innovation in developing new types of fibres that offer unique properties and benefits, while also promoting the transition of existing synthetic fibre production to more sustainable, bio-derived feedstocks. By doing so, the textile industry can maintain its performance and functionality standards while significantly reducing its environmental impact.

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 2.1 Enhance advanced processing of European natural fibres.** *This objective aims to innovate and enhance the harvesting and processing technologies and practices of natural fibres produced in Europe to improve their economics (even at small volumes), widen their application potential and enable the emergence of resilient regional value chains around their production, processing, use and recycling.*
- **R&I Objective 2.2 Development of next generation bio-based polymers and their processing into fibres such bio-synthetics or novel cellulosics.** *This objective targets the development of innovative bio-based polymers both for new fibre types as well as functional equivalents to widely used fossil-based synthetics such as polyesters, polyamides, polypropylenes, acrylics and polyurethanes as well as conventional cellulosics (e.g. viscose) and their related downstream processing to match and*

Key technologies and enablers

Sustainable chemistry and biotechnology

Next generation fibres and biosynthetics

Recycling

Resource-efficient process technologies

Ecodesign & LCA tools

wherever possible exceed economics and functionality of conventional fibre types while lowering impact.

- **R&I Objective 2.3 Utilisation of biotechnology for novel fibre development for high added value applications.** *This objective seeks to harness the potential of biotechnological processes involving microorganisms, enzymes, and proteins to directly create novel fibres or use bio-based feedstocks to synthetize innovative fibres for lower volume high added value applications in pharma, medtech or food-related sectors.*

Strategic Topic 3 Sustainable textile chemistry

General objectives and scope

The general objectives of this strategic topic are centred around enhancing the environmental and health profiles of textile production by phasing out hazardous chemicals or chemicals of concern throughout the entire textile value chain. This involves identifying and eliminating harmful substances used in dyeing, finishing, and other textile processes to ensure a safer and more sustainable production cycle.

A crucial aspect of this strategic topic is the replacement of conventional functionalizing chemicals with renewable and non-toxic alternatives that offer equivalent or superior performance. This initiative aims to prevent regretful substitution, where a hazardous chemical is replaced with another equally harmful one. By developing and promoting the use of safe and sustainable chemicals, the industry can achieve high functionality in textiles without compromising environmental and health standards.

Moreover, this research area emphasizes replacing traditional dyes, inks, and pigments with bio-derived alternatives or innovations that facilitate end-of-life removal. This not only reduces the environmental impact of textile coloration but also enhances the recyclability and biodegradability of textile products. Developing sustainable dyeing techniques and eco-friendly colorants can significantly decrease the pollution and waste generated by the textile industry.

Key technologies and enablers

Sustainable chemistry and biotechnology

Resource-efficient process technologies

Ecodesign & LCA tools

Additionally, this topic aims to help establish Safe-and-Sustainable-by-Design (SSbD) principles in textile chemistry and fibre material innovation. SSbD principles ensure that new materials and chemicals are developed with a focus on safety, sustainability, and circularity from the outset. This proactive approach supports the creation of textiles that are not only high-performing but also environmentally benign and safe for consumers.

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 3.1 Substitution of hazardous functional finishes, additives and coatings.** *This objective aims to pioneer sustainable alternatives to hazardous chemicals, including but not limited to PFAS, advancing the development of eco-friendly textile chemistry practices.*

- **R&I Objective 3.2 Development of clean solvents & auxiliaries.** *This objective focuses on innovating environmentally friendly solvents and auxiliaries to reduce chemical pollution from textile production and minimise and facilitate wastewater treatment needs.*
- **R&I Objective 3.3 Improvement of dyes, inks and pigments.** *This objective aims to develop and optimize sustainable formulations and application methods for natural or non-toxic dyes, inks, and pigments, using, for example, biotechnology.*
- **R&I Objective 3.4 Deployment of biotechnology processes.** *This objective aims to leverage biotechnological advancements to develop sustainable textile chemistry processes, utilizing natural sources such as mycelium, bacteria, enzymes, and proteins.*

Strategic Topic 4 Resource efficient processes

General objectives and scope

The general objectives of this strategic topic are focused on significantly lowering GHG emissions and other environmental impacts of textile production. Achieving this goal involves the more efficient use of energy, water, materials, and chemicals throughout the textile manufacturing process. By optimizing these inputs, the industry can reduce its carbon footprint and minimize adverse environmental effects.

Another critical aspect of this strategic topic is improving processability and the resulting product quality when utilizing recycled or alternative bio-based fibres instead of virgin conventional fibres. This includes refining technologies and methods to ensure that these sustainable fibres meet or exceed the performance standards of traditional materials. Enhancing the quality and consistency of products made from recycled or bio-based fibres will encourage broader adoption and acceptance in the market.

Furthermore, this research area aims to enable companies to upgrade or retrofit efficiency solutions into existing processing and manufacturing lines and factories. This approach ensures that improvements can be made without the need for entirely new infrastructure, making the transition more cost-effective and feasible for a broader range of companies. By incorporating advanced efficiency technologies into current operations, manufacturers can achieve significant resource savings and environmental benefits.

Lastly, lowering the cost and increasing the efficiency of cycling, recovering, and treating process and wastewater streams is a vital component. Developing innovative methods for recycling and treating water used in textile production not only conserves this valuable resource but also reduces pollution and operational costs. Enhanced water management practices are essential for a more sustainable and economically viable textile industry.

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 4.1 Implementation of process chemical and energy recovery & low-energy production.** *This objective strives to implement*

Key technologies and enablers

Sustainable chemistry and biotechnology

Resource-efficient process technologies

Electrification & renewable energy

Ecodesign & LCA tools

innovative technologies for the recovery of processing and functionalisation chemicals such as dyes, inks, auxiliaries and the recovery of process energy, especially heat recovery during wet processing and the promotion of low-energy production methods.

- **R&I Objective 4.2 Implementation of waterless and low-chemistry processing.** *This objective aims to develop and implement innovative technologies and methods that significantly reduce water usage and chemical inputs in wet textile processing, including reduction of laundering and drying and the exploitation of entirely water free processes that can reach surface functionalities conventionally only realised by wet processing.*

Traceability & DPF technology

Sensor and vision technology

- **R&I Objective 4.3 Development of new technologies/equipment for recycled and bio-based fibres processing.** *This objective seeks to develop innovative processing technologies and equipment to facilitate the efficient utilization of recycled, regenerated and bio-based fibres, for example during spinning, weaving, knitting or dyeing.*
- **R&I Objective 4.4 Adapting existing production lines and process chains for deploying new solutions.** *This objective aims to optimize and reconfigure current production infrastructure and entire process chains to rapidly integrate new sustainable solutions such as novel/recycled fibres/textiles or sustainable chemistry.*
- **R&I Objective 4.5 Development and implementation of water quality management and water recycling.** *This objective focuses on developing advanced techniques for managing process and wastewater quality and implementing effective water recycling and reuse strategies.*

Strategic Topic 5 Efficient end-of-life sorting, separation & recycling

Key technologies and enablers

General objectives and scope

The overarching objective is to enable a larger share of textile waste, particularly post-consumer waste, to be recycled back into textile fibres or other high-value inputs for non-textile value chains. This involves developing advanced technologies and systems to improve the recyclability of textiles, thereby reducing landfill waste and promoting circular economy principles.

Recycling

A critical focus is on enhancing cost-efficiency and minimizing the environmental footprint of recycling processes. This includes reducing energy consumption, solvent use, and other chemical inputs, especially in chemical recycling processes. Achieving higher yields of quality recycled material is essential for making recycling more economically viable and environmentally sustainable. Innovations in recycling technology can lead to more efficient processes and better-quality recycled outputs.

Resource-efficient process technologies

This strategic topic also aims to enlarge the available technology options for sorting, separation, and recycling of all major textile fibre types and their blends. This includes promoting efficient local small-scale recycling facilities to handle lower waste volumes, which can reduce costs and environmental impacts

associated with waste logistics. Decentralized recycling solutions can make it more feasible to process textile waste locally, thus enhancing overall efficiency.

Developing generally accepted quality standards for recycled fibres or textile products is another key objective. Standardization can improve processing stability and efficiency, facilitate coordination across the supply chain, and enhance market communication. Clear and consistent quality benchmarks ensure that recycled textiles meet industry requirements, fostering greater acceptance and use of recycled materials

Ecodesign & LCA tools

Big data & AI

Sensor and vision technology

Robotics & digital microfactories

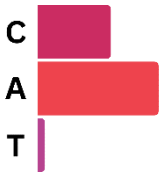
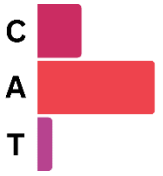
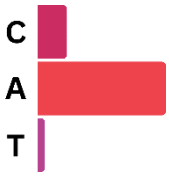
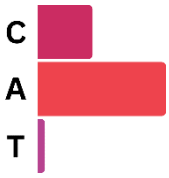
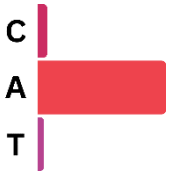
This Strategic Topic includes the following **Research & Innovation Objectives**:

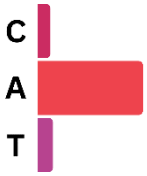
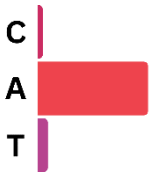
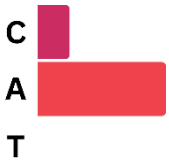
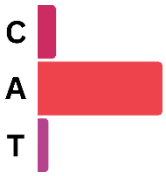
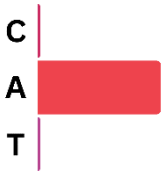
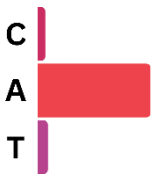
- **R&I Objective 5.1 Development and improvement of automated sorting technologies.** *This objective aims to advance the efficiency and accuracy of sorting processes through the development and enhancement of automated technologies.*
- **R&I Objective 5.2 Development of efficient products disassembly and material separation.** *This objective aims to develop innovative techniques for effectively disassembling complex products, separating multi-material layers and fibre blends and removal of non-textile components, coatings or contaminants to facilitate efficient recycling processes.*
- **R&I Objective 5.3 Scaling of efficient and sustainable recycling.** *This objective focuses on improving and optimizing of innovative and sustainable recycling methods and technologies both for mechanical and thermomechanical as well as chemical and biochemical processes targeting all major material types.*
- **R&I Objective 5.4 Development of standardised description of recycled materials.** *This objective seeks to establish standardized criteria and descriptions for recycled materials, streamlining classification processes.*
- **R&I Objective 5.5 Optimisation of reverse logistics and intelligent end-of-life material channelling.** *This objective aims to optimize reverse logistical processes for end-of-life products and other valuable textile material streams and the intelligent channelling of all resources to their highest waste pyramid use case and most efficient processing option.*

The following table 2 indicates the assessment of each Research & Innovation Objective for:

- their application sectors (C: mostly clothing and home textiles, A: all textile products, T: mostly technical textiles)
- their Technology Readiness Level (TRL) range
- their potential positive EU competitiveness impact
- their pilot investment scale (small: up to €10 million, medium: €10-100 million, large: €100 million+)

Additionally, their required key collaboration partners/competences were defined.

	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
R&I Objectives assessment of Priority Area I: Sustainable materials						
1.1	Development and utilisation of (local) bio-based materials (from side streams and waste)		Processing, service and waste management industries	4-6	Medium-high	Medium
1.2	Development and utilisation of sustainable agricultural, forestry and marine feedstocks		Agriculture, forestry and aquaculture	4-6	Medium-high	Medium
1.3	Development and utilisation of living organisms		Agriculture and biotechnology	3-5	Low	Small-medium
1.4	Digitise bio-based waste and raw material flows		Software, service and waste management industries	4-6	Medium	Small-medium
2.1	Enhance advanced processing of European natural fibres		Agriculture, chemistry process technology industry	5-7	High	Medium
2.2	Development of next generation bio-based polymers and their processing into fibres such bio-synthetics or novel cellulosics		Agriculture, forestry, chemistry & biotechnology, process technology industry	4-6	High	Medium-large
2.3	Utilisation of biotechnology for novel fibre development for high added value applications		Chemistry, material, biotechnology, process technology industry	3-5	Medium-high	Medium-large

	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
R&I Objectives assessment of Priority Area I: Clean processes						
3.1	Substitution of hazardous functional finishes, additives and coatings		Chemistry, biotechnology, process technology industry	5-7	Very high	Medium
3.2	Development of clean solvents & auxiliaries		Chemistry, biotechnology, process technology industry	4-6	High	Medium-large
3.3	Improvement of dyes, inks and pigments		Chemistry, process technology & mechatronics industry	5-7	High	Medium
3.4	Deployment of biotechnology processes		Chemistry, biotechnology, process technology industry	4-6	Medium-high	Medium-large
4.1	Implementation of process chemical and energy recovery & low-energy production		Utility services, environmental engineering, process technology, mechatronics industry	6-8	High	Small-medium
4.2	Implementation of waterless and low-chemistry processing		Environmental engineering, process technology & mechatronics industry	5-7	Very high	Medium
4.3	Development of new of technologies/equipment for recycled and bio-based fibres processing		Mechanical engineering & mechatronics	4-6	High	Medium

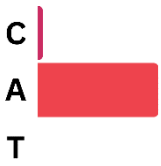
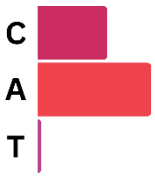
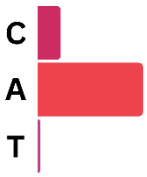
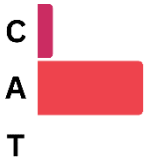
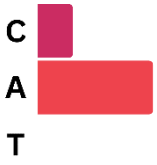
	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
4.4	Adapting existing production lines and process chains for deploying new solutions		Chemistry, material sciences, process technology, mechanical engineering & mechatronics	5-7	High	Small-medium
4.5	Development and implementation of water quality management and water recycling		Utility services, environmental engineering, process technology, mechatronics industry	6-8	Medium-high	Small-medium
5.1	Development and improvement of automated sorting technologies		Mechanical engineering, mechatronics, sensorics and vision technology	5-7	Very high	Medium
5.2	Development of efficient product disassembly and material separation		Chemistry & materials processing, mechanical engineering, mechatronics	4-6	Very high	Medium
5.3	Scaling of efficient and sustainable recycling		Chemistry, material sciences, process technology, mechanical engineering & mechatronics	5-7	Very high	Medium-large
5.4	Development of standardised description of recycled materials		Material sciences, process technology, IT systems	4-6	Medium-high	Small-medium
5.5	Optimisation of reverse logistics and intelligent end-of-life material channelling		Logistics and IT systems	4-6	Medium	Small-medium

Table 2: R&I Objectives assessment of Priority Area I: Sustainable materials & clean processes

Priority Area II:

Digital supply chains & circular business models

The Research & Innovation Priority Area II includes the following Strategic Topics, which were assessed for their potential positive sustainability impact.

This impact would be realised if research results and new material or technology solutions in this particular field were effectively deployed at an industrial scale:

Strategic topics	Sustainability impact
Design for sustainability & circularity	High
Digitalisation of the textile value chain	High
Sustainability & circular data management	Medium-high
Circular business models & value-added customer and end-user services	Medium-high

Table 3: Strategic Topic sustainability impact assessment of Priority Area II

Strategic Topic 6 Digitalisation of the textile value chain

General objectives and scope

The primary objective is to maximize the use of digitally generated, processed, and communicated data throughout the textile value chain. This approach aims to eliminate inefficiencies and errors inherent in manual or analogue processes, thereby enhancing productivity and precision.

A critical aspect of this strategic topic is ensuring the connectivity and interoperability of data and systems across the entire value chain. By facilitating seamless data flow, the industry seeks to improve speed, transparency, holistic optimization, legal compliance, and consumer information. Enhanced connectivity ensures that all stakeholders, from suppliers to end consumers, have access to accurate and timely data, fostering better decision-making and streamlined operations.

This research area also promotes the implementation of AI-assisted and AI-driven systems to manage complex and large-scale data processes and related decision-making. AI technologies can analyse vast amounts of data quickly and accurately, identifying patterns and insights that humans might overlook. This capability supports more informed and efficient decision-making, enhancing overall value chain performance.

Moreover, the use of digital twins is a pivotal component of this topic. Digital twins of materials, products, processes, machines, production lines, factories, and supply chains enable simulation, optimization, and precise reproduction. These virtual models allow for detailed analysis and testing in a digital environment, leading to improved product designs, optimized manufacturing processes, better supply chain management. Digital twins of products not only speed up processes but also reduce the need of a significant amount of materials for prototypes and sample collections, which often end up as waste.

Key technologies and enablers

Big data & AI

Virtualisation & digital twins

Sensor and vision technology

Traceability & DPP technology

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 6.1 Traceability system (digital and physical) of materials and products.** *This objective aims to develop comprehensive digital and physical traceability systems to enhance transparency and accountability across the textile value chain.*
- **R&I Objective 6.2 Integration of digital processes in the value chain.** *This objective focuses on seamlessly integrating digital technologies across the textile value chain to enhance efficiency, transparency, and collaboration.*
- **R&I Objective 6.3 Development and utilisation of digital tools for cost-effective material sorting.** *This objective aims to leverage digital technologies such as artificial intelligence to develop efficient and cost-effective solutions for material sorting within the textile value chain.*
- **R&I Objective 6.4 Development and utilisation of digital solutions for decision-making support, process optimization and supply chain management.** *This objective seeks to harness advanced digital technologies, including artificial intelligence, to provide effective decision-making support, speed up and optimize processes including in the design, prototyping, market testing and production*

ramp-up phases, and enhance supply chain management, for example through better planning, resource utilisation monitoring and quality management.

- **R&I Objective 6.5 Development and utilisation of digital twins for smart manufacturing.** *This objective aims to develop virtual replicas of textile production processes to enable real-time monitoring, analysis, and optimization, driving efficiency and innovation in smart manufacturing.*

Strategic Topic 7 Sustainability & circular data management

General objectives and scope

The primary objective is to develop and implement technologies that can capture, verify, and analyse primary data from all processes and value chain stages necessary for optimizing sustainability and circularity. Accurate and comprehensive data collection is essential for identifying opportunities for improvement and ensuring that sustainability goals are met.

A significant focus is on creating concepts, methods, systems, and standards for securely and efficiently sharing data among all actors along the value chain. Ensuring data security while avoiding unauthorized access, manipulation, loss, or misuse is critical. By establishing robust data sharing protocols, the textile industry can enhance transparency and collaboration, fostering a more integrated and sustainable value chain.

Key technologies and enablers

Big data & AI

Traceability & DPP technology

Additionally, this strategic topic emphasizes the development of systems that enable rapid, reliable, and cost-effective reporting and certification. These systems will support legal compliance and provide valuable information for customers and consumers, including digital product passports. Special attention is given to ensuring these tools are accessible to SMEs, public authorities, and consumers, promoting widespread adoption and transparency.

Moreover, the generation of relevant datasets accessible for research, education, and policy-making purposes is a key component. By making these datasets available, the initiative supports ongoing research and innovation, educational programs, and informed policy decisions that drive sustainability and circularity in the textile industry.

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 7.1 Ensure high data quality, confidentiality, and trustworthiness.** *This objective focuses on ensuring high-quality, confidential, and trustworthy data management practices across the textile value chain, promoting sustainability and circularity through robust data governance.*
- **R&I Objective 7.2 Establish standards for data interoperability and exchange between systems.** *This objective aims to establish standardized protocols to facilitate seamless data exchange and interoperability between systems across the textile value chain, enhancing sustainability and circularity through improved data management practices.*
- **R&I Objective 7.3 Establish data spaces and lakes for circularity & sustainability.** *This objective focuses on establishing integrated data platforms to collect, analyse, and share information across the textile value chain, fostering collaboration and driving sustainability and circularity.*
- **R&I Objective 7.4 Development and implementation of advanced DPP systems to support transparency and effective stakeholder information in circular value chains.** *This objective aims to*

develop and implement advanced digital product passport (DPP) systems to enhance transparency and traceability throughout circular value chains.

- **R&I Objective 7.5 Ensure availability of high-quality open access resources and datasets.** *This objective focuses on promoting the availability and accessibility of valuable resources and datasets related to sustainability and circularity in the textile value chain, fostering collaboration, innovation, and informed decision-making.*

Strategic Topic 8 Design for sustainability & circularity

General objectives and scope

The primary objective is to tightly integrate the design and development process of textile products with all stages of processing, use, and end-of-life management. This integration aims to maximize value creation while minimizing waste and other negative environmental impacts.

A crucial component of this strategic topic is ensuring access to deep data during the design phase. This data enables optimization of product creation to align with the chosen business model and key value creation parameters, such as cost, time-to-market, environmental impact, durability, recyclability, repairability, and legal compliance. By leveraging comprehensive data, designers can make informed decisions that enhance the sustainability and functionality of textile products.

Additionally, this research area focuses on enabling simulation and visualization of all material and product characteristics throughout production, use, and end-of-life management. Advanced simulation tools can predict how materials and products will perform, allowing designers to refine their choices to improve sustainability and circularity. This predictive capability is vital for creating products that meet high standards of durability and recyclability.

Moreover, creating seamless data flows and feedback loops from all stages of production, use, and end-of-life into the design process is essential. Continuous feedback ensures that insights gained during the lifecycle of a product are fed back into the design phase, fostering continuous improvement and innovation. This holistic approach ensures that products are designed with their entire lifecycle in mind, promoting a circular economy and reducing environmental impact.

Key technologies and enablers

Big data & AI

Virtualisation & digital twins

Sensor and vision technology

Ecodesign & LCA tools

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 8.1 Availability of (local) raw and recycled material and development of circular material models.** *This objective aims to foster accessibility to information on (local, regional) availability of primary or secondary raw materials or other un(der)utilised resources while advancing the development of circular material models.*

- **R&I Objective 8.2 Implementation of design for circularity and sustainability strategies (9R based)**[15]. *This objective focuses on implementing innovative design strategies guided by the principles of reduce, repair, reuse, remake, recycle, and other 9R principles throughout the lifecycle of textile products (production, use phase, End-of-Life).*
- **R&I Objective 8.3 Digitisation of materials & processing.** *This objective seeks to integrate digital technologies throughout the materials and processing phases including digital twins, enabling data-driven design decisions and fostering sustainability and circularity.*
- **R&I Objective 8.4 Foster collaboration between design, new materials, technologies and business models.** *This objective aims to foster synergies and acceptance between design practices and emerging materials, technologies, and business models, facilitating the integration of sustainable and circular principles.*
- **R&I Objective 8.5 Balance of creativity and design dimension with sustainability criteria.** *This objective seeks to balance innovative design and creativity with sustainability and circularity principles, ensuring that textile products maintain their aesthetic appeal and functional qualities while advancing environmental sustainability.*

Strategic Topic 9 Circular business models & value-added customer and end-user services

General objectives and scope

The general objectives of this strategic topic are to develop concepts and technologies that enable business models promoting circularity and value-added services in the textile sector. These models aim to facilitate sustainability through greater economic and user value creation with less material processing and reduced product sales.

A key focus are service-based business models that drive resource optimization, product use intensification and waste minimization. These models emphasize the intensified use of manufacturing resources and end products through sharing, renting, leasing, professional repair and care on the basis of subscriptions or and pay-per-use systems. By extending the lifecycle of textile products and maximizing their utilization, these models can significantly reduce waste and resource consumption.

Additionally, this research area seeks to develop technologies and services that facilitate consumer contributions to circularity. This includes return logistics, resale, repair, waste collection, and pre-sorting services. By making it easier for consumers to participate in recycling and product lifecycle extension, these technologies help close the loop in the textile value chain, promoting a more circular economy.

Key technologies and enablers

Big data & AI

Robotics & digital microfactories

Recycling

Moreover, the industry emphasizes the importance of collaborative and educational materials and tools to engage consumers and professional end users. These resources will support product and service design optimization, gather user feedback, and facilitate value sharing. By involving consumers and professionals in

[15] 9 R's: refuse, rethink, e.g. share or rent, reduce, re-use, repair, refurbish, remanufacture, repurpose, recycle. In: European Commission, *Categorisation System for the Circular Economy*, 2020.

the development and improvement of circular business models, the textile industry can create more effective and user-friendly solutions

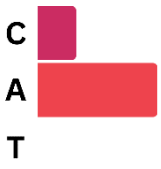
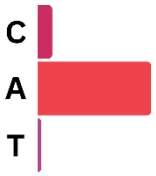
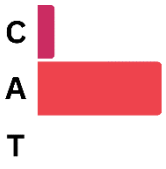
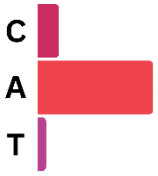
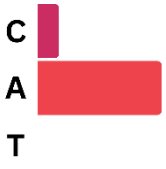
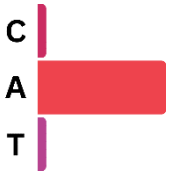
This Strategic Topic includes the following **Research & Innovation Objectives**:

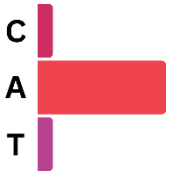
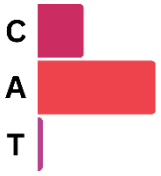
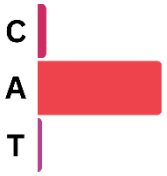
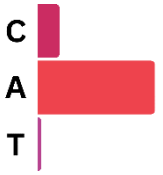
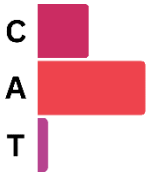
- **R&I Objective 9.1 Data & technology for customer engagement and sustainable consumption.** *This objective aims to leverage data and technology to empower professional users or private consumers with information and tools for making sustainable purchasing choices, promoting engagement with producers and driving sustainable consumption behaviours.*
- **R&I Objective 9.2 Promotion of slow fashion, use intensification and reduced material consumption, informed by social sciences & humanities.** *This objective aims to integrate insights from social sciences and humanities into fostering a behavioural shift towards sustainable consumption patterns by promoting slow fashion practices, product life cycle prolongation or total cost/impact of ownership concepts.*
- **R&I Objective 9.3 Development of effective circular business models (9R based).** *This objective aims to foster innovative circular business models centred around the 9R principles, including market strategies to drive demand for recycled textiles, and develop digital platforms to facilitate their adoption.*
- **R&I Objective 9.4 Collaborative design & manufacturing (manufacturing as a service).** *This objective aims to promote collaborative approaches to design and manufacturing processes, including the concept of manufacturing as a service, to enhance flexibility and efficiency in the textile value chain.*
- **R&I Objective 9.5 Local/regional hubs for textile circularity (9R based).** *This objective aims to establish decentralized hubs that prioritize the 9R principles to facilitate circularity in textile production, fostering regional sustainability.*
- **R&I Objective 9.6 Training & skill development for circular practices.** *This objective focuses on providing comprehensive training programs and skill development initiatives tailored to promote circular business models across industry, service providers and end users.*

The following table 4 indicates the assessment of each Research & Innovation Objective for:

- their application sectors (C: mostly clothing and home textiles, A: all textile applications, T: mostly technical textiles)
- their Technology Readiness Level (TRL) range
- their potential positive EU competitiveness impact
- their pilot investment scale (small: up to €10 million, medium: €10-100 million, large: €100 million+)

Additionally, their required key collaboration partners/competences were defined.

	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
R&I Objectives assessment of Priority Area II: Digital supply chain						
6.1	Traceability system (digital and physical) of materials and products		Material science, software & IT systems	5-7	Very high	Medium
6.2	Integration of digital processes in the value chain		Software & IT systems	5-7	Very high	Small-medium
6.3	Development and utilisation of digital tools for cost-effective material sorting		Vision technology, software & IT systems	4-6	Very high	Medium
6.4	Development and utilisation of digital solutions for decision-making support, optimization and supply chain management		AI, software & IT systems	5-7	High	Small
6.5	Development and utilisation of digital twins for smart manufacturing		Software & IT systems	4-6	Medium-high	Medium
7.1	Ensure high data quality, confidentiality, and trustworthiness		AI, software & IT systems	5-7	High	Small-medium
7.2	Establish standards for data interoperability and exchange between systems		Software & IT systems	5-7	High	Small-medium

	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
7.3	Establish data spaces and lakes for circularity & sustainability		AI, software & IT systems	4-6	Medium-high	Small-medium
7.4	Development and implementation of advanced DPP systems to support circular value chains		AI, software & IT systems	5-7	High	Medium
7.5	Ensure availability of high-quality open access resources and datasets		AI, software & IT systems	4-6	High	Small-medium
	R&I Objectives assessment of Priority Area II: New business models					
8.1	Availability of (local) raw and recycled material and development of circular material models		Software and IT systems	4-6	High	Medium
8.2	Implementation of design for circularity and sustainability strategies (9R driven)		Material science, design, software & IT systems	5-7	High	Small-medium
8.3	Digitisation of materials & processing		AI, software & IT systems	5-7	High	Small-medium
8.4	Foster collaboration between design, new materials, technologies and business models		Material science, design, software & IT systems	4-6	High	Small

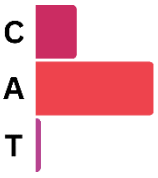
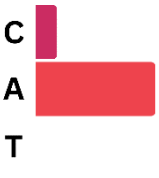
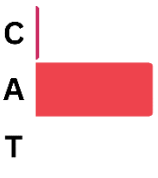
	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
8.5	Balance of creativity and design dimension with sustainability criteria		Material science, design, software & IT systems	5-7	Medium	Small-medium
9.1	Data & technology for consumer engagement and sustainable consumption		Behavioural science, AI, software & IT systems	5-7	Medium-high	Medium
9.2	Promotion of slow fashion use intensification and reduced material consumption		Social sciences & humanities	4-6	Medium	Small
9.3	Development of effective circular business models (9R based: reuse, rental, sharing, repairing, recycling)		Economics, design, software & IT systems	4-6	High	Medium
9.4	Collaborative design & manufacturing (manufacturing as a service)		Process design, software & IT systems	4-6	Medium-high	Medium
9.5	Local/regional hubs for textile circularity (9R based)		Design, software & IT systems	5-7	High	Medium
9.6	Training & skill development for circular practices		Material science, design, & social sciences	5-7	High	Small-medium

Table 4: R&I Objectives assessment of Priority Area II: Digital supply chain & new business models

Priority Area III:

Advanced manufacturing & high-performance textiles

The Research & Innovation Priority Area III includes the following Strategic Topics, which were assessed for their potential positive sustainability impact.

This impact would be realised if research results and new material or technology solutions in this particular field were effectively deployed at an industrial scale:

Strategic topics	Sustainability impact
Safe & sustainable materials for technical applications	High
(Multi)functional materials for technical applications	High
On-demand digital and networked manufacturing	Medium-high
Automated, AI supported smart manufacturing	Medium

Table 5: Strategic Topic sustainability impact assessment of Priority Area III

Strategic Topic 10 Automated and AI-supported smart manufacturing

General objectives and scope

The general objectives of this strategic topic are to enhance the productivity, versatility, and resource efficiency of textile manufacturing processes through the integration of advanced automation, digitalization, and artificial intelligence (AI). These technologies are pivotal in transforming traditional textile manufacturing into a more efficient and innovative industry.

A key goal is to address productivity and quality issues related to manual handling, integration, and assembly operations of textiles and non-textile parts. This will be achieved through the implementation of robotics, which can automate repetitive and complex tasks including the precise and reliable handling of flexible materials, reducing the likelihood of human error and increasing overall production speed and productivity. By leveraging robotics, the industry can streamline operations, reduce reliance on scare skilled manual labour and ensure higher consistency in product quality.

Improving product quality is another crucial focus, particularly through zero-defect manufacturing approaches. This involves utilizing AI and machine learning algorithms to detect and correct defects in real time during the manufacturing process. Such approaches ensure that products meet the highest quality standards, reducing waste and enhancing customer satisfaction.

Additionally, raising factory efficiency through predictive and remote maintenance is essential. AI-driven predictive maintenance can anticipate equipment failures before they occur, allowing for timely interventions that minimize downtime and extend the lifespan of machinery. Remote maintenance capabilities further enhance efficiency by enabling real-time monitoring and troubleshooting from any location.

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 10.1 Develop and integrate new manufacturing technologies for (technical & smart) textiles.** *This objective aims to develop and integrate advanced, automated, and AI-supported manufacturing technologies to enhance the production efficiency, quality, and innovation of textiles.*
- **R&I Objective 10.2 Develop and implement cost-efficient robotics & smart automation for soft material handling, assembly and finishing.** *This objective aims to develop and implement affordable robotic and smart automation solutions to improve the efficiency, precision, and cost-effectiveness of soft material handling, integration and assembly of non-textile components and structures and advanced finishing processes with a special focus on reducing manual operations that are imprecise, inefficient, unsafe or repetitive.*

Key technologies and enablers

Big data & AI

Virtualisation & digital twins

Sensor and vision technology

Robotics & digital microfactories

IoT and wearables

- **R&I Objective 10.3 Implement zero-defect & AI-assisted manufacturing.** *This objective aims to implement sensor, vision and AI-assisted technologies to achieve zero-defect production, enhancing the quality, efficiency, reliability and waste minimisation of textile manufacturing processes.*
- **R&I Objective 10.4 Implement AI and AR/VR-assisted predictive and remote maintenance.**[16] *This objective aims to leverage artificial intelligence and augmented and virtual reality technologies to enable predictive and remote maintenance, enhancing the resource efficiency, reliability, and cost-effectiveness of manufacturing processes.*

Strategic Topic 11 On-demand digital and networked manufacturing

General objectives and scope

This strategic topic aims to revolutionize the production and supply chain operations of textile-based products by enabling highly responsive, flexible, and efficient manufacturing processes.

A primary objective is to develop and integrate processes and technologies that support on-demand production of clothing and other time-critical or customisable textile products. This involves creating small, local manufacturing clusters that are highly networked to optimize supply chain operations and lower time to market. These clusters can respond quickly to market demands, reducing the need for large inventories and minimizing mark-down and unsold stock. By fostering localised production, the initiative also aims to strengthen regional economies and reduce the environmental impact of long-distance transportation.

This strategic topic further focuses on establishing full digitalisation and process integration to achieve flexibility, fast response, and cost-competitive manufacturing and delivery of small orders and customized products. Digital tools and systems will enable seamless communication and coordination across all stages of the value chain, from design to delivery. This integration ensures that manufacturers can swiftly adapt to changing consumer preferences and market trends, offering personalized products without sacrificing efficiency or quality.

Moreover, the industry seeks to extend automation and industrial efficiency to the after-sales phase, including product care, maintenance, and repair. By integrating automated systems for these services, the initiative aims to enhance the lifespan and functionality of textile products, promoting a circular economy. This approach not only adds value for consumers but also reduces the overall environmental footprint of the textile industry.

Key technologies and enablers

Big data & AI

Virtualisation & digital twins

Robotics & digital microfactories

Ecodesign & LCA tools

This Strategic Topic includes the following **Research & Innovation Objectives**:

- **R&I Objective 11.1 Establish micro-factories for flexible AI-driven local on-demand manufacturing of clothing and other assembled textile products.** *This objective aims to develop and integrate technologies and organisational concepts to establish small-scale clothing and other textile*

[16] Augmented reality (AR), virtual reality (VR).

production facilities equipped with AI-driven capabilities, enabling flexible and efficient on-demand manufacturing processes across Europe.

- **R&I Objective 11.2 Integrate digital supply chain processes with networked manufacturing concepts.** *This objective seeks to enhance value chain efficiency by integrating digital technologies across supply chain processes from design, to ordering, scheduling, production, distribution and customer engagement and linking them with flexible networked manufacturing capacities.*
- **R&I Objective 11.3 Foster all-digital processing.** *This objective aims to revolutionize textile manufacturing processes by transitioning to fully digital workflows, including the integration of product design, material selection, prototyping and sampling with weaving, knitting, digital printing, dyeing and finishing operations all the way to product assembly and packaging, driving flexibility, time-to-market and cost-efficiency even for small runs or single piece orders.*
- **R&I Objective 11.4 Implement digitised, automated and resource-efficient care, repair and remanufacturing.** *This objective aims to enhance sustainability and efficiency in the textile product use phase by implementing digital and flexibly automated processes for cost-effective care, repair, and remanufacturing of textiles.*

Strategic Topic 12 Safe & sustainable materials for technical applications

General objectives and scope

The primary objective is to ensure that smart and high-performance textiles are made from safe and sustainable feedstocks and materials. This involves the development and integration of sustainable materials that meet the functional and regulatory requirements of technical applications, ensuring both performance and sustainability.

A key aspect of this strategic topic is the development of processes and chemicals that comply with SSbD principles. By adhering to SSbD guidelines, materials and processes will be created that are not only high-performing but also environmentally benign and safe for human health. This includes the use of non-toxic, renewable chemicals and processes that minimize environmental impact throughout the product lifecycle.

Furthermore, this research area emphasizes the importance of ensuring that an increasing share of complex technical textiles and textile-non-textile material mixes can be recycled. This goal aims to minimize the incineration and landfilling of such materials, promoting a circular economy also in the technical textile sector. Developing recycling technologies and processes that can handle complex material compositions is crucial for achieving this objective.

Another critical focus is growing the use of bio-based and recycled textile materials in high-performance technical applications. The industry seeks to ensure that these sustainable materials meet the stringent standards set by regulators, customers, and end users. This includes rigorous testing and certification processes to guarantee that bio-based and recycled materials can perform on-par with conventional alternatives in demanding technical applications to avoid regrettable substitution.

Key technologies and enablers

Sustainable chemistry and biotechnology

Next generation fibres and biosynthetics

Resource-efficient process technologies

This Strategic Topic includes the following **Research & Innovation Objectives**:

Recycling

- **R&I Objective 12.1 Develop, process and implement safe and sustainable materials for technical applications.** *This objective focuses on developing smart and high-performance fibre-based materials that meet high environmental and user safety standards and meet other sustainability criteria in production, installation, use and end-of-life (following SSbD principles), enhancing the performance and environmental impact of technical applications and systems in which they are used.*
- **R&I Objective 12.2 Develop and implement safe and sustainable chemicals and processes for advanced functionalities.** *This objective aims to SSbD chemicals and processes that do not compromise high performance standards and provide advanced functionalities for technical textiles or the end products in which they are applied.*
- **R&I Objective 12.3 Recycling of smart and technical textiles and complex multi-materials.** *This objective aims to develop advanced disassembly, separation and recycling technologies and processes to safely and efficiently reclaim valuable materials from smart textiles, technical textiles, and complex multi-material products and minimise non-recyclable waste streams.*
- **R&I Objective 12.4 Development and utilisation of bio-based fibres, yarns, textiles and materials for technical applications.** *This objective aims to develop and utilize bioderived or bioprocessed feedstocks and materials to create safe and sustainable fibres, yarns, textiles and materials for smart and high-performance technical applications.*
- **R&I Objective 12.5 Uptake of recycled content in high-performance textiles &and related manufacturing processes and testing.** *This objective aims to increase the use of recycled materials in high-performance textiles by developing and optimizing related processes and testing methods that ensure that performance and efficiency levels of conventional virgin materials can be met.*
- **R&I Objective 12.6 Update existing and develop new standards and certifications for smart & high-performance textile products.** *This objective aims to update and develop standards and certification processes to ensure the safety, performance, and sustainability of smart and high-performance textile materials or products.*

Strategic Topic 13 (Multi)functional materials for technical applications

Key technologies and enablers

Sustainable chemistry and biotechnology

General objectives and scope

The general objectives of this strategic topic are to innovate multifunctional textile solutions that provide high-added value across a variety of end markets and use cases. This involves creating textiles that integrate multiple functionalities, enhancing their versatility and appeal in different sectors, from medical to automotive to aerospace.

A key focus is on engineered functional structures and surfaces that meet demanding requirements, such as general durability and lasting functionalities in harsh use environments. This includes developing textiles that can withstand extreme conditions while maintaining their performance, such as flame retardance, high resistance to abrasion, high pressures or tearing forces, great temperature

fluctuations as well as impermeability and maintenance of material integrity in the presence of defined (chemical or biological) substances. By engineering advanced functional surfaces and structures, these textiles can offer superior performance and reliability.

Additionally, this strategic topic aims to raise the durability and functionality of e-textiles and wearables. This involves improving their cost-effectiveness through automated and integrated manufacturing and assembly approaches. Automation not only reduces production costs but also enhances the precision and consistency of these advanced textiles, making them more viable for widespread use. Enhanced durability and functionality ensure that e-textiles and wearables can perform effectively over longer periods, even in demanding conditions.

Moreover, developing suitable test methods for novel multifunctional textile materials in their specific use cases is critical. Tailored testing protocols ensure that these innovative materials meet the necessary standards and perform as expected in real-world applications. This rigorous testing is essential for validating the effectiveness and reliability of multifunctional textiles.

This Strategic Topic includes the following **Research & Innovation Objectives**:

Next generation fibres and biosynthetics

Robotics & digital microfactories

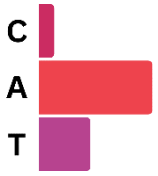
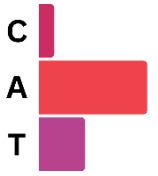
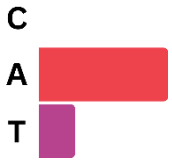
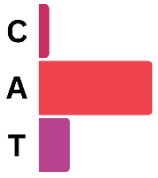
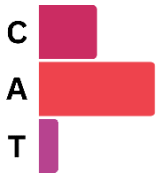
IoT and wearables

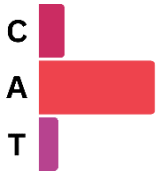
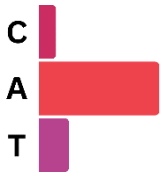
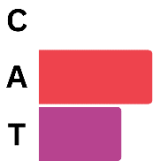
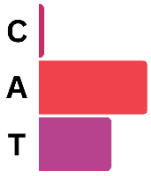
- **R&I Objective 13.1 (Multi)functional materials for technical applications.** *This objective focuses on developing high-performance engineered textile structures and surfaces with multifunctional properties tailored to meet the diverse requirements of technical applications within the textile industry and major non-textile end markets such as transport, construction, protection, sports, healthcare, filtration, energy, agriculture, marine, landscaping and environmental protection.*
- **R&I Objective 13.2 Functional finishes and coatings for durability and multifunctional applications.** *This objective focuses on developing advanced coatings and finishes that enhance the durability and multifunctionality of materials, catering to technical applications with high-performance requirements and in harsh use environments.*
- **R&I Objective 13.3 Sustainable and cost-efficient e-textiles and smart wearables incl. their automated and high-throughput manufacturing.** *This objective aims to develop innovative solutions that combine functionality with durability, sustainability and cost-effectiveness in the production of electronic textiles and smart wearables, meeting the demands of various end markets.*
- **R&I Objective 13.4 Standardised test methods to evaluate durability and advanced functionalities.** *This objective seeks to establish universally accepted testing protocols and tools to assess the durability and performance of (multi)functional materials, ensuring reliability and consistency in technical applications.*

The following table 6 indicates the assessment of each Research & Innovation Objective for:

- their application sectors (C: mostly clothing and home textiles, A: all textile products, T: mostly technical textiles)
- their Technology Readiness Level (TRL) range
- their potential positive EU competitiveness impact
- their pilot investment scale (small: up to €10 million, medium: €10-100 million, large: €100 million+)

Additionally, their required key collaboration partners/competences were defined.

	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
	R&I Objectives assessment of Priority Area III: Advanced manufacturing					
10.1	Develop and integrate new manufacturing technologies for (technical & smart) textiles		Material science, mechanical engineering and mechatronics	5-7	High	Medium
10.2	Develop and implement cost-efficient robotics & smart automation for soft material handling, assembly and finishing		Material science, mechanical engineering, software, robotics and mechatronics	5-7	Medium-high	Medium
10.3	Implement zero-defect & AI-assisted manufacturing		Mechanical engineering, AI, software and mechatronics	4-6	Medium-high	Medium
10.4	Implement AI and AR/VR-assisted predictive and remote maintenance		Mechanical engineering, mechatronics, AI and software	4-6	Medium-high	Small-medium
11.1	Establish micro-factories for flexible AI-driven local on-demand manufacturing of clothing and other assembled textile products		Mechanical engineering, mechatronics, AI and software, organisational science	4-6	Medium-high	Medium
11.2	Integrate digital supply chain processes with networked manufacturing concepts		AI and software, logistics, organisational science	4-6	Medium-high	Small-medium

	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
11.3	Foster all-digital processing		Process and mechanical engineering, AI, software and mechatronics	4-6	Medium	Medium
11.4	Implement digitised, automated and resource-efficient care, repair and remanufacturing		Process and mechanical engineering, AI, software, mechatronics and robotics	4-6	Medium-high	Medium
	<u>R&I Objectives assessment of Priority Area III: High-performance textiles</u>					
12.1	Develop, process and implement safe and sustainable materials for technical applications		Material science, chemistry, process technology	4-6	High	Medium-large
12.2	Develop and implement safe and sustainable chemicals and processes for advanced functionalities		Chemistry, biotechnology, process technology	4-6	High	Medium-large
12.3	Recycling of smart and technical textiles and complex multi-materials		Material science, chemistry, process technology, mechanical engineering	4-6	High	Medium-large
12.4	Development and utilisation of bio-based fibres, yarns, textiles and materials for technical applications		Material science, chemistry, biotechnology, process technology, mechanical engineering	4-6	High	Medium
12.5	Uptake of recycled content in high-performance textiles and related manufacturing processes and testing		Material science, chemistry, process technology, mechanical engineering	4-6	Medium-high	Small-medium

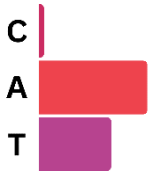
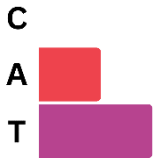
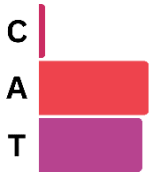
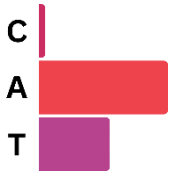
	R&I Objective	Textile application sectors*	Required key collaboration partners/ competences	TRL range	Priority for EU competitiveness	Pilot investment scale
		(C: clothing and home textiles, A: all textile products, T: technical textiles)*				
12.6	Update existing and develop new standards and certifications for smart & high-performance textile products		Material science, chemistry, metrology	4-6	Medium	Small
13.1	(Multi)functional materials for technical applications		Material science, chemistry, process technology	5-7	Very high	Medium-large
13.2	Functional finishes and coatings for durability and multifunctional applications		Material science, chemistry, process technology	5-7	Very high	Medium
13.3	Sustainable and cost-efficient e-textiles and smart wearables incl. their automated and high-throughput manufacturing		Material science, microelectronics, process technology, mechanical engineering	4-6	Medium-high	Medium
13.4	Standardised test methods to evaluate durability and advanced functionalities		Material science & metrology	5-7	Medium-high	Small

Table 6: R&I Objectives assessment of priority area III: Advanced manufacturing & high-performance textile

05
Implementation

The Vision and objectives of the Partnership will be realised through the implementation of a **strategic programme of activities** co-funded by the European Commission and other private and public stakeholders actively engaged in the programme and overseen by a **Partnership Board** composed of representatives of the European Commission and the European textile ecosystem. All activities and stakeholder engagements take place at an appropriate level of **openness and transparency** and results achieved will be disseminated widely to promote rapid technology adoption and best practice diffusion within the European textile ecosystem.

Strategic programme of activities

Textiles of the Future projects

The core of the programme of activities will be represented by research and innovation actions carried out in collaborative projects involving industry, research organisations and other stakeholders, selected in competitive open calls for proposals following the procedures and timelines of the Horizon Europe programme.

Specific call topics of the Textiles of the Future Partnership are expected to be included in the Horizon Europe annual work programmes of 2025, 2026 and 2027. These call topics will address several of the identified strategic topics described in this SRIA with a focus on applied research above TRL 5, demonstration of innovative technologies in industrial environments and active dissemination of results in view of rapid adoption by innovative SMEs and start-ups from the European textile ecosystem.

To boost the involvement of SMEs and start-ups in Textiles of the Future projects, the cascade funding model (financial support to third-parties) will be employed where appropriate. It allows for flexible provision of micro-grants to SMEs that were not part of the initial project consortium, on the basis of open calls launched throughout the project period.

Collaborative projects selected for funding under these open calls will be implemented in the period of 2026 to 2030.

Additional and complementary activities

Additional research and innovation activities related to the priority areas of this SRIA will be implemented through funding of other open call topics under different clusters of Horizon Europe, in collaboration with related partnerships or EIT Knowledge and Innovation Communities as outlined in the collaborations chapter below.

The Partnership will also promote complementary activities funded at regional or national level or by EU level funding programmes, which support follow-up activities based on the Partnership's research results such as demonstration, pilot testing, early market replication, education, and training through programmes like Interregional Innovation Investments (I3), Interreg, LIFE+ or ERASMUS+.

Coordinated by the Partnership's lead organisation Textile ETP, stakeholder interaction such as project brokerage, continuous activity and results monitoring and rapid identification of emerging innovation challenges or enabling technologies, will be organised throughout the implementation period of the Partnership. Given the short initial duration of the Partnership, preparatory activities for its continuation and reinforcement under the following EU research and innovation framework programme, expected to start in 2028, will be undertaken from the start.

ECOSYSTEX: a unique approach to dissemination and community building

All projects funded under the partnership will be encouraged to join the existing ECOSYSTEX Community of Practice for a Sustainable Textile Ecosystem.[17] ECOSYSTEX brings together virtually all research and innovation projects related to textile sustainability and circularity funded under Horizon Europe and other EU-level innovation support programmes. It organises cross-project expert collaboration through technical working groups, joint dissemination activities through the ECOSYSTEX website, a regular webinar series, an annual conference and social media activities. It also ensures that project results with relevance for EU policy making are actively shared with EU policymakers and civil society stakeholders.

Resources

The strategic programme of activities will be funded 50:50 through grant financing provided by the European Commission as part of the Horizon Europe programme and equally matching in-kind contributions by private sector stakeholders engaged in the collective partnership activities and the individual collaborative research projects launched under the Partnership. The exact amounts and modalities of the co-funding mechanism will be fixed in the Memorandum of Understanding (MoU) to be signed between the European Commission and Textile ETP, as representative of the private sector, before the end of 2024.

[17] Textile ETP, *ECOSYSTEX*, 2023.

Examples of contributions by the private sector stakeholders involved in the Partnership include:

- In-kind contributions to the funded collaborative projects (on the basis of non-reimbursed eligible costs), with lower funding rates for higher TRLs;
- Additional investments by recipients of cascade funding grants related to demonstration, pilot line set-up and other exploitation related expenses;
- Additional investments being done by companies where the trigger of the investments will come from technology advances provided by the Partnership projects;
- Private funding which companies invest in national and regional initiatives that relate to the strategic priorities of the Partnership;
- Costs incurred by Partnership stakeholders for participation in collective activities such as strategic programme development and implementation monitoring; brokerage, technology transfer and training activities.

Governance

The Textiles of the Future Partnership is formalised through a MoU for a Co-programmed European Partnership to be signed before the end of 2024, which constitutes an agreement to undertake all efforts necessary to achieve the strategic objectives of the Partnership.

The main governance body of the Partnership is the Partnership Board composed of representatives of the relevant services of the European Commission and representatives of the private stakeholders, the latter of which being nominated by Textile ETP. The Board will be co-chaired by a representative of the European Commission and a representative of the private sector. The composition of the Board will follow various representativeness principles such as adequate coverage of relevant European Commission services, adequate representation of different private sector stakeholders, including SMEs, as well as geographical coverage and gender balance.

The main role of the Partnership Board is to identify the strategic priorities to be addressed through call topics defined in the Horizon Europe work programmes and the overall monitoring and assessment of implementation and impact of the Partnership's programme of activities.

It is the responsibility of Textile ETP as private sector lead of the Partnership to ensure that a broad spectrum of stakeholders from the European textile ecosystem remains actively engaged in the activities of the Partnership throughout the entire implementation period.

Openness and transparency

The Partnership Board will define an adequate level of openness and transparency to ensure that the strategic objectives of the Partnership are reached with the widest possible participation of European textile ecosystem stakeholders engaged in the programme of activities.

Textile ETP as lead entity ensures open communication and dissemination of Partnership activities in line with the rules laid down in the MoU.

Collaboration and synergies with other partnerships

The focus of the Textiles of the Future Partnership is to tackle very specific research and technology challenges that hold back the European textile ecosystem, especially its many small- and medium-sized enterprises, from realising the full potential of the green and digital transition mandated by the *EU Strategy for Sustainable and Circular Textiles*.

However, there is a much broader range of research and technology development activities that can benefit the competitiveness and sustainability of the European and global textile ecosystems beyond the specific objectives of the EU textile strategy. In addition, innovative textile material and technology solutions can positively impact many industrial sectors and end markets. For this reason, the Textiles of the Future Partnership will actively seek collaborations and synergies with other European partnerships and other parts of Horizon Europe beyond Cluster 4 to share knowledge and resources for greater impact.

Figure 10: Collaboration and synergies with other partnerships

The list below is an indicative list of potential Horizon Europe clusters, related partnerships and European research initiatives with which the Textile Partnership will explore collaboration opportunities.

- **Horizon Europe Cluster 2: Culture, Creativity and Inclusive Societies**: exploiting design-based and other creative approaches to sustainability with a special focus on fashion and interior textiles, also focussed on traditional and artisanal approaches to local and regional textile material valorisation, product creation, responsible consumption, circularity and cultural heritage preservation.

- **Horizon Europe Cluster 4: Digital, Industry & Space**
  - ***Made in Europe Partnership:*** exploring multisectoral approaches to advanced, digitised and networked manufacturing and innovative end-of-life concepts such as repair, disassembly or remanufacturing.

- ***Processes4Planet Partnership:*** exploring multidisciplinary and multisectoral approaches to material circularity and process efficiency as well as the application of the SSbD principle across different material sectors.
- ***Innovative Materials for Europe Partnership*** (under preparation): exploring multi-material combinations and multisectoral application potential for smart and highly engineered fibre and textile-based materials and their advanced processing, manufacturing, system integration and circularity challenges.
- ***AI-Data-Robotics Partnership***: exploiting artificial intelligence, machine learning and big data processing capabilities for sustainable optimisation or radical innovation of complex textile material, product design, manufacturing or supply chain challenges. Exploring application of robotic and smart automation advances in complex textile material handling, assembly, repair, disassembly and recycling processes.

- **Horizon Europe Cluster 6: Food, Bioeconomy, Natural Resources, Agriculture and Environment**
  Exploring contributions of more sustainable fibre production and textile processing, greater circularity to a more responsible use of natural resources, lower impact on soils, fresh and marine water. Focus areas are natural and bio-based fibres and feedstocks, GHG emission and water pollution prevention and reduction, textile-to-textile recycling and mitigation of microfibre release from textile products.
  - **Circular and Bio-based Europe Joint Undertaking:** exploring opportunities for utilising sustainable bio-based resources for textile fibres or processing and functionalisation chemicals as well as circular economy approaches favouring biocatalytic processes or safe biodegradation.

- **The European Institute of Innovation and Technology (EIT)**
  - **EIT Climate-KIC:** exploring innovative sustainable textile production and consumption approaches at local and regional community level to prevent, reduce and mitigate the textile and clothing sector's contribution to anthropogenic global warming and other global resource challenges.
  - **EIT Digital:** mobilisation of digital technologies and entrepreneurial approaches to solving textile innovation and sustainability challenges, establishing new business models and rapidly diffusing and scaling digitally enabled sustainable textile products and services.
  - **EIT Manufacturing:** exploring innovative approaches to advanced, digitised and networked manufacturing and rapid diffusion of new manufacturing technologies with a focus on local and regional networks and supply chains enabling on-demand production and closed-loop material flows.
  - ***EIT Cultural and Creative Sectors and Industries KIC***: exploring design-based and other creative approaches to sustainability with a special focus on fashion and interior textiles.

- ***The New European Bauhaus initiative***: exploring the application of textile material science and engineering, design and aesthetics to multidisciplinary challenges of our daily lives and living spaces to create sustainable, beautiful and inclusive societal solutions.

Collaboration work planned

The envisaged collaboration will take many forms such as common meetings and conferences, joint dissemination of results, scoping of joint topics of interest, research and innovation policy papers, contributions to standards etc.

Continuous dialogue on priorities and results, work done or in progress should result in synergies between the partnerships or initiatives so that the resources employed can reach a bigger impact, results can be exploited faster and work in silos is avoided.

References

Apparel Impact Institute, *Taking Stock of Progress Against the Roadmap to Net Zero,* 2024. Accessed 9 July, 2024. https://apparelimpact.org/resources/taking-stock-of-progress-against-the-roadmap-to-net-zero-2024/.

EURATEX, *EURATEX Manifesto. Recommendations from the European textiles and apparel industry for the European elections of June 2024*, 2023. Accessed 10 July 2024. https://euratex.eu/wp-content/uploads/EURATEX-Manifesto-2024-Final.pdf.

EURATEX, *Facts & Key Figures*, 2024. Accessed 9 July, 2024. https://euratex.eu/facts-and-key-figures/.

European Commission, *Categorisation System for the Circular Economy*, 2020. Accessed 10 July 2024. https://circulareconomy.europa.eu/platform/sites/default/files/categorisation_system_for_the_ce.pdf.

European Commission, *EU Strategy for Sustainable and Circular Textiles*, 2022. Accessed 9 July, 2024. https://environment.ec.europa.eu/strategy/textiles-strategy_en.

European Commission, Textiles industry transition pathway, 2023. Accessed 9 July 2024, https://single-market-economy.ec.europa.eu/sectors/textiles-ecosystem/textiles-transition-pathway_en

European Environment Agency (EEA), *Textiles and the environment*, 2022. Accessed 9 July, 2024. https://www.eea.europa.eu/publications/textiles-and-the-environment-the.

Joint Research Centre, *Preparatory study on textiles for product policy instruments (draft),* 2024. Accessed 9 July, 2024. https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/467/documents.

Joint Research Centre, *Techno-scientific assessment of the management options for used and waste textiles in the European Union*, 2023. Accessed 9 July, 2024. https://publications.jrc.ec.europa.eu/repository/handle/JRC134586.

Textile ETP, *ECOSYSTEX*, 2023. Accessed 10 July 2024. https://textile-platform.eu/ecosystex.

Textile Exchange, *Materials Market Report,* 2023. Accessed 9 July, 2024. https://textileexchange.org/knowledge-center/reports/materials-market-report-2023/.

Further reading

ECOSYSTEX, *Research Gaps and Needs for the Green Transition of the European Textile Ecosystem*, 2023. Accessed 9 July, 2024. https://cdn2.assets-servd.host/deranged-cormorant/production/ECOSYSTEX_Research-Gaps-and-Needs_2023-07-05-090528_cvtd.pdf.

EURATEX, *STEP2030 Manifesto*, 2023. Accessed 9 July, 2024. https://euratex.eu/wp-content/uploads/STEP2030-Manifesto_final_evaluated-10.07.23.pdf.

European Commission, *Transition pathway for the textiles ecosystem*, 2023. Accessed 9 July, 2024. https://op.europa.eu/en/publication-detail/-/publication/6392f189-0416-11ee-87ec-01aa75ed71a1/language-en.

Textile ETP, *Ready to Transform. A Strategic Research and Innovation Agenda to underpin the EU Strategy for Sustainable and Circular Textiles*, 2022. Accessed 9 July, 2024. https://cdn2.assets-servd.host/deranged-cormorant/production/SIRA_graphical-version-PDF-version.pdf.

List of tables and figures

Tables

Figures

Abbreviations

9Rs	Refuse, rethink, reduce, re-use, refurbish, remanufacture, repurpose, recycle
AI	Artificial intelligence
AR	Augmented reality
ATC	Agreement on Textiles and Clothing
BREF	Best available technology reference document
CSDDD	Corporate Sustainability Due Diligence Directive
DPP	Digital Product Passport
EEA	European Environment Agency
EIT	European Institute of Innovation and Technology
EPR	Extended Producer Responsibility
ESPR	Ecodesign for Sustainable Products Regulation
EU	European Union
GCD	Green Claims Directive
GHG	Greenhouse gases
ICT	Information & communications technology
IED	Industrial Emissions Directive
IoT	Internet of Things
IT	Information technology
LCA	Lifecycle assessment
LCC	Lifecyle cost
MFA	Multifibre Arrangement
MoU	Memorandum of Understanding
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
R&I	Research & Innovation
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
S-LCA	Social-lifecycle assessment
SME	Small and Medium Enterprises
SRIA	Strategic Research and Innovation Agenda
SSbD	Safe-and-Sustainable-by-Design
TCLF	Textile, Clothing, Leather and Footwear industries
TRL	Technology readiness level
UN	United Nations
VR	Virtual reality
WFD	Waste Framework Directive

Textiles of the Future

PARTNERSHIP UNDER HORIZON EUROPE

ETP
Fibres Textiles Clothing
EUROPEAN TECHNOLOGY PLATFORM

European Technology Platform for the Future of Textiles and Clothing a.i.s.b.l.
Rue Belliard 40, 1040 Brussels, Belgium – ✉ info@textile-platform.eu – 💻 www.textile-platform.eu