Monitoring industrial ecosystems

TEXTILES

Analytical report – 2024 edition

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Executive Summary

This report has been prepared within the 'European Monitor of Industrial Ecosystems' (EMI) project with the objective to analysing the green and digital transformation of industrial ecosystems and progress made over time, in this specific case textiles.

The second edition of the Industrial Ecosystems series has divided the analysis into two sections meaning, 'green transition' and 'digital transition' followed by three subsections each showing: a) industry efforts, b) framework conditions and c) the impact on the environment and on productivity.

The key findings of this year's analysis are being presented below:

Green Transition

What progress has the industry made in taking action for the environment?

- Green transition related patent activity has been **relatively low** but shows positive dynamics over time ranging from 5% to 10% over the period from 2017 to 2021. Advanced materials and clean production technologies remain the two most relevant innovations in textiles but recently **there has been an increase in particular related to renewable energy technologies**.

- 65% of textile companies adopted waste reduction measures and 58% implemented energy saving actions in 2024. The **most significant improvement** occurred in the field of **energy saving technologies and in the use of renewable energy** (also reflected in the patenting trends).

- On the other hand, only **18% of companies in the textiles industrial ecosystem adopted strategies for climate neutrality in 2024, showing a modest commitment**.

- **Dynamic startup activity demonstrates the important role of startup initiatives in driving the green transition**. Startups specialising in advanced sustainable materials accounted for the highest share in total, although their broader deployment in the industry was still limited.

- There has been an increase in the number of recycling startups. Many **examples demonstrate the potential in scaling up recycling initiatives** in the textiles industrial ecosystem despite the notable failures. A key barrier is still lack of investment and broader uptake.

- A significant portion of textile businesses, amounting to **36%, do not currently allocate any resources toward implementing resource efficiency initiatives and those who do spend low**. This lack of investment reflects financial constraints, a lack of awareness about the potential benefits, or competing priorities within these organisations.

- Nonetheless, the **existing cases of late-stage VC investments (even if overall low) in the textile industry is a positive sign and highlights the sector's potential** and the strategic importance of supporting innovative textile startups.

To what extent do framework conditions such as public financing and skills support the green transition?

- The total number of projects funded by the European Regional Development Fund in the textile ecosystem launched over the period from 2014 to 2020 was 6 137, with a total funding of EUR 2.71 bn. It is only **12.4% of this ERDF funding (EUR 336.4 m) supported the green transition**, indicating an untapped potential.

- Throughout the Horizon 2020 programme, over **EUR 102 m was allocated to projects related to the green transition of the textiles industry**, amounting to nearly EUR 14.5

m per year. In the initial four years of Horizon Europe, **a substantial increase** occurred and close to EUR 130 m was dedicated to green transition related textiles projects, averaging over EUR 32 m annually.

- More specifically, **nearly half (45%) of the EU research and innovation funding allocated to textile projects was directed toward supporting the green transition.** This share was 73% in the case of Horizon Europe highlighting the importance of this funding source.

- Textile companies employed in general 2.6 full time employees (per company) in green jobs some or all of their time. However, **54% indicated that they do not employ any professionals in green jobs and 32% of the companies have 1-5 employees only**. This highlights the urgency in addressing existing skills gaps.

- The share of professionals registered on LinkedIn and employed in the textile industrial ecosystem with **skills relevant to the green transition remained low reaching 2.9% in 2024**, showing an increase over the past two years.

- The share of online job advertisements requiring skills related to the green transition in 2023 was particularly low around 1%.

- Critical skills gaps in the textiles industrial ecosystem are related to the **use of advanced materials, recycling and circular economy skills,** moreover capacity to follow up ongoing regulatory changes.

How is the industrial ecosystem's impact on the environment changing?

- The **textiles industrial ecosystem keeps on facing significant environmental challenges** not yet solved in particular, the sector still lags behind in its impact on material extraction and waste generation.

- In 2021, **greenhouse gas emissions generated by the textiles industrial ecosystem in the EU amounted to 143 mega tonnes of carbon dioxide equivalent** (CO2e) in total, as found by the analysis of Exiobase data in terms of consumption account.

- **Material use of EU textiles production (according to production-based accounting) has been gradually decreasing from 2018 to 2022**, even if material use linked to EU consumption has been further increasing (a similar trend identified in the previous report).

- The **land use of textiles in the EU decreased** from 20 thousand km2 to 17.4 thousand km2.

- Despite an increase in 2020 of water consumption of the textiles industry, the consumption levels in 2022 were almost the same as in 2016. This stabilisation is a positive improvement.

Digital Transition

What is the progress of industrial efforts towards digitalisation?

- Digital technologies related innovation has played an increasing role in the textiles industrial ecosystem. The **share of patents related to the digital transition of the EU textiles industry remains low but shows a growing** trend.

- **Advanced manufacturing and robotics and micro- and nanoelectronics lead technological innovation** with a growing share. Most importantly, there are several innovations emerging related to the field of smart textiles.

- The **EU shows disadvantages in textiles related digital technology innovation globally trailing behind the USA, China and Japan**. In particular, in smart textiles, it has been less active as international counterparts.

- Interestingly, **Artificial Intelligence and big data exhibit a decreasing trend in terms of patent applications** dropping below a share in total EU applications of 1% in 2021 indicating challenges. On the other hand, in terms of technology uptake, there has been an increasing uptake of AI solutions and notably 25% indicated adoption in the EU textiles industry in 2024 even if this is much below the average of all industrial ecosystems.

- Overall, **26% in the textiles industry stated that they have adopted a strategy for the digital transformation in 2024** according to the results of the EMI Enterprise Survey, which is a relatively low share.

- Trends over time indicate a **growing diversity of startups focusing on various digital technologies** beyond e-commerce and online platforms, with the most **dynamic growth seen in software solutions and AI-based startups**.

- Textiles companies allocate between **1-5% of their annual revenue to cloud computing, reflecting its relatively more widespread adoption**. In contrast, AI investments remained relatively modest, with most companies dedicating less than 1% of their total investment budget to AI technologies.

To what extent do framework conditions such as public financing and skills support the digital transition?

- The European Regional Development Fund (ERDF) plays a vital role in the digital transition of the textiles industrial ecosystem. Over the period 2014-2020, about **12% (EUR 329 bn) of the funding to textiles ERDF projects supported the digital transition**.

- However, within the ERDF funding allocated to the digital transition in textiles, **only 19% is directed toward advanced digital technologies**, highlighting that the majority of the funding focuses on more fundamental digitalisation efforts.

- **39% of the Horizon 2020 funding and 33% of Horizon Europe contributed to the digital transition of the textiles industry.** Under Horizon 2020, over EUR 87 m was spent on projects related to the digital transition in textiles, more than EUR 12 m per year. In the first three years of Horizon Europe, nearly EUR 58 m were spent on digital topics, averaging EUR 15 m per year.

- In 2024, **43% of textiles companies had 2-5 full-time employee** in roles directly related to the digital transition, 26% of respondents reported employing 1 person in digital roles such as related to the general IT infrastructure of the company, supply chain management platforms and e-commerce.

- In 2024, **only 4% of professionals registered on LinkedIn and employed within the textiles industrial ecosystem possessed advanced digital skills** and 20% possessed other more moderate digital skills, marking an increase from the levels observed in 2022. This suggests progress in overall digital competences, while the adoption of more advanced digital expertise is below the average of all industrial ecosystems.

- The share of online job advertisements requiring skills related to the digital transition was relatively low notably: 21% of job ads requested moderate digital skills and 8% advanced digital skills in 2023. Data also suggest no further progress since 2021.

- Requirements for digital skills listed on online job advertisements within textiles has been growing over the period from 2019-2023.

What is the impact of digital technologies on competitiveness?

- The adoption of advanced digital technologies increased **productivity 10% in the case of robotics among those that adopted this technology and around 1-5%** in the case of other digital technologies.

- The largest share of respondents witnessed an increase in productivity clearly due to the introduction of **Robotics** among all advanced digital technologies.

- **Artificial Intelligence (AI)** is driving productivity gains by enabling automation, data analysis, and process optimisation.

- **Cloud computing**, on the other hand, offers scalable computing resources and data storage over the internet, which allows textiles companies to store and access vast amounts of data without the need for significant on-site infrastructure.

1. Introduction

1.1. Objectives

This report has been prepared within the '**European Monitor of Industrial Ecosystems' (EMI)** project, initiated by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA). The overall objective of the project is to **contribute to the analysis of the green and digital transformation of industrial ecosystems** and progress made over time.

The EU's updated industrial strategy[1] has identified 14 industrial ecosystems[2] – one of them being **'Textiles'[3]** - that is in the focus of this report. The industrial strategy defined industrial ecosystems as encompassing all players operating in a value chain: from the smallest startups to the largest companies, from academia to research, service providers to suppliers. The notion of ecosystems captures the complex set of interlinkages and interdependencies among sectors and firms across the EU. Industrial transition is driven by technological, economic, and social changes, and by the adoption of green and digital technologies and that move towards sustainable competitiveness. The process is however characterised by complex, multi-level, and dynamic developments. To make transition sustainable, technological change needs to be coupled with new business models, the necessary investments and financial tools, skills, regulatory framework conditions and behavioural change across the ecosystem.

The indicator framework includes a **set of traditional and novel data sources that allow shedding new light on ongoing transformation patterns.** The novelty of the analysis lies in the exploratory and innovative data sources used across the different chapters of the report. **Due to its effort to analyse industrial ecosystems using a standardised set of indicators, the study cannot address all aspects of the green and digital transition.** Therefore, additional analysis and industry-specific data sources should be used to supplement a full assessment.

Measuring performance and change is vital to allow policymakers and industry stakeholders to track progress over time and get feedback whether the system is moving in the desired direction. To measure performance, a dedicated **monitoring and indicator framework** has been set up for the purposes of this project with an aim to capture them in regular intervals (see the overview of the monitoring framework in Figure 1).

The **methodological report** that sets the conceptual basis and explains the technical details of each indicator is found in a separate document uploaded on the EMI website. Moreover, some of the specific industry codes used throughout this analysis have been also included in Appendix B. The green and digital technologies considered in this study include the following:

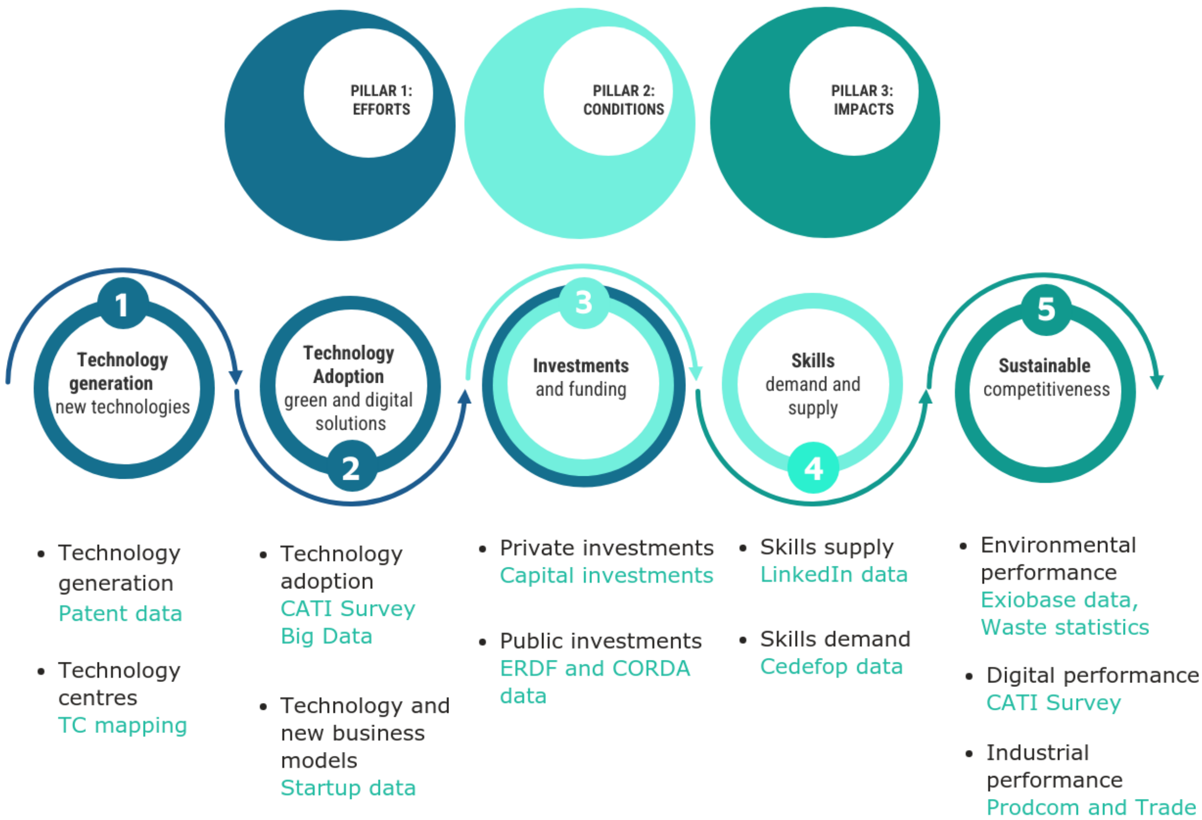
- ***Green transition technologies***: advanced materials, biotechnology, clean production technologies, energy saving technologies, recycling technologies, renewable energy.
- ***Advanced digital technologies***: advanced manufacturing and robotics, Artificial Intelligence and big data, augmented and virtual reality, blockchain, cloud computing, Internet of Things, digital security.

[1] European Commission (2020). A New Industrial Strategy for Europe, COM/2020/102 final and European Commission (2021). Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery, COM(2021) 350 final

[2] The 14 industrial ecosystems include: construction, digital industries, health, agri-food, renewables, energy intensive industries, transport and automotive, electronics, textile, aerospace and defence, cultural and creative culture industries, retail, proximity and social economy, and retail

[3] The textiles industrial ecosystem has been defined following the Annual Single Market Report and including the NACE codes of C13 Manufacture of textiles, C14 Manufacture of wearing apparel, C15 Manufacture of leather and related products.

Figure 1: Overview of monitoring industrial ecosystems and relevant data sources



Source: Technopolis Group, IDEA Consult and Fraunhofer ISI

This report contributes to the analysis of the **key pillars put forward in the 'Blueprint for the development of transition pathways'**[4] of the Industrial Forum developed in 2022.

As a commitment under the European Green Deal, the **EU Strategy for Sustainable and Circular Textiles**[5] was adopted on 30 March 2022 to address the production and consumption of textiles, while recognising the importance of the textiles sector. The concrete and actionable plans to enable the green and digital transitions and to strengthen the resilience of the of textiles ecosystem are outlined in the **Transition Pathway for Textiles**[6].

This strategy foresees a number of legislative and non-legislative measures to tackle the impact of textiles on the environment. The environmental impact of textile products is addressed by the **Ecodesign for Sustainable Products Regulation** (EU) 2024/1781 (ESPR), which came into force in July 2024, introduces a Digital Product Passport (DPP) and sets the general framework for product ecodesign requirements on information and required minimums of performance on sustainability and circularity. Through a **Delegated Act for textiles**, foreseen adoption end 2026, the Commission is considering ecodesign requirements for textiles to be more sustainable, durable and easier to repair and recycle.

The EU has adopted a voluntary **EU eco-label on textiles and clothing** in 2014 that aims to provide consumers with information about environmental and social impacts of textiles

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[4] https://ec.europa.eu/docsroom/documents/49407/attachments/1/translations/en/renditions/native

5EU Strategy for Sustainable and Circular Textiles, COM/2022/141 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022DC0141.

[6] European Commission (2023). Transition pathway for the Textiles ecosystem. https://single-market-economy.ec.europa.eu/system/files/2024-03/Report%20on%20stakeholder%20pledges%20and%20commitments.pdf

production[7]. The EU Ecolabel for textile products guarantees a more sustainable fibre production, a less polluting production process, strict restrictions on the use of hazardous substances, and a long-lasting final product. The proposal for a **Directive on Green claims**[8] put forward in March 2023 by the European Commission would require companies to substantiate the voluntary green claims they make in business-to-consumer commercial practices, by complying with a number of requirements regarding their assessment. Under the proposal consumers will have more clarity and stronger reassurances that when something is sold as green, it is actually green.

1.2. Scoping the ecosystem

The European textile industrial ecosystem is a major contributor to the European economy, with a turnover of EUR 227 bn and more than 222 562 enterprises in the EU in 2023[9]. The textiles industrial ecosystem employed 1.6 million persons in 2023, with 90% of the companies being micro enterprise[10], while small and medium enterprises accounted for approx. 99.7%[11]. Despite the pre-eminence of small businesses in the industry, the EU ranks among the leading innovation actors in terms of patents and industrial designs' applications as well as trademarks registered.

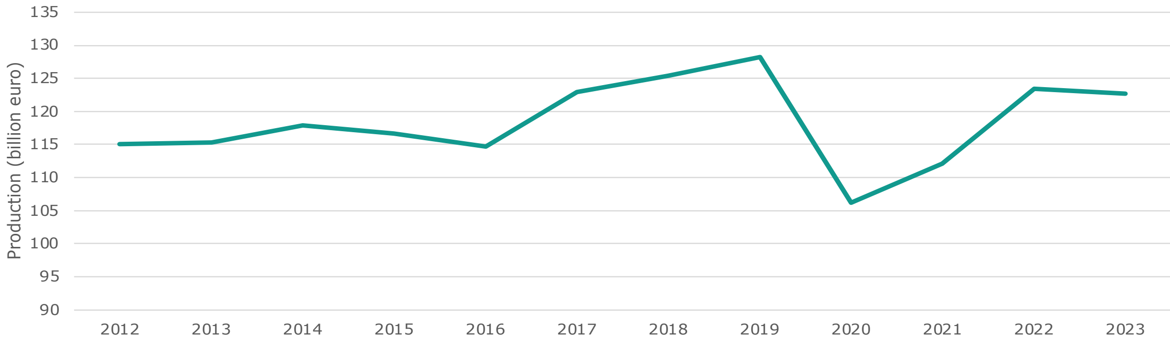
Technical textiles is rapidly expanding, making up a growing share of EU textile production representing 29% of the total textile production in the EU in 2021[12]. They are an input to other industries such as the automotive, medical devices, construction and agri-food sectors. The technical textiles industry is commonly regarded as a top value-added growth industry, where Europe has a strong market position.

The total production value for the textiles industrial ecosystem gives insight into the production performance of the overall ecosystem. Data on production were extracted from the PRODCOM dataset of Eurostat[13]. PRODCOM statistics reveal the total values of production of manufactured goods conducted by enterprises located in EU27. The textiles industrial ecosystem has been delineated by the NACE 2 classification based on weights identified in the Annual Single Market Report[14].

Production value saw overall growth between 2012 and 2023, with a sharp decline in 2020 due to the COVID-19 pandemic and a downward trend beginning in 2022-2023 (see Figure 2). The strong recovery from Covid-19 has lost momentum as rising costs and declining demand put pressure on businesses. The textile industry that initially rebounded are now facing challenges, with inflation, supply chain disruptions, and cautious consumer spending slowing growth.

[7] European Commission, EU Ecolabel - Clothing and textiles, https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel-home/product-groups-and-criteria/clothing-and-textiles_en.
[8] https://environment.ec.europa.eu/publications/proposal-directive-green-claims_en
[9] Eurostat (2024). Downloaded from: https://ec.europa.eu/eurostat/databrowser/view/sbs_sc_ovw__custom_15743399/default/table?lang=en
[10]EUR EUR EUR EUR Eurostat (2024). Downloaded from: https://ec.europa.eu/eurostat/databrowser/view/sbs_sc_ovw__custom_15743399/default/table?lang=en
[11] Euratex, 2024, Facts & Key Figures 2022 of the European textile and clothing industry
[12] Euratex, 2024, Facts & Key Figures 2022 of the European textile and clothing industry
[13]Eurostat (2023) Industrial production statistics introduced – PRODCOM. Retrieved from: https://www.bain.com/globalassets/early_movers_food_system_transformation.pdf
[14] European Commission (2021). Commission Staff Working Document. Annual Single Market Report 2021. Retrieved from: https://commission.europa.eu/system/files/2021-05/swd-annual-single-market-report-2021_en.pdf

Figure 2: Evolution of the production value in the textiles industrial ecosystem



Source: IDEA Consult based on Eurostat (prodcom)

The textiles industrial ecosystem faces significant challenges, including geopolitical unrest, the energy crisis, increasing cost of living and declining consumer confidence, making it difficult for entrepreneurs to thrive[15]. The industry is undergoing the green and digital transition, driven by the need for sustainability and innovation. Companies are integrating eco-friendly materials, circular production processes, and digital technologies to enhance efficiency and reduce environmental impact. Green transition plays an important role in branding, reputation, and competitiveness, as consumers and stakeholders increasingly demand sustainable and ethical practices[16].

The opaque value chain of the textiles industry makes it difficult to monitor and manage the industry's environmental impacts effectively. It is only 20% of the primary raw materials used in textile products that are produced or extracted in Europe, and a large part of the production is outside Europe[17]. The increasing demand for trusted information about textiles products makes it challenging for business to meet requirements without interoperable and scalable traceability systems. More specifically, it faces the following key challenges:

- Scaling up recycling technologies and systems[18] for a circular textile and to reduce waste: This includes developing innovative methods for fibre recovery, improving the efficiency of material separation, and establishing infrastructure to process post-consumer and industrial textile waste.
- Ensuring traceability and accountability across complex global supply chains[19] to address sustainability and social objectives. This involves implementing robust tracking systems, such as blockchain or digital labelling, to monitor the journey of raw materials and finished products from origin to end-use. By enhancing transparency, businesses can verify ethical sourcing, reduce the risk of labour exploitation, and ensure compliance with environmental regulations.
- Investing in new technologies such as smart textiles, bio-based fibres, and advanced manufacturing to stay competitive in a rapidly evolving market[20]. Smart textiles, embedded with sensors and responsive materials, offer innovative applications in sectors like healthcare, sports, and fashion, enabling products that can monitor health, adapt to environmental conditions, or enhance user comfort. Similarly, bio-based fibres, derived from renewable resources such as agricultural waste or algae, provide sustainable alternatives to traditional synthetic or cotton materials, reducing environmental impact while meeting consumer demand for eco-friendly products.

[15] Euratex (2024). Key facts and figures 2024
[16] Euratex (2024). Key facts and figures 2024
[17] https://www.eea.europa.eu/publications/textiles-and-the-environment-the/textiles-and-the-environment-the
[18] See more https://www.rehubs.eu/
[19] https://unece.org/sites/default/files/2024-06/SustainabilityPledge-3yrsMonitoringReport_0.pdf
[20] https://www.smartx-europe.eu/

2. Green transition

2.1. Industry efforts to green the industrial value chain

What progress has the industry made in taking action for the environment?

- **Green transition related patent activity has been relatively low but shows positive dynamics over time.** Figures range between 5% and 10%, indicating an increase over the period from 2017 to 2019 and a new revival most recently in patenting activity related to sustainable textiles.

- **Advanced materials and clean production technologies** are the two most relevant technologies in textiles related patenting but recently there has been an increase also related to renewable energy technologies.

- **65% of textile companies adopted waste reduction measures and 58% implemented energy saving actions in 2024.** However, overall progress since 2021 has been relatively slow.

- **The most significant improvement occurred in the field of energy saving technologies and in the use of renewable energy**.

- In 2024, **18% of companies in the textiles industrial ecosystem have adopted strategies for climate neutrality**, showing a modest commitment.

- While 'Other environmental startups' that use **sustainable materials, organic textiles** or recycled content and companies specialising in advanced sustainable materials accounted for the highest number of startups between 2015-2020, **the past years saw a further surge in the number of recycling startups**. Many examples demonstrate the potential in scaling up recycling initiatives in the textiles industrial ecosystem.

- Startups focusing on **advanced materials (bio-based, recycled and other)** have been further growing rapidly, even if their broader deployment in the industry is still limited.

- **A significant portion of textile businesses, amounting to 36%, do not currently allocate resources toward implementing resource efficiency initiatives**. This lack of investment may reflect financial constraints, a lack of awareness about the potential benefits, or competing priorities within these organisations.

- Nonetheless, the **increasing volume of late-stage VC investments in the textile industry is a positive sign** and highlights the sector's growing potential and the strategic importance of supporting innovative textile startups.

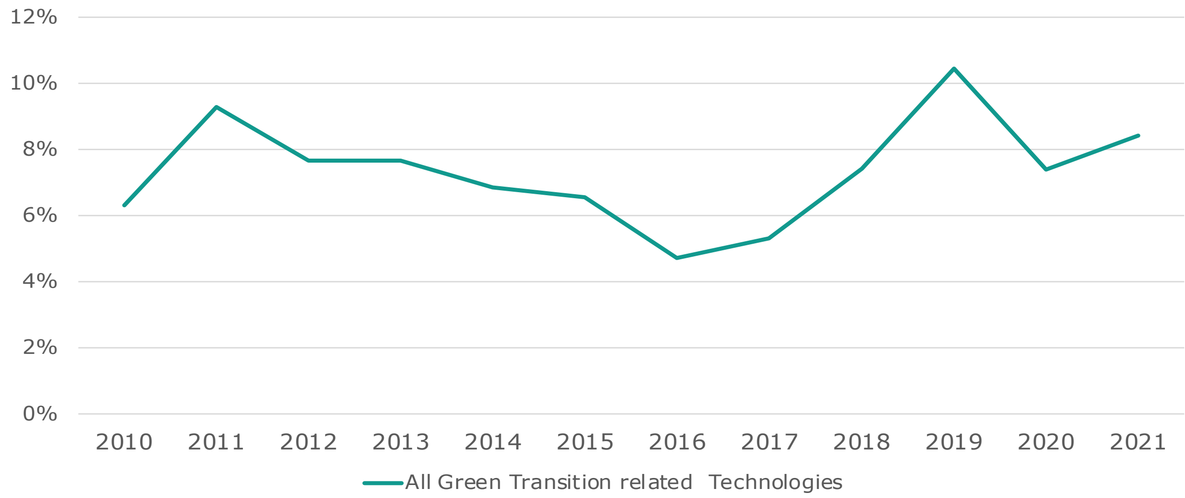
This section reports first on the progress of firms within the industrial ecosystem towards the green transition, focusing on the adoption of environmental technologies and circular business models. It also analyses technology generation and how startups and young companies that provide environmental solutions for the textiles industry contribute to the transformation of the industrial value chain. Moreover, it examines the level of investment by companies in the green transition.

2.1.1. Technology generation

Technology development in the textiles industrial ecosystem has been captured based on the patenting activities related to the specific sectoral activities. The analysis is based on 'transnational patents' (Frietsch/Schmoch, 2010) (i.e. PCT/WIPO filings or direct applications at the EPO, excluding double counts) and was conducted on an extended version of the EPO's Worldwide Patent Statistical Database that Fraunhofer ISI implemented locally. Technologies relevant to the ecosystem have been defined based on a search that refers to patent classifications (IPC) and/or use keywords to identify relevant applications across classes.

Green transition related patent activity has been relatively low but shows positive dynamics over time. Looking at the technologies related to the green transition as presented in the methodological framework, the Figure below presents the share of all green transition related patents in all patents filed for the textiles industrial ecosystem among the EU27 industrial ecosystems overall. Figures range between 5% and 10%, indicating an increase over the period from 2017 to 2019, which was halted by the pandemic but has been reviving since then.

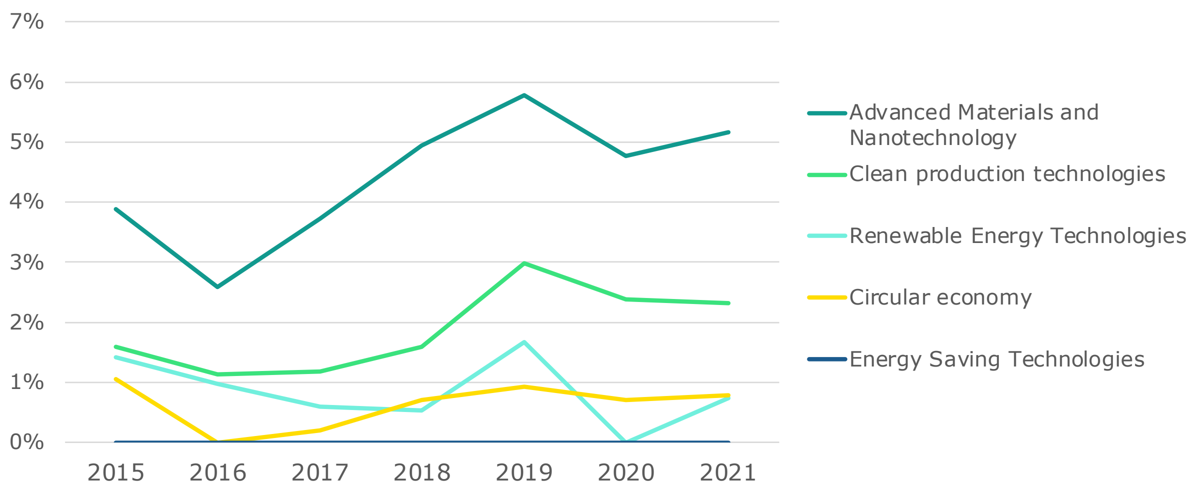
Figure 3: Share of green transition related patents in all patents filed for the textiles industrial ecosystem among the EU27 industrial ecosystems overall



Source: Fraunhofer based on PATSTAT

At the level of green technologies, advanced materials and clean production technologies are the two most relevant technologies according to patenting activities for the textiles industrial ecosystems in terms of patenting activities (see Figure below). Recent years show increasing importance for advanced materials, renewable energy technologies and circular economy related technologies.

Figure 4: Share of respective green transition technologies in overall patents filed in the textiles industrial ecosystem



Source: Fraunhofer based on PATSTAT

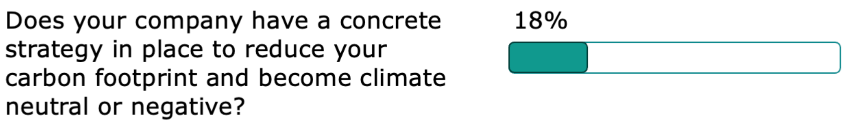
It has to be noted, however, that patenting is relatively underutilised for technological innovation in the textile ecosystem. This is largely due to the fast-paced nature of the market, the dominance of small and specialised niches, and the limited financial resources of many companies, which often cannot justify the high costs associated with patenting. Hence, the results of the patent analysis have to be interpreted together with findings from other data sources.

2.1.2. Uptake of environmental technologies and circular business models

The adoption of technologies and circular business models in the textiles industrial ecosystem has been investigated in detail by the Eurobarometer 2024 and has been complemented by a Computer Assisted Telephone-based Interview CATI-survey conducted as part of the EMI project (the EMI Enterprise Survey) over the period from July-September 2024 with a sample of 578 companies in the textiles industrial ecosystem.

According to the Eurobarometer 2024 survey results, 18% of textiles companies have a concrete strategy in place to reduce carbon footprint or become climate neutral or negative, with no change compared to 2022.

Figure 5: Share of companies in the textile industrial ecosystem that has adopted a strategy to reduce their carbon footprint



Source: Eurobarometer survey 2024, n=234

The Eurobarometer survey indicates that **72% of textile companies adopted waste reduction measures and 66% implemented energy saving actions in 2024**. However, progress since 2021 has been relatively slow. The most significant improvement occurred in the use of renewable energy (20 percentage point increase) and saving water (17 percentage point increase). On the other hand, the least adopted measure has been related to selling residues and waste to another company, which reflects slow progress in terms of the circular economy efforts.

Figure 6: Share of companies in textile industrial ecosystem that have undertook specific actions to become resource efficient in 2021 and 2024 (What actions is your company undertaking to be more resource efficient?)

Environmental measures	***Share of adoption (2021)***	***Share of adoption (2024)***
Minimising waste	72%	72%
Saving energy	58%	66%
Saving materials	65%	63%
Recycling, by reusing material or waste within the company	51%	55%
Saving water	38%	55%
Switching to greener suppliers of materials	47%	49%
Designing products that are easier to maintain, repair or reuse	50%	33%
Using predominantly renewable energy	13%	33%
Selling your residues and waste to another company	22%	27%

Source: Eurobarometer survey 2024, n=234

Besides environmental measures, companies in the textile industry also adopted specific green technologies. According to the EMI Enterprise Survey 2024, 48% **of textile companies have made the most progress in implementing energy-saving**

technologies, marking a significant increase compared to the previous year. The use of other technologies remained at similar levels.

Figure 7: Adoption of green technologies and circular economy models by companies in textile

Green technologies	***Share of adoption (2023)***	***Share of adoption (2024)***
Energy-saving technologies	28%	48%
Waste management technologies	27%	30%
Advanced materials	25%	29%
Clean production technologies	28%	25%
Biotechnology	8%	8%
Circular industrial business models	20%	21%

Source: EMI Enterprise Survey 2024, n= 578

Energy saving and renewable energy

The textile industry has energy intensive manufacturing processes. This is why **the increases in the adoption rate of energy-saving technologies in the textiles industry** across the EU has been a step toward achieving not just sustainability but addressing the challenge of increasing energy prices as stressed during interviews conducted in this study. These technologies include advanced energy-efficient machinery, automated systems that optimise production processes, and smart sensors that monitor and regulate energy usage in real-time. Textile manufacturers in Portugal and Spain reported on investments into renewable energy sources, such as solar power, to reduce dependence on fossil fuels. Additionally, waste heat recovery systems, which capture, and reuse heat generated during production, have been also becoming more common in textile facilities.

Recycling of textiles

The EU manufacture industry of textiles, wearing apparel, leather generated 500 000 tonnes of textiles waste in the EU27 in 2022, only 10 000 tonnes less than in 2020 according to Eurostat[21]. However, the overall textiles waste generated by the consumers within the EU was 1.95 million tonnes corresponding to 4.4 kilograms per capita[22]. The recycling rate of textiles despite the ongoing policy and industry efforts remained low. The current recycling rates are hard to assess in particular when considering fibre-to-fibre recycling. A recent study by the European Topic Centre of the European Environmental Agency[23] found that there were 17 fibre-to-fibre recycling actors across Europe with a total capacity of 1.3 million tonnes per year and with 1 million tonnes for mechanical recycling and 250 000 tonnes for chemical recycling. It is also noted that the volume for mechanical recycling is likely underestimated. Data reported by countries through the topic centre's questionnaire significantly underestimates the recycling capacity documented in literature, amounting to only 194 552 tonnes annually from the seven countries that provided data.

Several factors contribute to the low recycling rate[24]:

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[21] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics#Total_waste_generation
[22] Deckers, J., Duhoux, T., & Due, S. (2024). Textile waste management in Europe's circular economy. European Topic Centre on Circular economy and resource use (ETC-CE) and European Environment Agency (EEA).
[23] Deckers, J., Duhoux, T., & Due, S. (2024). Textile waste management in Europe's circular economy. European Topic Centre on Circular economy and resource use (ETC-CE) and European Environment Agency (EEA).
[24] Resortecs (2024). From Waste to Profit: Maximizing Textile Recycling with Design for Disassembly: https://resortecs.com/from-waste-to-profit-unlocking-industrial-scale-textile-recycling-in-europe/

- The diversity and complexity of textile products are major obstacles. A significant portion of clothes, 78%, are made of different materials and/or have disruptors such as zippers and buttons that impede recycling. Furthermore, 9% of all clothes produced are multilayered. Also, Most textile-based products consist of material composites, including fibre blends, fabric treated with dyes, inks, or finishes, and combinations of textiles with trims[25]. Separating these components is complex, expensive, and often inefficient, typically yielding recycled materials of lower quality or higher cost than their virgin counterparts.

- Fashion is not typically designed for disassembly. To preserve the fabric's quality for textile-to-textile recycling, multi-material products often require labour-intensive manual disassembly, which is not feasible on an industrial scale. Consequently, many clothes destined for recycling are instead shredded into low-quality mixtures. Current disassembly methods have limitations. Manual disassembly, while yielding high-quality feedstock, is time-consuming, costly due to its reliance on extensive manpower, and not scalable.

- Blended fabrics, made from a combination of different fibres, pose further recycling challenges due to the difficulty in separating the blended materials. While these blends can offer improved fabric properties, they often lack feedstock value for recycling.

Nonetheless, it is expected that following the entry in force of the Waste Framework Directive[26] in 2025, mandating EU Member States to establish separate collection systems for used textiles, more efforts will be done to foster recycling and second use of items.

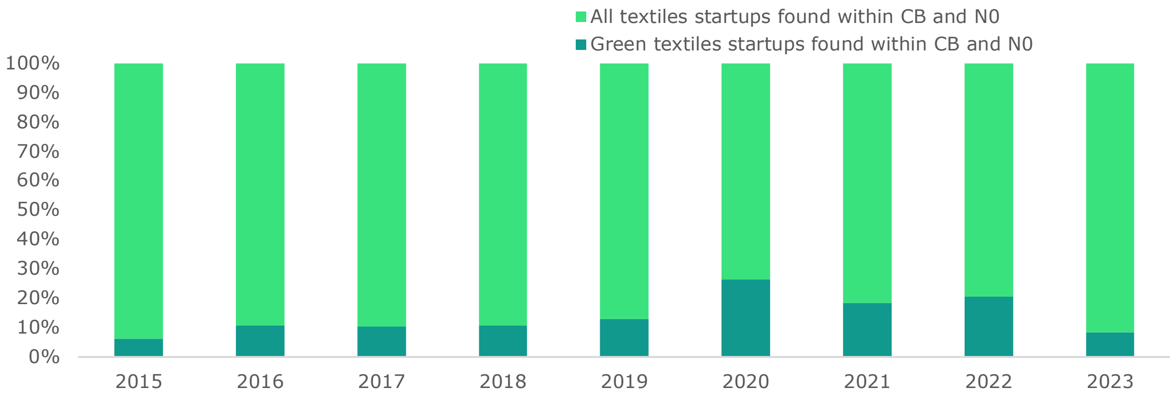
2.1.3. Environmental startups in textiles

Capturing information on startup creation allows to give insight into the novel technologies being generated related to the textile industrial ecosystem. The analysis of startup generation has been compiled through a database encompassing Crunchbase and Net Zero Insights[27] data.

A total of 3 753 textile startups were founded between 2015 and 2023, as identified through these data sources. These startups primarily focus on technology, innovation, and environmental solutions, and do not necessarily represent overall business creation in the industry. Zooming into the evolution of environmentally focused textile companies (or tech companies working within the textiles industry and addressing its green transition) created over the considered period, the first observation to make is the increase in the share of startups with green technologies active within the textile industrial ecosystem after 2019. In particular, a total of **526 textiles startups were created related to the green transition** between **2015 and 2023**.

[25] See article of Lutz Walter available here:
[26] https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en
[27] www.crunchbase.com and https://netzeroinsights.com/

Figure 8: Share of green textile startups identified within Crunchbase and Net Zero Insights databases

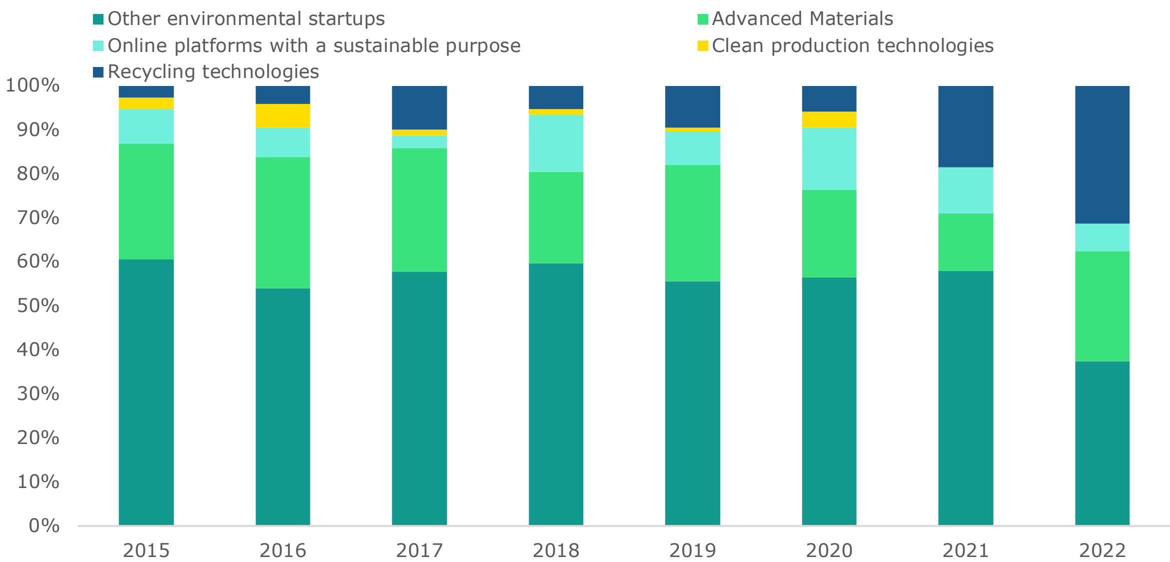


Source: Technopolis Group based on Crunchbase and Net Zero Insights

A break-down of textiles startups per green transition related technology is presented in the Figure below. The category 'Other environmental startups' that constitute the largest category over the years, mostly entails textile companies and retailers that **use sustainable materials, organic textiles or recycled content**.

Between 2015 and 2020, companies specialising in **advanced sustainable materials** accounted for the highest number of startups, second only to those classified under the 'other' category.

Figure 12: Breakdown by green technology and circular business model in the textile industrial ecosystem



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Recycling startups have gained significant traction since 2021, reaching a total of 51 active startups in 2024. Most of these startups are headquartered in the Netherlands, Germany, France, Italy, Finland and Sweden. Following the rise and fall of Renewcell, one of Sweden's largest recycling startup initiatives, the company is now making a comeback in a new form.

Box 8: The case of Renewcell

Renewcell was a significant player in circular fashion with a commercial factory opened in Sweden in 2022. This facility was the first industrial-scale textile-to-textile recycling plant globally. However, less than two years later, Renewcell declared bankruptcy due to lower than expected demand, which hindered its ability to secure long-term funding. This event was considered a setback for textile innovation and waste reduction efforts in the industry.

In 2024, Renewcell has been bought by a Swedish private equity firm, Altor, and has been rebranded as Circulose, which is also the name of its recycled textile pulp product. This acquisition is seen as a second chance for the company to advance recycled fabrics and circularity in the fashion industry. Canopy, a non-profit organisation that supported Renewcell, believes the company has learned valuable lessons that will improve its ability to scale and compete within established supply chains.

Several notable brands, including H&M and Levi's, had previously partnered with Renewcell and expressed interest in their Circulose pulp. However, scaling up to commercial production presented challenges, particularly in coordinating with the complex fashion industry supply chain. Some initial commitments did not materialise into actual orders, and the price of Circulose-based fibres was higher than traditional viscose. Additionally, fulfilling the orders they did receive was difficult due to supply chain complexities.

A key lesson learned was the need for simplification and streamlining of material blends. The new company is also expected to streamline its yarn and fabric offerings to expedite market entry.

Source: Article by Kristin Toussaint available at Fastcompany

Many examples demonstrate the potential in scaling up recycling initiatives in the textiles industrial ecosystem. Relevant recycling startups attracting the highest funding include for example Resortecs[28] that focuses on innovative solutions for textile recycling by developing heat-dissolvable stitching threads, Rester[29] that specialises in collecting and processing post-consumer and industrial textile waste and Recyc'Elit[30] is dedicated to transforming textile waste into regenerated fibre, promoting circular economy practices and sustainable fashion production.

There is a growing number of startups that develop environmentally sustainable advanced materials (bio-based, recycled and other) for the textiles industry and are growing rapidly, even if their broader deployment in the industry is still limited as pointed out the survey results discussed in the previous section. While currently available sustainable materials provide some improvements, they only partially mitigate the industry's environmental and resource challenges. This underscores the potential in scaling advanced materials in the future. Some anticipate[31] that demand for these advanced materials is expected to surpass supply by 2030, emphasising the urgency of accelerating their development and adoption.

Online platforms with a green focus include companies such as Vinted[32] or Vestiarie Collective[33] that provide a digital marketplace promoting sustainability and facilitating the resale and recycling of fashion items. Vinted and Vestiaire Collective specialise in second-hand clothing, allowing users to buy and sell pre-owned fashion.

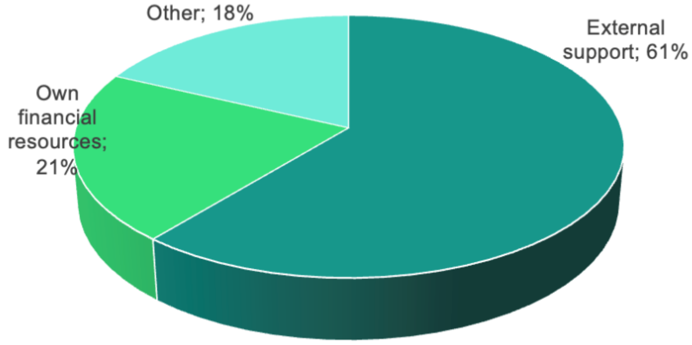
2.1.4. Private investments

Private investments in the textiles industry are instrumental in driving innovation, sustainability, and competitiveness across the ecosystem. In recent years, there has been a marked increase in capital directed toward digitalisation, reflecting the industry's response to evolving market demands and regulatory pressures. According to the Eurobarometer 2024 results, the majority of businesses in textiles (61%) rely on external financial support for resource efficiency measures and producing green products. The

[28] https://resortecs.com/
[29] https://rester.fi/en/
[30] https://www.recyc-elit.com/en
[31] Fashion For Good and BCG (2025). Scaling next-gen materials in fashion – an executive guide.
[32] https://www.vinted.de/
[33] https://www.vestiairecollective.com/

significant dependency on external funding suggests that many textile businesses, particularly SMEs, face financial constraints that hinder their ability to invest independently in green technologies and processes.

Figure 9: Use of financial resources for resource efficiency and producing green products or services



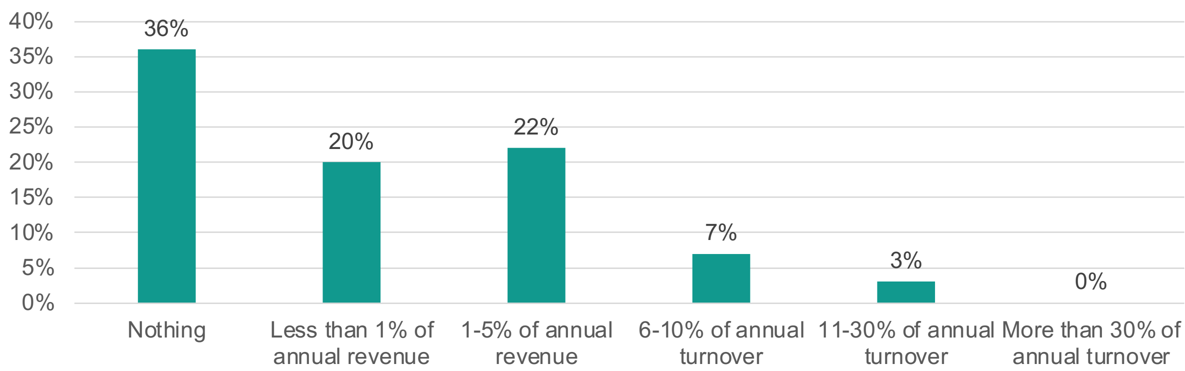
Source: Eurobarometer survey 2024, n=234

A significant portion of textile businesses, amounting to 36%, do not currently allocate resources toward implementing resource efficiency initiatives (see Figure below). This lack of investment may reflect financial constraints, a lack of awareness about the potential benefits, or competing priorities within these organisations.

On the other hand, 22% of businesses actively invest between 1-5% of their annual revenue, on average, in measures aimed at enhancing resource efficiency. These actions may include adopting energy-efficient machinery, implementing water-saving technologies, utilising recycled or sustainable materials, and optimising production processes to reduce waste.

This level of investment demonstrates a growing recognition of the importance of sustainability within the sector and its role in maintaining competitiveness, complying with regulatory requirements, and meeting consumer demand for greener products. However, the relatively low percentage of revenue dedicated to such actions also highlights the need for further encouragement through incentives, funding opportunities, and policy support to accelerate the transition toward a more sustainable and resource-efficient textile industry.

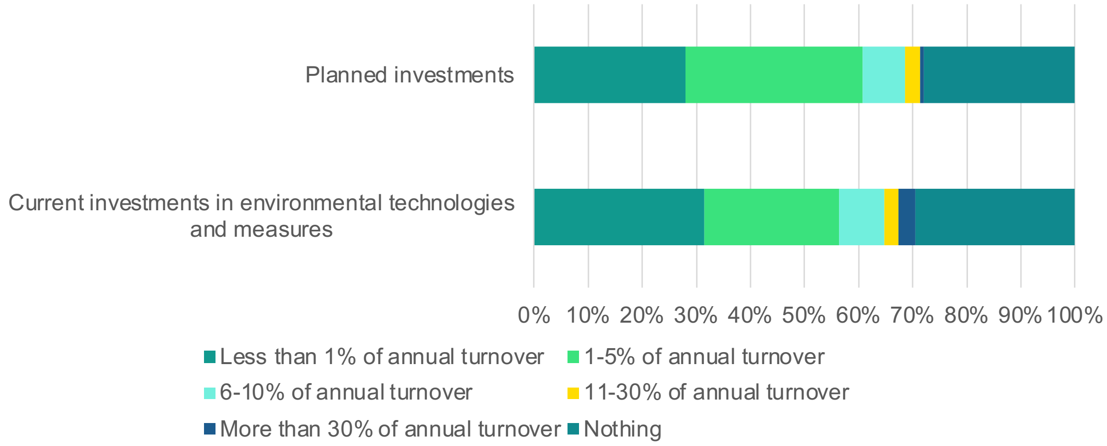
Figure 10: Share of annual revenue invested on average per year to be more resource efficient.



Source: Eurobarometer survey 2024, n=234

The findings of the EMI Enterprise Survey 2024 complement the Eurobarometer survey results, which also show that surveyed companies are planning to increase their investments in the next 2 years. For instance, the percentage of companies intending to invest 1-5% of their annual turnover is expected to rise by 5 percentage points in the following years.

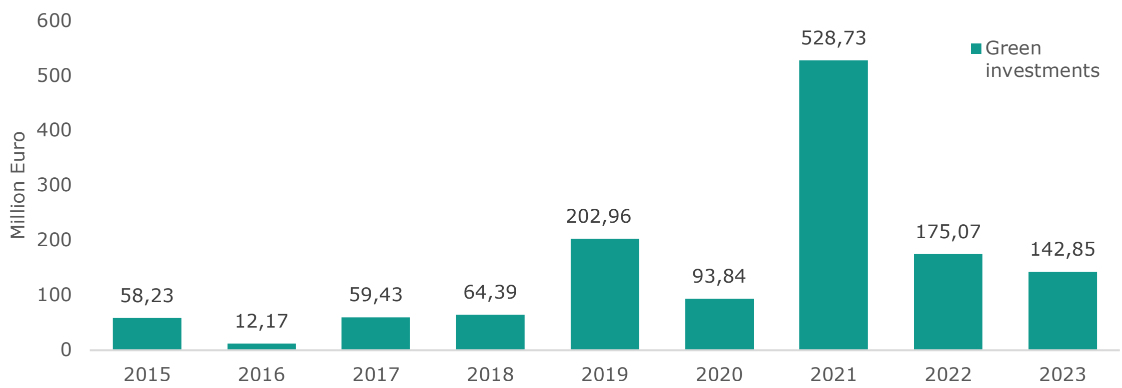
Figure 11: Current and planned investments in environmental technologies



Source: EMI Enterprise Survey, 2024, n= 578

Annual venture capital investment into green tech companies in the field of textiles have been growing steadily during the period 2015-2023 reaching a total amount of EUR 1.38 bn (see Figure below). Venture capital investments were tracked through the Crunchbase and Net Zero Insights data sets. The data set looks at venture capital investments in young companies (age 10 years or less) and gives insights into the amount of investment related to the green transition, as well as investments related to technologies underpinning the transition, notably online platform with a sustainable purpose, advanced sustainable materials, recycling technologies, clean production technologies as well as circular business models. Venture capital data remains sufficiently well reported that general trends can be observed however some data lags for the most recent year (2023) may be present.

Figure 12: Year evolution of investments into young textile companies working toward the green transition in the industry



Source: Technopolis Group based on Crunchbase and Net Zero Insights

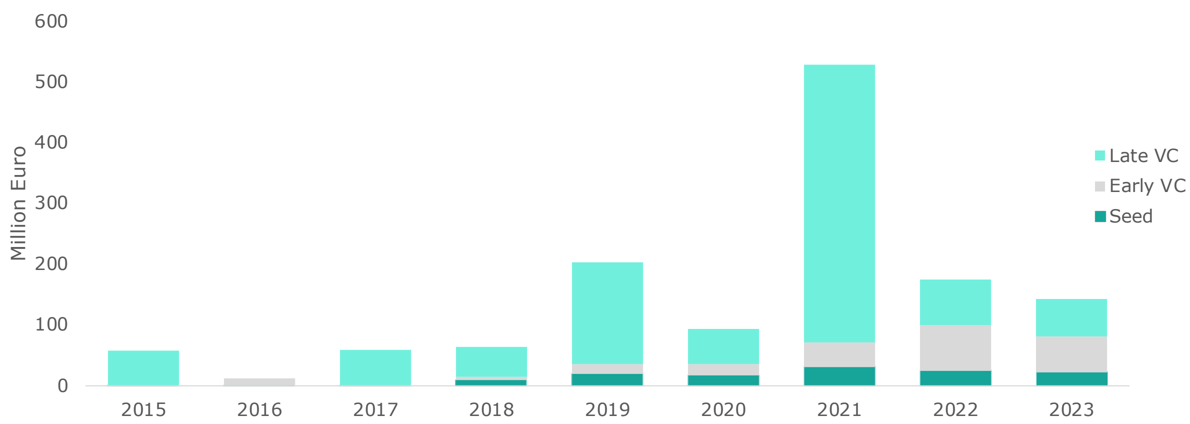
VC investments into environmentally-focused and green technology companies offering solutions for the textiles industry show that **online platforms and digital marketplaces with a sustainable purpose has been attracting most VC investments in 2023,** as opposed to the volume of startups presented above.

Companies developing alternative sustainable materials have also been increasingly receiving funding, with some companies showing maturity and scaling up across the years as also discussed in the section on startups above.

As an example, the company **biopolymer producer AMSilk**[34] has raised a total of EUR 59 m in five funding rounds since 2011, with the last one being a Series C of EUR 25 m in 2023.

The increasing volume of late-stage VC investments in the textile industry highlights the sector's growing potential and the strategic importance of supporting innovative textile startups. In terms of the venture capital investment stages in the green transition of textiles startups, the Figure below presents these according to seed, early venture capital (VC) and late VC, where one can observe the consolidation of the market for green textile startups. Moreover, zooming into the 2021 investments, the peak can be explained by several late VC rounds undertaken by online platforms with a sustainable purpose, such as Vinted, Vestiaire Collective and Otrium.

Figure 13: Venture capital investments stages into green transition of textiles startups



Source: Technopolis Group based on Crunchbase and Net Zero Insights

[34] http://amsilk.com

2.2. Framework conditions – assessment of the broader ecosystem supporting the green transition

To what extent do framework conditions such as public financing and skills support the green transition?

Public funding

- The total number of ERDF projects in the textile ecosystem launched over the period from 2014 to 2020 was 6 137, with a total funding of EUR 2.71 bn. Out of this, **12.4% (EUR 336.4 m) of the funding to textile ERDF projects supported the green transition.**

- While the **Horizon 2020 programme allocated EUR 196 m to projects within the textiles industrial ecosystem, Horizon Europe has so far provided EUR 160.27 m** in funding.

- Under Horizon 2020, **nearly half (45%) of the EU research and innovation funding allocated to textile projects was directed toward supporting the green transition.** This focus has further intensified under **Horizon Europe, where 73% of the European Commission's funding for textile projects contributes to green transition initiatives**.

Skills

- Textile companies employed in general 2.6 full time employees (per company) in green jobs some or all of their time. However, **54% indicated that they do not employ any professionals in green jobs and 32% of the companies have 1-5 employees only**.

- The share of professionals registered on LinkedIn and employed in the textile industrial ecosystem with **skills relevant to the green transition remained low reaching 2.9% in 2024**, showing an increase over the past two years.

- The **share of online job advertisements requiring skills related to the green transition in 2023 was particularly low around 1%**.

- Critical skills gaps in the textiles industrial ecosystem are related **to the use of advanced materials, recycling and circular economy skills, moreover capacity to follow up ongoing regulatory changes**.

Framework conditions that support the green transition refer to various structural and institutional elements that create an enabling environment for businesses to transition towards more sustainable and environmentally friendly practices. These conditions are crucial for driving the adoption of green technologies and fostering circular economies. Key components of these framework conditions include public policy, skills demand and supply and demand-side factors among others that are analysed in the sections below.

2.2.1. Public investments

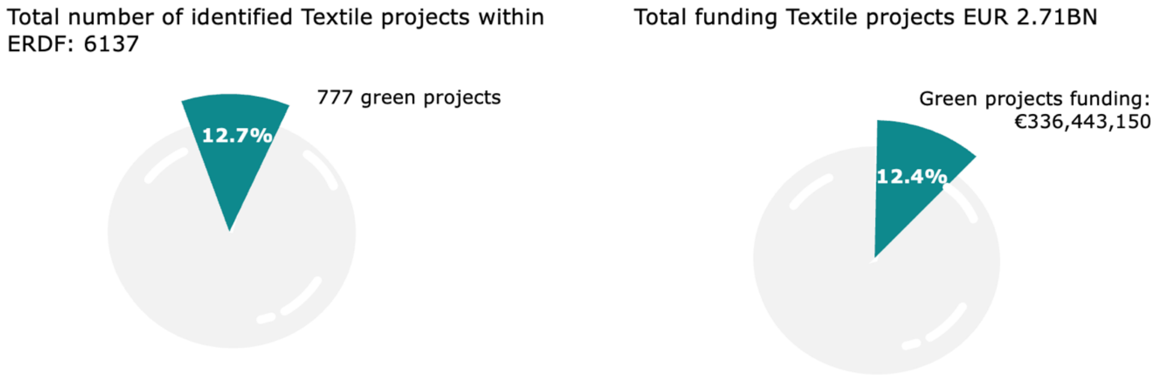
2.2.1.1. European Regional Development Fund

A key source of public funding that enables the green transition is the **European Regional Development Fund (ERDF)**. For this analysis, two data sources have been used and merged, namely the Cohesion Open Data maintained by the European Commission and the

Kohesio data. The latter contains more than 1.7 million projects and approximately 500 000 beneficiaries financed throughout the funding period 2014–2020[35].

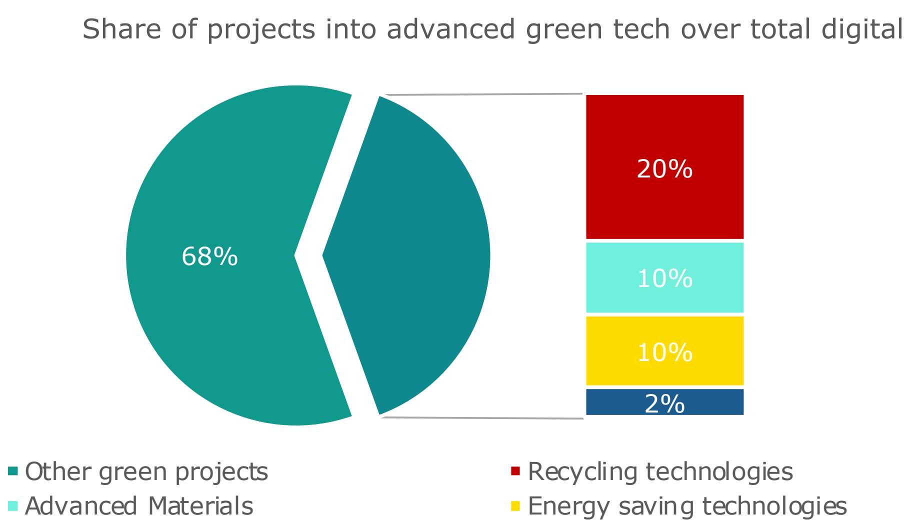
ERDF projects[36] that are related to the textiles industrial ecosystem could be identified in the data based on the codes of economic activity and additional keyword searches in the project descriptions. The total number of **ERDF projects in the textile ecosystem** launched over the period from 2014 to 2020 was 6 137, with a total funding of EUR 2.71 bn. The analysis shows that **about 12.4%** (EUR 336.4 m) **of the funding to textile ERDF projects supported the green transition[37]**.

Figure 14: Share of green projects and funding within the textile projects identified within ERDF



Source: Technopolis Group based on Kohesio

Figure 15: Share of projects in 'advanced green technologies' in the total of ERDF textiles projects that contribute to the green transition



Source: Technopolis Group based on Kohesio

[35] European Union (2022) Linking data: Kohesio platform. Retrieved from: https://data.europa.eu/en/publications/datastories/linking-data-kohesio-platform
[36] The European Regional Development Fund (ERDF) supports projects aimed to strengthen economic, social and territorial cohesion in the European Union. It aims to correct imbalances between regions enabling investments in a smarter, greener, more connected and more social Europe that is closer to its citizens. The ERDF finances programmes in shared responsibility between the European Commission and national and regional authorities in Member States.
[37] The projects related to the green transition were filtered in the same manner, using a selected list of green keywords that were also constructed for other parts of the data collection in this project.

In terms of number of projects, 12.7% of the identified textile projects contribute to the green transition. Of this set of green projects, **31% are active in advanced green technologies** (or EUR 139 m), such as recycling technologies, alternative sustainable materials and energy saving technologies. In particular, the Figure below shows that 20% of the green funding goes into projects supporting recycling technologies or practices. As an illustration of the latter, the French project called 'Pilot Line for Recycling Cotton and Mixed Fibres' developed a pilot line for research and innovation in the field of recycling of end-of-life textiles for industrialists (processing of production waste) and distributors (end-of-life articles).

Box 9: ERDF project examples

ERDF textile projects supporting the green transition

The Portuguese ERDF project titled '**New Eco&Natural Wear International Trends'** was implemented between 2018 and 2023. The launch of innovative clothing collections includes recycled fibre-based designs for the sports segment under the new brand OWL and the new MUSTIKE collection of knitted clothing made from bamboo fibres and sunflower for the fashion segment, with a focus on expanding into new international markets. Falling under the category of alternative sustainable materials, the project received EU funding of EUR 142 222.

Most of the energy saving type of projects normally fall under the thematic objective of low-carbon economy and mostly fund the installation of measures that enhance energy efficiency. For instance, in 2017 the Bulgarian project **'Increasing the competitiveness of Eliteks EOOD through the implementation of energy efficiency measures'** funded the company Elitex with EUR 399 121 to achieve more energy-efficient production.

Source: the authors based on Kohesio

2.2.2. The EU Framework Programmes for Research and Innovation

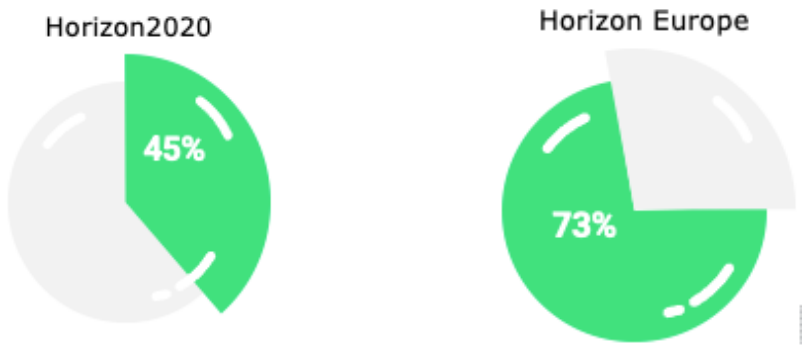
The analysis of the European Union's Framework Programmes for Research and Innovation cover both Horizon 2020 (2014-2020) and Horizon Europe (2021-2027). The results show that while the Horizon 2020 programme funded EUR 226 m to projects classified under the textiles industrial ecosystem[38], Horizon Europe has thus far[39] provided EUR 177 m in funding.

Throughout the Horizon 2020 programme, over **EUR 102 m was allocated to projects related to the green transition of the textiles industry**, amounting to nearly EUR 14.5 m per year. In the initial four years of Horizon Europe, **a substantial increase** occurred and close to EUR 130 m was dedicated to green transition related textiles projects, averaging over EUR 32 m annually.

Under Horizon 2020, **nearly half (45%) of the EU research and innovation funding allocated to textile projects was directed toward supporting the green transition**. This focus has further intensified under Horizon Europe, where **73% of the European Commission's funding for textile projects contributes to green transition initiatives.** These figures underscore the increasing emphasis placed on sustainability within the sector, reflecting the EU's commitment to fostering environmentally friendly practices, technologies, and innovations. The prioritisation of the green transition within the Framework Programmes highlights its critical role in achieving long-term sustainability goals and driving the transformation of the textile industry toward a more sustainable and circular economy.

[38] The methodological report provides detailed insights into the methodology. In particular, the CORDIS data have been merged with the relevant EuroSciVoc data. EuroSciVoc connects projects to relevant scientific concepts, providing a deeper understanding of the research focus.
[39] Cut-off date: March 2024

Figure 16: Share of Horizon 2020 and Horizon Europe electronics projects that contribute the green transition



Source: Technopolis Group analysis

Two examples of textile projects funded under Horizon 2020 and Horizon Europe supporting the green transition is described in the Box below.

Box 10: Horizon projects supporting the textiles industrial ecosystem

Horizon 2020 and Horizon Europe textile projects supporting the green transition

The project **Insuwaste**[40] is funded under **Horizon 2020** under the title "Recycling of hard-to-treat, post-consumer textile wastes and conversion to insulation material for construction industry using a novel conversion technology". The project started in 2014 and it has raised a total amount of EUR 9.2 million.

The **Insuwaste** project aims to scale up and commercialize a process for converting contaminated fiber waste from carpets and mattresses into thermal and acoustic insulation for the construction industry. It will develop an insulation panel or roll along with an efficient manufacturing system that includes anti-bacterial treatments. A techno-economic feasibility study will be conducted to improve thermal performance and address bacterial contamination in recycled fibers. The production line will require machinery for cutting, cleaning, and anti-bacterial processing. EC support is essential for accelerating market entry and facilitating licensing in Europe. Expected benefits include access to valuable textile fibers, reduction of carbon emissions, and sustainable business models, helping to decrease dependence on imported textiles in Europe.

The project **CISUTAC** is funded under Horizon Europe under the title 'Circular & Sustainable Textiles & Clothing'. The project started in 2022 and it has raised a total of EUR 7.6 million.

CISUTAC addresses key challenges in transitioning to a circular textile industry, focusing on polyester, cotton, and cellulosic fibers, which make up about 90% of textile materials in the garment, active wear, and workwear sectors. The project employs a holistic approach, targeting technical, sectoral, and socioeconomic aspects to drive systemic innovation. It includes three pilot initiatives to demonstrate value recovery through repair, disassembly, sorting, reuse, and recycling. A semi-automated workstation will be developed to analyze material flow digitally and improve sorting processes. CISUTAC fosters collaboration with diverse stakeholders, including leading brands and NGOs, to create a comprehensive circular value chain. Ultimately, the project aims to reduce CO2 emissions by approximately 975,000 tons annually, generate around EUR 250 million in new business opportunities, and create about 1,300 full-time equivalent jobs, supporting the social economy.

Source: Technopolis Group based on Cordis

[40] European Commission (2024) FlAgship demonstration of industrial scale production of nutrient Resources from Mealworms to develop a bioeconomY New Generation. Retrieved from: https://cordis.europa.eu/project/id/837750/reporting

2.2.3. Skills supply and demand underpinning the green transition

This section analyses the demand and supply side of the labour market in terms of green transition skills (green skills relevant for environmental protection, implementation of green technologies, or the circular economy). Regarding demand, it utilises experimental data from Cedefop's Knowledge OVATE database, particularly the Online Job Advertisement tables. To examine the supply of skilled professionals relevant to the green transition, data from LinkedIn has been employed. LinkedIn, being the largest professional networking platform, offers rich information such as profile summaries, job titles, job descriptions, and fields of study, which can aid in identifying professionals with skills pertinent to the green transition. Both analyses have been further enhanced by desk research and interviews.

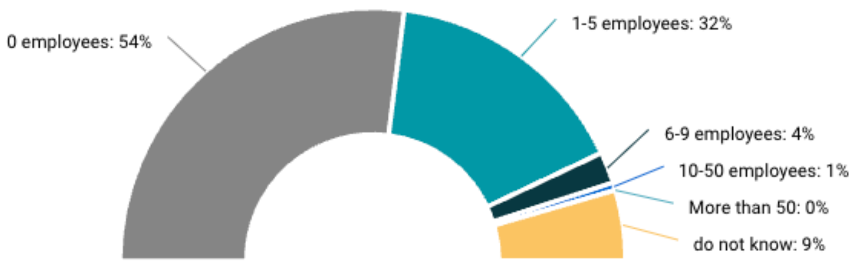
The analysis of green transition related skills followed the definition of Cedefop, notably "*the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society*" (Cedefop, 2012). Green skills have been defined as skills related to environmental protection, environmental services, resource efficiency, biodiversity, low carbon technologies, renewable energy, the circular economy, waste management, management of food waste, and clean production technologies and business models related skills (the list of keywords that have been used and are possible to track with the algorithm of LinkedIn is included in Appendix B).

2.2.3.1. Supply of skills relevant for the green transition

The **Eurobarometer 2024 indicates that organisations in the textile industrial ecosystem employed in general 2.6 full time employees (per company) in green jobs some or all of their time**[41]. 54% indicated that they do not employ any professionals in green jobs and 32% of the companies have 1-5 employees only.

In addition, the EMI Survey 2024 found that **12% of companies in the textile created new positions or job titles dedicated to environmental sustainability** over the past five years.

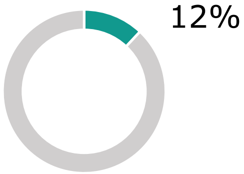
Figure 17: Number of full-time employees that work in green jobs some or all of the time in the textile industrial ecosystem in the EU27 in 2024



Source: Eurobarometer 2024, n=234

[41] Eurobarometer survey 2024

Figure 18: Share of textiles companies that created new positions or job titles in environmental sustainability over the past five years

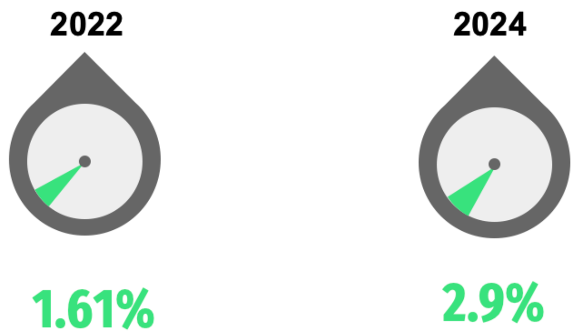


Source: EMI Enterprise Survey 2024, n=578

To gain insights into the supply of skilled professionals, LinkedIn data has been utilised. 1.3 million professionals were registered on LinkedIn and working in the textiles ecosystem in October 2024. More specifically, there were **431 000 professionals in textile and apparel manufacturing and on LinkedIn**. Comparing these results with Eurostat data on employment, this represents around 26% of textile manufacturing professionals, most including professionals with higher education degrees and more relevant positions.

The share of professionals registered on LinkedIn and employed in the textile industrial ecosystem with skills relevant to the green transition reached 2.9% in 2024, showing an increase from 2022 (see Figure below). This low share may also be attributed to the tendency of many companies to outsource environmental functions and subcontract external organisations for environmental development initiatives (as the analysis of startups in the previous sections also demonstrate).

Figure 19: Share of professionals in textile with skills relevant for the green transition in the EU27



Source: Technopolis Group based on LinkedIn

The textiles industry keeps on facing critical green transition related skills gaps, including expertise in sustainable material innovation, circular economy practices, and eco-friendly manufacturing processes. For example, many brands are unequipped for the material transition already underway[42]. There is a shortage of knowledge in the field of recycling and renewable energy use. The textiles industry requires significant upskilling and reskilling to implement circular practices such as repair and recycling, yet access to education and training remains limited in low- to middle-income countries[43]. Manual sorting in textile waste management demands expertise but is often undervalued as a low-skilled role. As technology advances, workers need training for technology-assisted roles in the circular economy, while designers must be upskilled in circular design principles. Additionally, expanding technical training, mentorship, and financial support can enhance workforce inclusion.

Moreover, keeping up with constantly evolving environmental regulations, obtaining sustainability certifications, and meeting ESG (Environmental, Social, and Governance) reporting requirements pose significant challenges for the industry. Textiles businesses

[42] Fashion For Good and BCG (2025). Scaling next-gen materials in fashion – an executive guide. "
[43] Circle Economy (2024). Circularity Gap Report Textiles

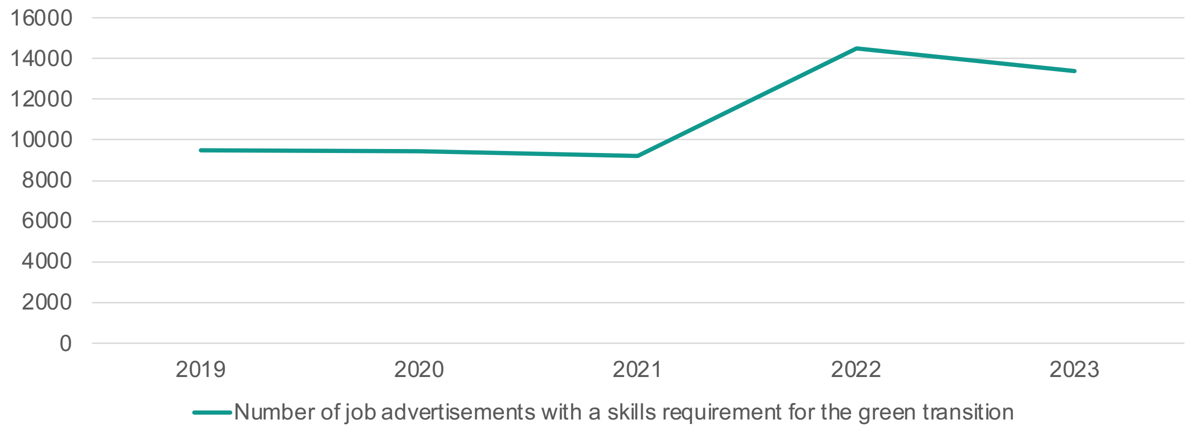
must navigate complex and frequently updated legal frameworks and comply with various industry standards.

2.2.3.2. Demand for skills relevant for the green transition

Skills demand has been analysed following the skills intelligence insights of Cedefop, the European Centre for the Development of Vocational Training[44]. This dataset covers the EU27 Member States (plus UK) and is based on the collection and analysis of more than 530 online job advertisement sources (424 distinct websites) which are open-access sites. The dataset provides information on most requested occupations and skills across European countries based on established international classifications, e.g., ISCO-08 for occupations, ESCO for skills, and NACE rev. 2 for sectors.

The share of online job advertisements requiring skills related to the green transition in 2023 was around 1%. The total number of job ads referring to green skills was even until 2021 but shows an increase since then. The low requirement for environmental skills in the textile is due to a combination of factors.

Figure 20: Share of online job advertisements with a requirement for environmental skills



Source: Technopolis Group based on analysis of Cedefop data

2.2.4. Demand for environmentally friendly textiles

On the one hand, numerous studies highlight a growing expectation for green products in the textile industry, driven by the increasing environmental awareness of consumers[45]. Shoppers are increasingly concerned about the environmental impact of textile production, particularly regarding excessive water use, carbon emissions, and waste. Consumers are beginning to seek out textiles made from sustainable materials like organic cotton, recycled fabrics, and biodegradable fibers, and expect brands to be transparent about their sourcing and production processes. Media attention on the negative impacts of fast fashion has further fueled this demand for more eco-friendly options, with many consumers feeling compelled to make more environmentally responsible purchasing decisions.

On the other hand, interviews conducted in the framework of this study revealed that while the demand for sustainability is rising, price and simplicity still dominate the decision-making process for many customers. Although they express concern for the environment, consumers typically favor sustainable products only when they are affordable and easily accessible. In practice, most buyers choose green textiles or second-hand items primarily when these options are more cost-effective than traditional products. This suggests that while there is an emerging interest in sustainability, the majority of consumers are not yet

[44] https://www.cedefop.europa.eu/en/tools/skills-online-vacancies
[45] See for example: Samuel, Benneet. (2023). Consumer awareness and preference towards green apparel.; Zver, Manca & Vukasović, Tina. (2021). Consumers' Attitude Towards Eco Friendly Textile Products. Tekstilec. 64. 159-171. 10.14502/Tekstilec2021.64.159-171.; https://europa.eu/eurobarometer/surveys/detail/704

fully prioritising it unless it aligns with their financial incentives and convenience. Thus, balancing affordability and sustainability will be critical for the widespread adoption of green products in the textile industry.

2.3. The impact of the industrial ecosystem on the environment

How is the industrial ecosystem's impact on the environment changing?

- The **textiles industrial ecosystem keeps on facing** significant environmental challenges not yet solved in particular, the sector **still lags behind in its impact on material extraction and waste generation**.

- In 2021, greenhouse gas emissions generated by the textiles industrial ecosystem in the EU amounted to 143 mega tonnes of carbon dioxide equivalent (CO2e) in total, as found by the analysis of Exiobase data in terms of consumption account.

- **Material use of EU textiles production** (according to production-based accounting) **has been gradually decreasing from 2018 to 2022,** even if material use linked to EU consumption has been further increasing (a similar trend identified in the previous report).

- The **land use of textiles in the EU decreased** from 20 thousand km2 to 17.4 thousand km2 indicating the increasing importance of virtual space in particular in textiles retail.

- **Despite an increase in 2020 of water consumption of the textiles industry**, the consumption levels in 2022 were almost the same as in 2016. This stabilisation is a positive improvement.

This section summarises the main indicators that capture the environmental impact of the textiles industrial ecosystem. It also reflects on the progress made over time and to what extent targets are being reached.

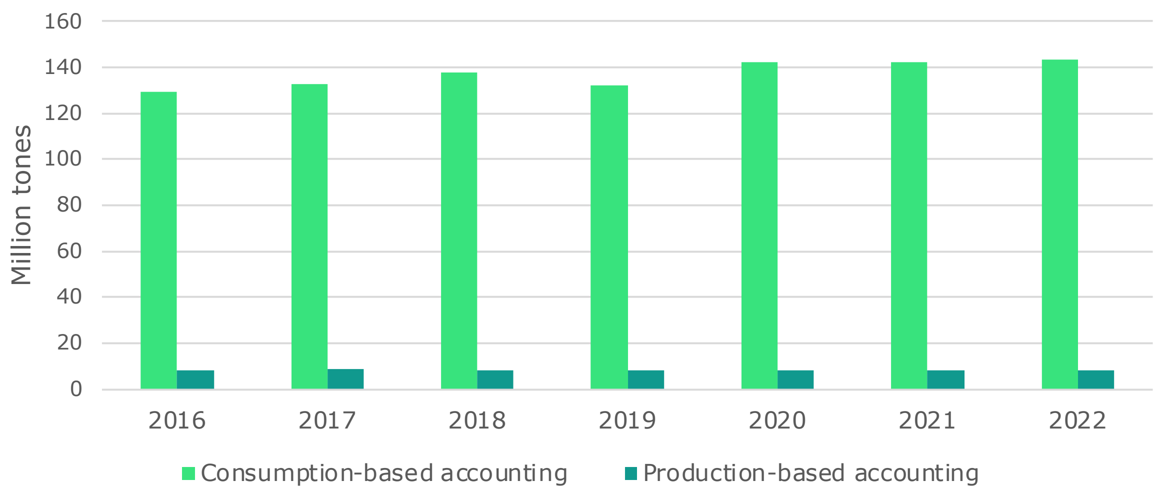
Textile products are the fourth highest-pressure category for the use of primary raw materials and water, after food, housing and transport[46]**.** The environmental impacts of textile production and consumption are many and varied. The largest portion of textiles' climate impact, approximately 80%, arises during their production stage, encompassing the extraction, processing, and fabric creation from raw materials[47]. The remaining 20% of impact is distributed across the use, distribution and retail and end-of-life phases. Production is the most emission-intensive phase due to energy, water, and chemical usage, alongside significant emissions from raw material extraction like cotton and petroleum[48]. The use phase, accounting for around 14% of the impact, involves textile washing, drying, and transportation[49]. The end-of-life phase, making up about 3% of the impact, involves disposal methods like incineration or landfilling[50].

Emissions

In 2021, greenhouse gas emissions generated by the textiles industrial ecosystem in the EU amounted to **143 mega tonnes of carbon dioxide equivalent** (CO2e) in total, as found by the analysis of Exiobase data in terms of consumption account.

Figure 21: CO2 emissions of the textile industrial ecosystem in EU27 (consumption and production accounts)

[46] European Environment Agency (2020). Textiles and the environment: the role of design in Europe's circular economy, Available at: https://www.eea.europa.eu/publications/textiles-and-the-environment-the
[47] Ibid.
[48] Ibid.
[49] Ibid.
[50] Ibid.



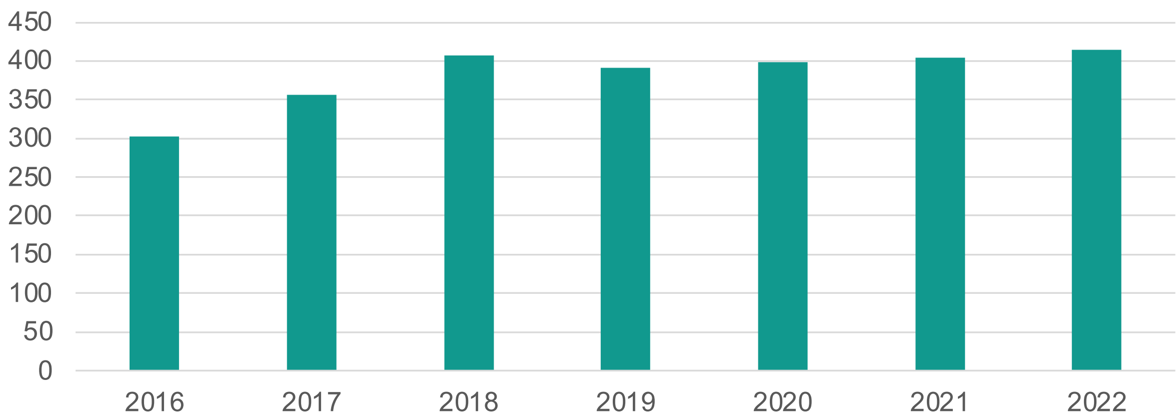
Source: Technopolis Group based on Exiobase data, calculations in 2024

Almost half of these emissions are produced by clothes, 30% by household and 20% by footwear[51]. The results of the analysis show that while the EU production of textiles products has a decreasing impact on greenhouse gas emissions, there is a renewed tendency of the textile industry overall in terms of consumption towards increasing its trade embodied GHG emissions. An additional embodied emission monitored is the particulate matter (PM10 and PM2.5)[52], which has a local impact where industrial activities take place. The trade-embodied particulate matter (PM) of the textile industry has been in a downward trend over the period from 2010 to 2017, with a total decline of 5.9 percentage points compared to 2010. However, an increase can be observed since 2018.

Resource extraction

According to data from Exiobase (see Figures below), **material use in terms of EU consumption has increased** from 302 thousand megatons to 414 thousand megatons over the period from 2016 and 2022 (according to consumption-based accounting). However, **material use of EU production (according to production-based accounting) has been gradually decreasing** from 2018 to 2022.

Figure 22: Material extraction by the textile industrial ecosystems (consumption-based accounting)



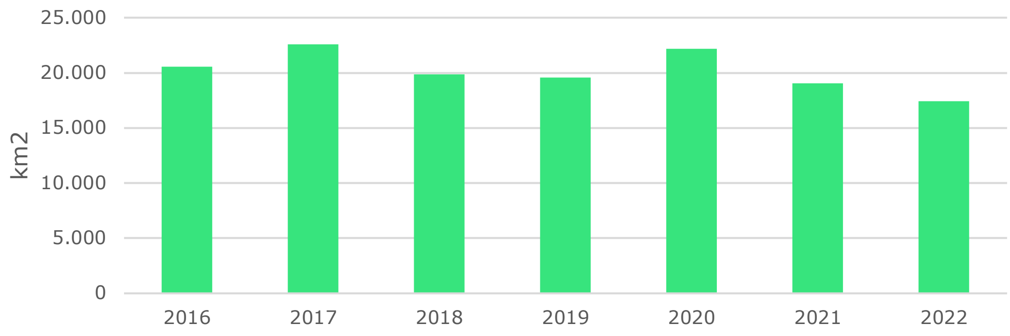
Source: Technopolis Group based on Exiobase data, calculations in 2024

The land use of textiles in the EU decreased from 20 thousand km2 to 17.4 thousand km2 indicating the increasing importance of virtual space in particular in textiles retail.

[51] EEA, 2022. Textiles and the Environment: The role of design in Europe's circular economy
[52] EEA (2022) Particulate matter definition. https://www.eea.europa.eu/themes/air/air-quality/resources/glossary/particulate-matter

This reduction in physical land use highlights a trend toward digitisation and e-commerce, which reduce the need for expansive physical infrastructure. Additionally, the industry's move toward more efficient production processes and sustainable practices contributes to this decline.

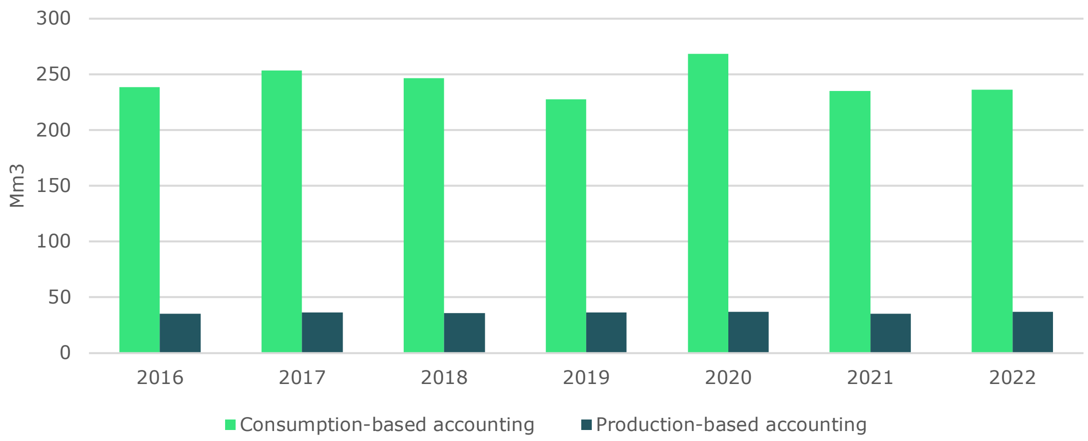
Figure 23: Land use in the EU (km2) (consumption-based accounting)



Source: Technopolis Group based on Exiobase data, calculations in 2024

Despite an increase in 2020 of **water consumption of the textiles industry**, the consumption levels in 2022 were almost the same as in 2016. This stabilisation suggests that the industry has made strides in managing resource efficiency and adopting water recycling systems with investments in water-efficient manufacturing processes.

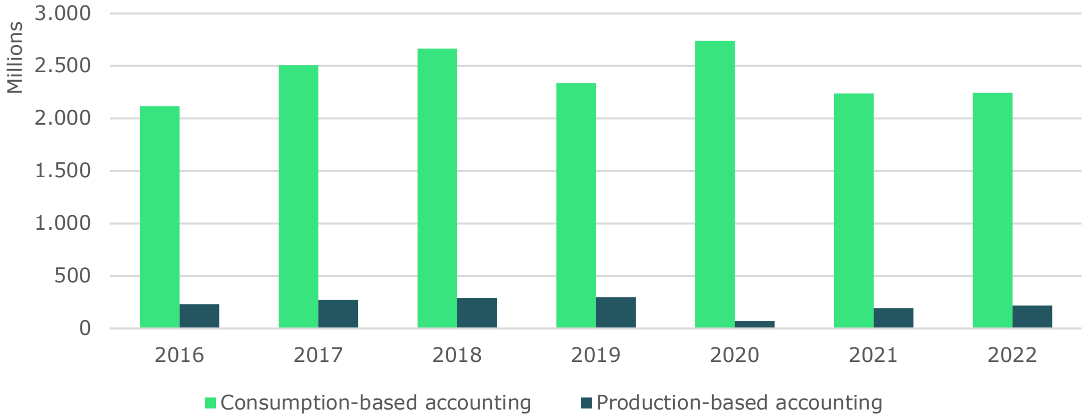
Figure 24: Water consumption in the EU (Mm3)



Source: Technopolis Group based on Exiobase data, calculations in 2024

The **damage to the ecosystem** increased according to both the production and consumption-based accounting. The still prevailing combination of production volumes, resource-intensive processes, consumption habits, and lack of scale in recycling systems is further amplifying the textile industry's ecological footprint.

*Figure 25: Damage to the ecosystem by 14B ecotoxic emissions (Million * PDF)*



Source: Technopolis Group based on Exiobase data, calculations in 2024

3. Digital transition

3.1. Industrial efforts in transitioning towards digitalisation in textiles

What is the progress of industrial efforts towards digitalisation?

- Digital technologies related innovation has played an increasing role in the textiles industrial ecosystem. The share of patents related to the **digital transition of the EU textiles industry remains low but shows a growing trend**.

- **Advanced manufacturing and robotics and micro- and nanoelectronics** lead technological innovation with a growing share. Most importantly, there are several innovations emerging related to the field of **smart textiles**.

- **The EU shows disadvantages in digital technology innovation globally trailing behind the USA, China and Japan**. In particular, in smart textiles, it has been less active as international counterparts.

- **Artificial Intelligence and big data** exhibit a decreasing trend in terms of patent applications dropping below a share in total EU applications of 1% in 2021 indicating challenges. On the other hand, in terms of technology uptake, there has been an **increasing uptake of AI solutions and notably 25% indicated adoption in the EU textiles industry in 2024.**

- Overall, **26% in the textiles industry stated that they have adopted a strategy** for the digital transformation in 2024 according to the results of the EMI Enterprise Survey, which is a relatively low share.

- Trends over time indicate a **growing diversity of startups** focusing on various digital technologies beyond e-commerce and online platforms, with the most **dynamic growth seen in software solutions and AI-based startups**.

- Textiles companies allocate between 1-5% of their annual revenue to cloud computing, reflecting its relatively more widespread adoption. In contrast, AI investments remained relatively modest, with most companies dedicating less than 1% of their total investment budget to AI technologies.

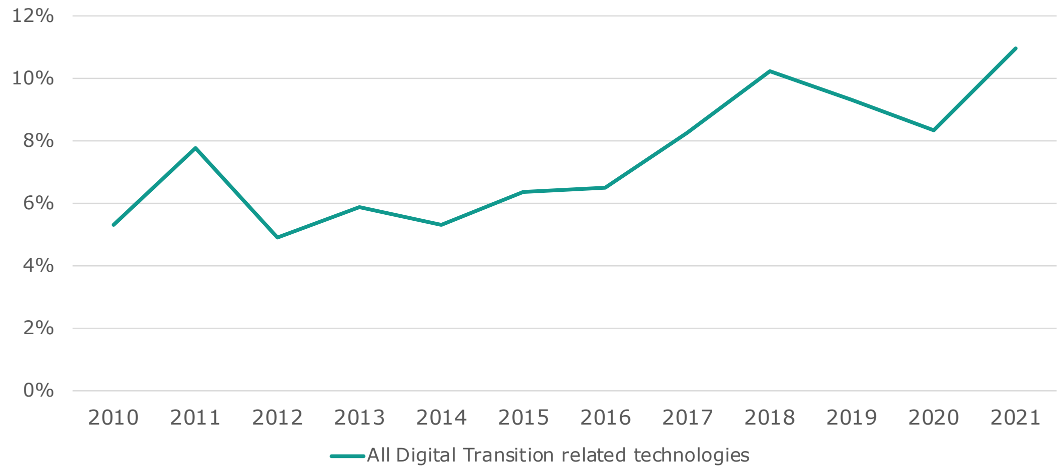
This section analyses the generation and uptake of digital technologies, the evolution of textile tech startups and private investments. It explores the progress that organisations in the textiles industrial ecosystem have made in integrating digital technologies to enhance operations, streamline processes, and improve customer experiences over the past years.

3.1.1. Technology generation

Patent activity related to technology generation for the digital transition complements the patenting trends highlighted in the green transition chapter above.

The share of patents related to the digital transition filed in the EU27 textiles industrial ecosystem remains low but shows a growing trend. Over the period from 2010 to 2021, the share of digital transition related patent applications in textiles within all patents filed in all other EU industrial ecosystems grew from 5% to 11% as presented in the Figure below.

Figure 26: Share of digital transition-related patents in the textiles industrial ecosystem in all patents filed in EU27 industrial ecosystems



Source: Fraunhofer based on PATSTAT

Advanced manufacturing and robotics have played a key role in driving technological innovation within the textile industrial ecosystem. This technology group sharply increased its share in terms of patents filed in textiles representing 6% in 2021 (see Figure below). Related innovations focus on advancements in manufacturing and functionality of textiles, including improvements in diagnostics, infrastructure upgrades (for example improving methods for enhancing urban heating pipes), advanced fabric production techniques (for example creating double-selection fabrics with distinct texture variations). They also cover cleaning technologies for textiles[53].

The potential of smart textiles is highlighted by the micro- and nanoelectronics and photonics patenting trends being the second most significant technology (representing 2%) according to patenting activities for textiles in the EU in 2021. In the EU, the SmartX project was a three-year initiative (2019–2022) designated as cascading funding to support SMEs in the field[54]. Projects were related to smart personal protective equipment or for example a smart glove designed for industrial applications, enhancing safety and efficiency. Internationally an important trend to highlight is the move of large technology companies investing in smart textiles. Apple has filed a patent for a touch-sensitive smart textile in 2023 that can detect touch, location, and pressure using conductive threads made from materials like copper or silver[55]. This technology could be integrated into clothing and wearable devices, continuing Apple's exploration of smart fabrics following previous patents for fabric-based controls and smart accessories.

Artificial Intelligence and big data exhibit a decreasing share dropping below 1% in 2021. This trend highlights the important challenges of AI in the textiles industry, as it requires overcoming complexities in data extraction and operational integration. Legal and ethical concerns, particularly around intellectual property and compliance, further complicate AI's role in textiles[56].

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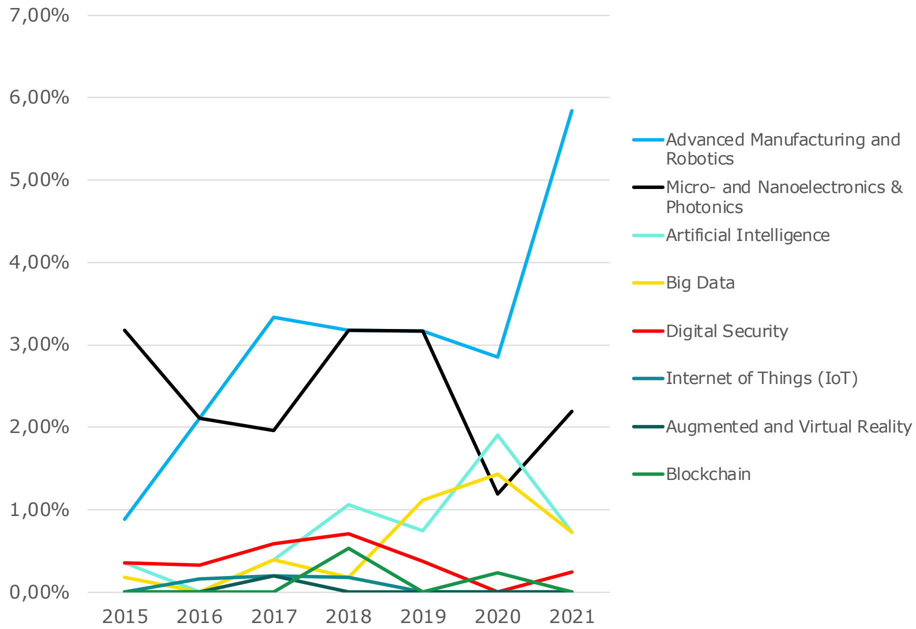
[53] See also in patent applications highlighted by Centexbel available at https://www.centexbel.be/en/patents
[54] https://www.smartx-europe.eu/
[55] Cooke (2023). Signal: Apple files patent application for smart touch-sensitive textile https://www.just-style.com/news/signal-apple-files-patent-application-for-smart-touch-sensitive-textile/?cf-view
[56] See also in https://www.knittingindustry.com/challenges-and-opportunities-for-ai-in-textiles-and-clothing/

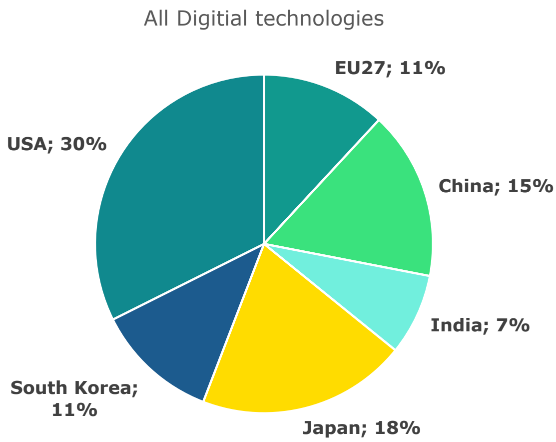
Figure 27: Share of respective digital transition technologies in overall patents filed in the textiles industrial ecosystem



Source: Fraunhofer based on PATSTAT

In a global context, the EU has been lagging in digital textiles innovation. Textiles and accessories had one of the highest shares of patent applications across all other sectors in 2022 (notably 15.6%)[57]. However, digital transition related patenting in textiles has been the highest in the USA followed by Japan and China, while the EU took only the fourth position globally in 2021. Data also shows that the textiles and accessories sector dominated at the patent offices of Germany, India and South Korea[58].

Figure 28: Share of digital transition technologies in overall patents filed in the textiles industrial ecosystem globally



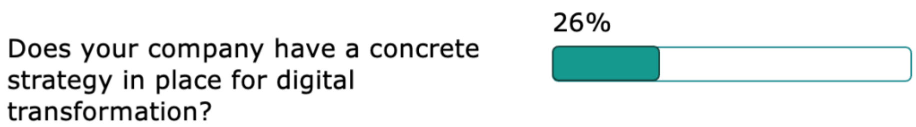
Source: Fraunhofer based on PATSTAT

[57] WIPO (2023). World Intellectual Property Indicators 2023 available at: https://www.wipo.int/edocs/pubdocs/en/wipo-pub-941-2023-en-world-intellectual-property-indicators-2023.pdf
[58] WIPO (2023). World Intellectual Property Indicators 2023 available at: https://www.wipo.int/edocs/pubdocs/en/wipo-pub-941-2023-en-world-intellectual-property-indicators-2023.pdf

3.1.2. Uptake of digital technologies

With the objective to monitor the adoption of digital technologies, the EMI enterprise survey was implemented in the framework of this study as mentioned also under Chapter 2. The survey collected data about the progress in adopting advanced digital technologies among textile businesses. **The survey found that 26% of the respondents indicated that they have adopted a strategy for the digital transformation in 2024.** This indicates that approximately one-quarter of textile businesses are actively planning and executing initiatives to integrate digital technologies into their operations including both general and advanced digital tools. This is, however, still a low result compared to other industrial ecosystems. The industry's integration of digital tools has lagged behind other sectors, mainly due to the specific challenges of garment manufacturing such as the need for small production runs, rapid fashion cycles, and the complexities of working with textile materials[59].

Figure 29: Share of companies in the textile ecosystem that has adopted a strategy for the digital transformation



Source: EMI Enterprise Survey, 2024, n= 578

The more detailed survey results indicate a **growing use of AI and big data technologies** in the textiles industry. The adoption rates of cloud technologies and robotics remained more or less stable, while the share of augmented and virtual reality technologies indicates a drop.

Figure 30: Share of companies in the textile industrial ecosystem that has adopted digital technologies

Digital Technologies	***Share of adoption (2023)***	***Share of adoption (2024)***
Cloud	**32%**	**33%**
Artificial Intelligence	**8%**	**25%**
Internet of Things	**14%**	**20%**
Big Data	**12%**	**12%**
Augmented and Virtual Reality	8%	5%
Robotics	8%	9%
Blockchain	2%	5%

Source: EMI Enterprise Survey, 2024, n= 578

According to interviews conducted in the framework of this study, big data has been playing a significant role in transforming the textile industry, driving efficiency, innovation, and informed decision-making across various stages of production, distribution, and customer interaction. One of the key areas where big data has made impact is demand forecasting. By analysing vast amounts of data on consumer behaviour, sales history, and market trends, textile companies can predict future demand more accurately. This helps align production with actual market needs, reducing overproduction and minimising waste, which is critical in an industry prone to fast-changing trends.

[59] Glogar, M.; Petrak, S.; Mahni´c Nagli´c, M. (2025). Digital Technologies in the Sustainable Design and Development of Textiles and Clothing—A Literature Review. Sustainability 2025, 17, 1371. https://doi.org/10.3390/su17041371

Another major benefit of big data reported is its ability to enhance personalisation and customer insights. In particular in the fashion segment of textiles, companies are leveraging big data to offer personalised products by analysing customer preferences and purchase histories. This allows businesses to create customised fabrics, designs, and fashion items, enhancing the customer experience and tailoring products to individual tastes. This level of customisation is also facilitated by advancements in digital printing and online platforms that enable consumers to personalise their textile products with ease.

Supply chain optimisation is also being revolutionised by big data. By providing real-time insights into the movement of raw materials and production processes, big data enhances visibility throughout the supply chain. Manufacturers can monitor logistics more effectively, anticipate delays, and optimise production schedules. This allows for more responsive production cycles, reducing bottlenecks and improving efficiency in a globally distributed textile ecosystem.

Box 11: Use case of Petit Bateau

Digital transformation at Petit Bateau

Petit Bateau, a French children's fashion brand, embarked on a digital transformation to align with evolving consumer expectations. By leveraging cloud, big data and AI solutions, the initiative aimed to enhance transparency, customer satisfaction, and operational efficiency. Key efforts included optimising structures to better communicate with clients, increasing development speed by shortening sprint cycles, and improving user experience through post-payment feedback. These strategic changes enabled Petit Bateau to modernise its approach while maintaining its commitment to quality and tradition. In addition, to enhance its conversational experience while managing a growing volume of online queries, Petit Bateau implemented chatbot automation. Using an AI-based tool and connector, the chatbot retrieves order tracking details, allowing customers to check their order status instantly. This automation reduces the burden on customer service while ensuring quick and efficient responses to frequent inquiries[60].

Artificial Intelligence is used in applications that can help meet customer demand, personalisation, data analytics and help the recycling process. Interestingly, the adoption of Artificial Intelligence (AI) has seen a substantial increase, rising to 25% in 2024. This growth can largely be attributed to the widespread use of AI tools, such as OpenAI, which have made AI technologies more accessible and easier to integrate into various business processes. The increased availability of user-friendly AI platforms has enabled textile companies to harness the power of AI for a range of applications. The contribution of Artificial Intelligence to the textile industry is multifaceted and can be applied throughout the whole industrial value chain.

- Most importantly, the survey revealed that **AI has been most impactful in the field of data analysis**. In the design phase, AI helps textile firms create new patterns and styles based on existing datasets as mentioned in interviews. During production, it can be applied to recognise fabric patterns and fabric colours, to detect visual defects and measure wrinkles in the fabric. Machine learning can identify previously hidden patterns from raw data to help businesses improve efficiency and maintenance and can optimise inventory and supply chain management or AI-based yarn fibres for new designs prototypes and materials. AI applications offer several benefits to textile industry companies including dashboards to provide quantified real-time data of the market, trend feed with trend reports and market analysis and also access to the product images on the market.
- AI also gained momentum in the **recycling of textiles with AI-powered sorting systems** offering a solution for efficient waste management. By leveraging machine

[60] https://www.iadvize.com/success-story/petit-bateau and https://www.hubvisory.com/fr/use-case/optimisation-du-e-commerce-chez-petit-bateau

learning algorithms, these systems accurately identify and sort materials, enhancing recyclability rates.

Digitalisation in the industry is driven by the upcoming introduction of the Digital Product Passport (DPP)[61]. The DPP is designed to provide comprehensive and easily accessible digital information about a product throughout its life cycle. While consumer products already include essential details such as materials, ingredients, or care instructions, this information is often provided in a physical format. Transitioning to a digital system will enable greater accessibility, improved sustainability tracking, and broader data sharing across the value chain[62].

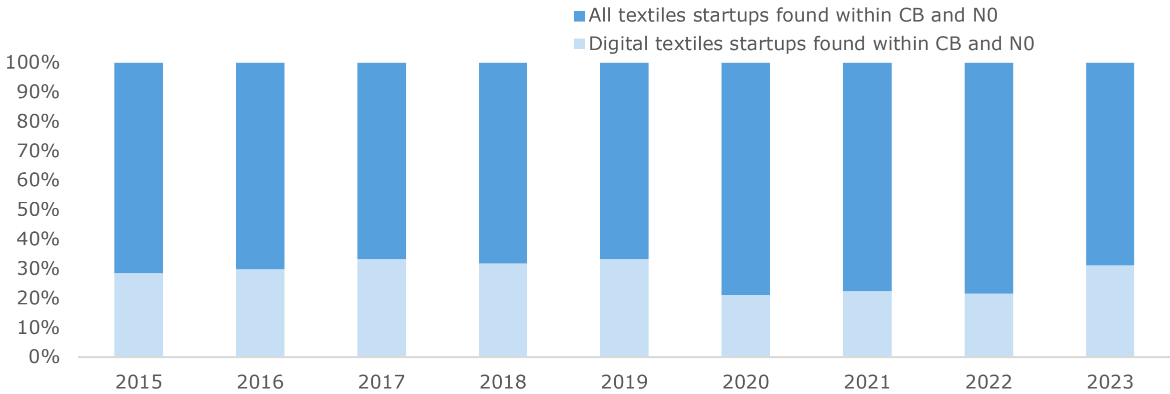
For businesses in the textile industry, preparing for the DPP involves staying informed about regulatory developments and ensuring reliable data collection on materials and production processes[63]. The integration of digital technologies, such as QR codes, RFID tags, and AI-driven analytics, will be crucial for compliance and operational efficiency. While the shift presents challenges, it also offers opportunities for cost savings, improved supply chain transparency, and enhanced product lifecycle management.

There is a trend towards the increased use of robotics and related advanced manufacturing technologies to enhance efficiency, reduce production costs, and improve production quality, although survey results indicate a slower progress over time (9% in 2024). New robotics solutions include automating tasks such as fabric cutting, sewing, bonding, pressing, sorting of raw materials, identification of textiles for recycling, and defect detection. The need for agile equipment with quick change solutions for end effectors is a growing trend, particularly to support small batch production efficiently[64].

3.1.3. Tech startups in textiles

A **total of 1 639 digital transition related startups[65]** were active in 2024 in relation to the textile industrial ecosystem, according to the data compiled from Crunchbase and Net Zero Insights datasets[66]. These startups are companies that focus on developing and implementing digital technologies exclusively focusing on the textiles industrial ecosystem.

Figure 31: Startups related to the digital transition in textile industrial ecosystem



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Besides the use of **e-commerce and online marketplaces**, the analysis of digital textiles technology startups shows that the main digital technologies that allow the creation of new

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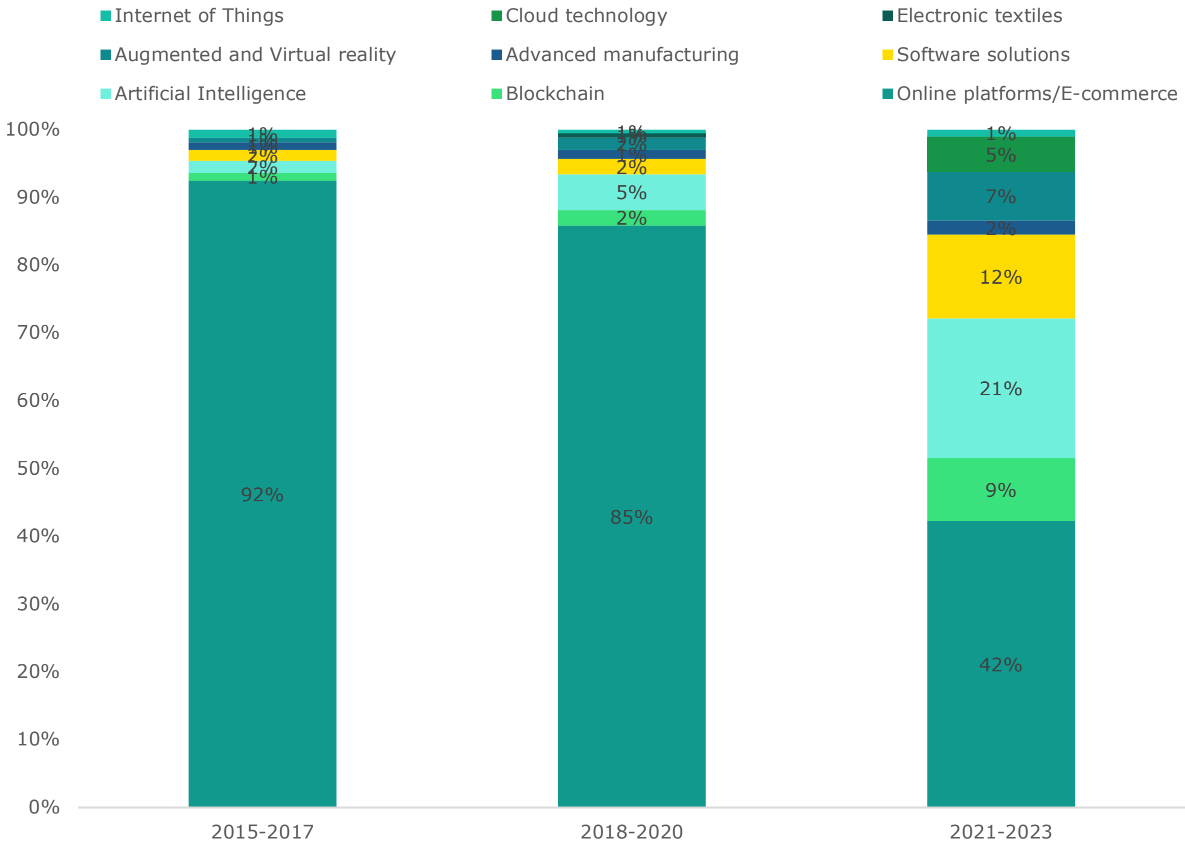
[61] See further here: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14382-Digital-product-passport-rules-for-service-providers_en
[62] See further in European Parliament (2024). Digital product passport for the textile sector
[63] Walter L. (2024). The Digital Product Passport
[64] Postlethwaite, S., Thiel, K., Atkinson, D., McCall, C., & Tupikovskaja-Omovie, Z. (2025). Advancing Automation and Robotics for Sustainable Manufacturing Strategic Pathways for the UK Fashion and Textile Industry. Produced by the Robotics Living Lab (RoLL), Circular Fashion Innovation Network (CFIN), UK Fashion & Textile Association (UKFT) and the Manufacturing Technology Centre (MTC).
[65] Startups have been defined in this analysis as companies founded within the past seven years.
[66] www.crunchbase.com and https://netzeroinsights.com/

added value products and services include **Artificial Intelligence, augmented and virtual reality (AR/VR), and software solutions**. Trends over time indicate a growing diversity of startups focusing on various digital technologies with the most dynamic growth seen in software solutions and AI-based startups (see Figure below).

Figure 32: Technologies underpinning digital tech startups in the textiles industrial ecosystem



Source: Technopolis Group based on Crunchbase and Net Zero Insights

With the increasing adoption of AI technologies, AI startups in the textile industry leverage AI to analyse shopper behaviour, tracking key interactions such as scrolls and clicks to improve the user experience, offer cloud-based, API-first service, transforming fashion product image retouching by automating bulk processing. They offer virtual assistants, data analytics for consumer preference prediction, or predictive maintenance. A larger share of AI-based textiles startups focuses on fashion and design than on textiles manufacturing.

- For instance, the company Sizey[67] uses AI to generate accurate size advice based on 2 full body images and on metaverse-ready 3D body measuring.
- A different application is seen in the company AiSight[68] , which has developed an AI-driven solution that offers a sensor node capable of monitoring industrial machines in real time, helping to prevent machine downtime.

Most startups leveraging augmented and virtual technologies focus on overcoming challenges related to virtual try-ons, aiming to reduce returns and enhance user experience. Additionally, they serve as omnichannel platforms that enable fashion brands to virtualize and customise their collections in 3D, reducing sample costs while elevating

[67] https://sizey.ai
[68] https://sensirion-connected.com:443/predictive-maintenance

customer engagement. However, as seen by the results of the EMI enterprise survey, such solutions are less adopted across the broader textiles industry than Artificial Intelligence.

Box 12: Use case of augmented and virtual reality and AI

Augmented and virtual reality and AI solutions

The French Veesual was founded in early 2020 in France with the objective of using generative AI to revolutionise fashion imagery. Veesual aims to help fashion brands create inclusive online experiences by leveraging AI-driven image generation to better connect with a wider audience. The company reacts to the industry's growing need for diverse and engaging visuals.

3.1.4. Industrial investments into digital technologies

The textiles industrial ecosystem is increasingly prioritising digital investments to enhance operational efficiency, improve audience engagement, and foster innovation in product offerings. These investments span a variety of areas, reflecting both the sector's unique characteristics and the evolving demands of consumers. As the industry faces growing competition, rapid technological advancements, and shifting consumer expectations, digital transformation has become a key driver of success.

Figure 36 below indicates the share of respondents who indicated to make investments in advanced digital technologies in the textile industrial ecosystem based on the EMI enterprise survey 2024. The findings indicate that cloud computing is the primary focus of digital investments for most textile companies among advanced digital technologies, followed by Artificial Intelligence (AI). A significant portion of companies allocate between 1-5% of their annual revenue to cloud computing, reflecting its relatively more widespread adoption. In contrast, AI investments remain relatively modest, with most companies dedicating less than 1% of their total investment budget to AI technologies.

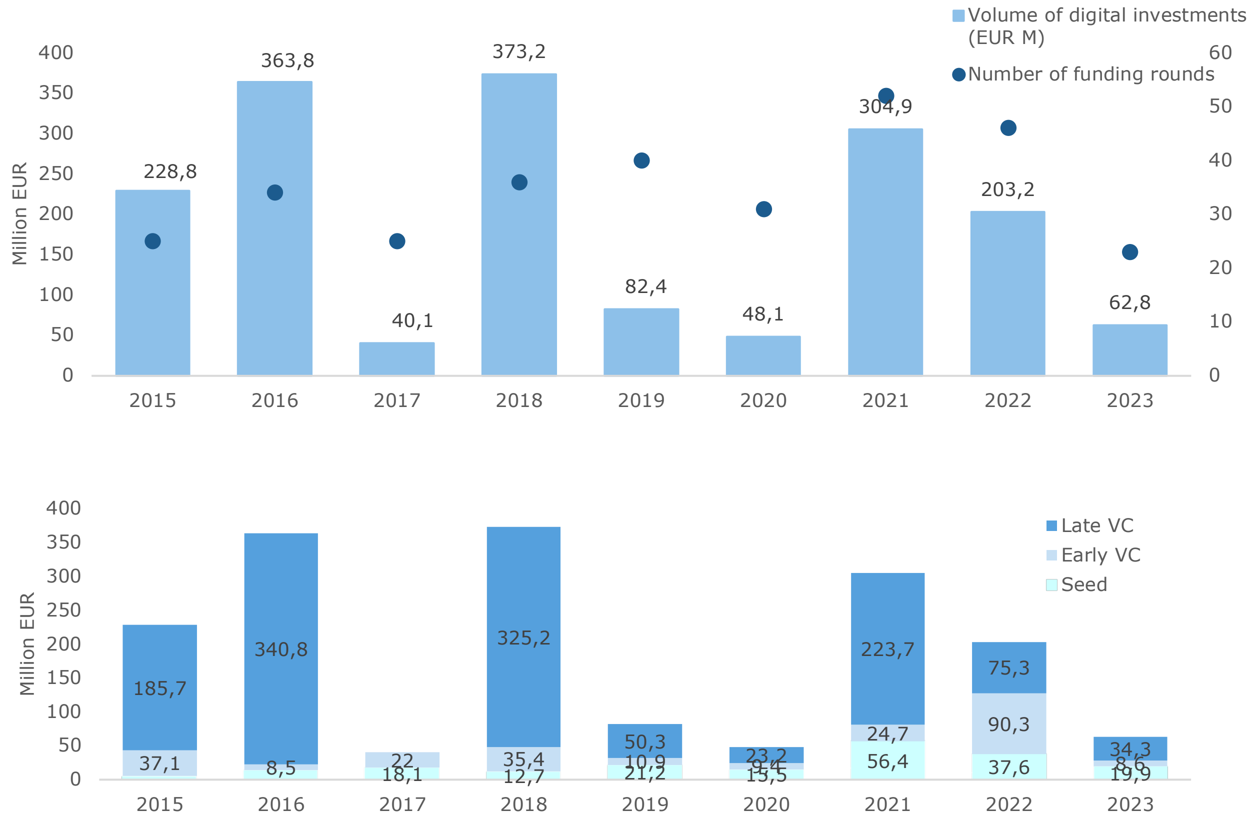
Figure 33: Level of investment of businesses in textile into digital technologies

Technologies	<1%	1-5%	6-10%	>30%
Cloud Computing	11.27%	12.68%		2.82%
Artificial Intelligence	16.90%	4.23%		
Big Data	7.04%	2.82%	1.41%	
Internet of Things	8.45%		4.23%	
AVR	2.82%	2.82%		

Source: EMI Enterprise Survey, 2024

The Figure below illustrates venture capital investments related to the digital transition within the textile industry ecosystem from 2015 to 2023. The investment volumes over this period reveals an uneven trend, with noticeable peaks in certain years. However, when we consider the number of funding rounds, there is an overall positive trend, despite a marked decline in 2023. Late-stage venture capital consistently accounts for the largest share of total funding, driving peaks observed in specific years (notably in 2015, 2016, 2018, and 2021).

Figure 34: Year evolution of venture capital into digital textile young companies



Source: Technopolis Group based on Crunchbase and Net Zero Insights

Investment into companies which digital component are online marketplaces, or e-commerce has been the most common type of funding as depicted in the Figure below. Zooming into advanced digital technologies, young textile companies developing or powered by Artificial Intelligence technologies have increasingly raised across the years, and attracted a total of EUR 185.5 m over the period from 2015-2023.

Details on the funding rounds of further select young companies based on the Crunchbase and Net Zero Insights dataset include. Global Fashion Group[69] develops an online platform for fashion markets. It offers fashion online, and it offers brands the chance to enter the fashion e-commerce sector. It has raised a total of EUR 518 m during four funding rounds, SafeSize[70] is a tech company offering an innovative AI-powered virtual fitting omnichannel solution which helps people find the fitting shoes in physical and online stores. It has raised a total of EUR 27 m since 2013. LUKSO[71] is an open blockchain ecosystem specifically created for the fashion and lifestyle industry. Founded in 2017, it raised EUR 15 m in 2021 through a seed funding round.

[69] https://global-fashion-group.com/
[70] https://www.safesize.com/
[71] https://lukso.network/

Figure 35: Distribution of venture capital funding across digital technologies or solutions

Source: Technopolis Group based on Crunchbase and Net Zero Insights

3.2. Framework conditions – assessment of the broader ecosystem supporting the digital transition

To what extent do framework conditions such as public financing and skills support the digital transition?

Public funding

- The European Regional Development Fund (ERDF) plays a vital role in the digital transition of the textiles industrial ecosystem. Over the period 2014-2020, **about 12% (EUR 329 bn) of the funding to textiles ERDF projects supported the digital transition.**

- However, within the ERDF funding allocated to the digital transition in textiles, only **19% is directed toward advanced digital technologies**, highlighting that the majority of the funding focuses on more fundamental digitalisation efforts.

- **39% of the Horizon 2020 funding and 33% of Horizon Europe contributed to the digital transition of the textiles industry**. Under Horizon 2020, over EUR 87 m was spent on projects related to the digital transition in textiles, more than EUR 12 m per year. In the first three years of Horizon Europe, nearly EUR 58 m were spent on digital topics, averaging EUR 15 m per year.

Skills

- In 2024, **43% of textiles companies had 2-5 full-time employee in roles directly related to the digital transition**, 26% of respondents reported employing 1 person in digital roles such as related to the general IT infrastructure of the company, supply chain management platforms and e-commerce.

- In 2024, **only 4% of professionals registered on LinkedIn and employed within the textiles industrial ecosystem possessed advanced digital skills and 20% possessed other more moderate digital skills, marking an increase from the levels observed in 2022**. This suggests progress in overall digital competences, while the adoption of more advanced digital expertise is below the average of all industrial ecosystems.

- **Requirements for digital skills listed on online job advertisements within textiles has been growing** over the period from 2019-2023. 12% of the job advertisements included a requirement of advanced digital skill such as **AI, big data, augmented and virtual reality, cloud**, compared to 25% of the job advertisements requiring moderate digital skills.

- The share of online job advertisements requiring skills related to the digital transition was relatively low notably: **21% of job ads requested moderate digital skills and 8% advanced digital skills in 2023.** Data also suggest no further progress since 2021.

3.2.1. Public investments

This study examines the **public investments supporting the digital transition in the textile industrial ecosystem.** The public investment sources analysed are the Cohesion policy, and in particular the European Regional Development Fund (ERDF), and the Framework Programmes, Horizon 2020 and Horizon Europe.

3.2.1.1. The role of the European Regional Development Fund

A key source of public funding that enables the digital transition is the **European Regional Development Fund**. ERDF projects[72] that are related to the textile industrial ecosystem could be identified in the data[73]. As mentioned in Section 2, the total number of **ERDF projects in the textile industrial ecosystem** that could be identified in 2014-2020 was 6 137, representing a total funding of EUR 2.71 bn.

The analysis shows that **about 12.1%** (or EUR 329.4 m) **of the funding to textiles ERDF projects supported the digital transition**.

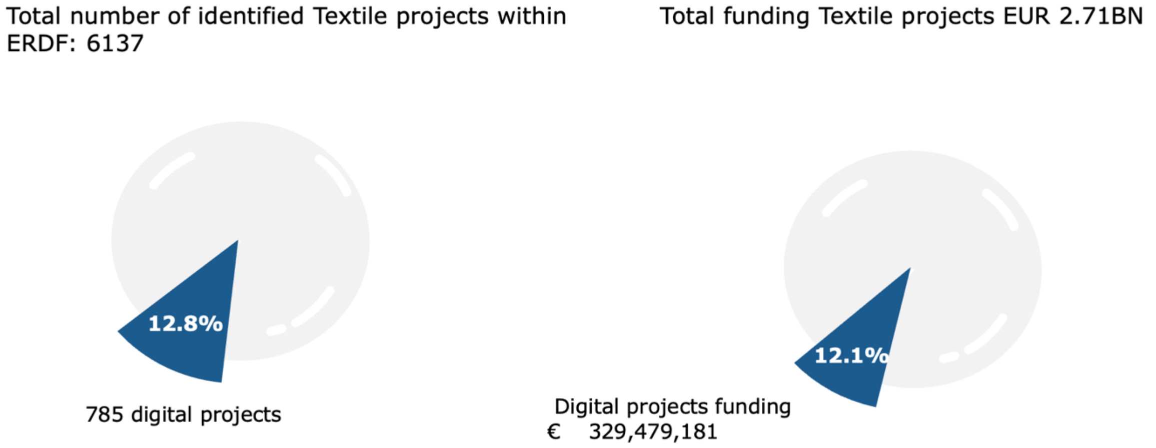
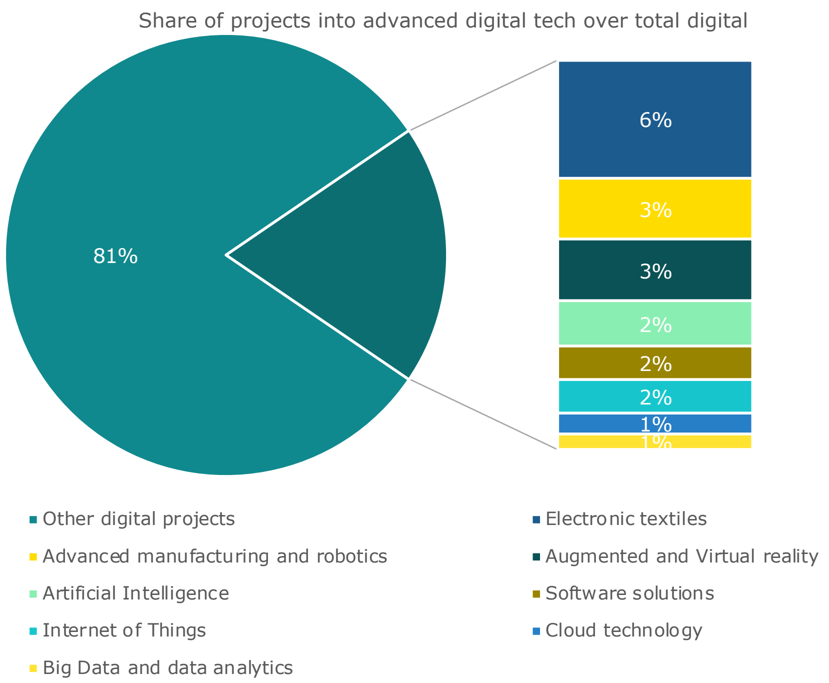


Figure 36: Share of funding contributing to the digital transition in the textile ecosystem by category (2014-2020)



Source: Technopolis Group based on Kohesio

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[72] The European Regional Development Fund (ERDF) supports projects aimed to strengthen economic, social and territorial cohesion in the European Union. It aims to correct imbalances between regions enabling investments in a smarter, greener, more connected and more social Europe that is closer to its citizens. The ERDF finances programmes in shared responsibility between the European Commission and national and regional authorities in Member States.

[73] Based on the codes of economic activity and additional keyword searches in the project descriptions.

Furthermore, when examining the ERDF textiles projects that contribute to the digital transition, only 19% of the funding in these projects is going towards projects related to advanced digital technologies[74] (see Figure below), which indicates that the majority of funding is related to more basic digitalisation.

An example of an ERDF textiles project supporting the digital transition is in the Box below.

Box 6: Examples of ERDF projects dedicated to textiles

Examples of projects co-financed by the ERDF

German developed a project titled "RapidLab4PrototypingDevelopment laboratory for the digital networking of textile manufacturing processes and non-textile functionalisation for the fast, reliable and scalable development of smart textiles for the textile industry" from 2020 to 2022, funded by the EU with a budget of EUR 789 600.

Portugal developed the LEATHER3D project which aimed at the research and development of leather material solutions for additive manufacturing technologies (AM, Additive Manufacturing). The project was funded by the EU with a budget of EUR 469 613.

Cyprus developed a project that investigated smart circular processing of advanced carbon fibre fabrics based on machine learning and non-linear automatic control models. The project was funded with a total of EUR 169 950.

Source: Technopolis Group based on Kohesio

3.2.2. Public investments – Horizon2020 and Horizon Europe

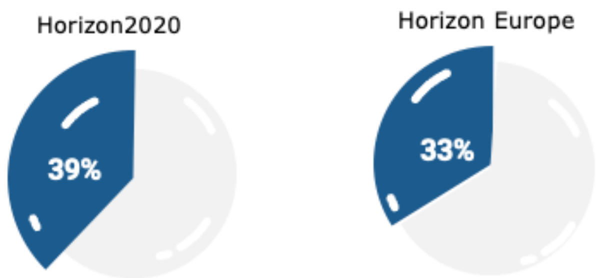
Framework Programmes

The Framework Programmes for Research and Innovation cover both Horizon 2020 (2014-2020) and Horizon Europe (2021-2027) in the analysis of the textiles industrial ecosystem.

Under Horizon 2020, over EUR 87 m was spent on projects related to the digital transition in textiles, more than EUR 12 m per year. In the first three years of Horizon Europe, nearly EUR 58 m were spent on digital topics, averaging EUR 15 m per year, which shows an increase but less so than in the case of the green transition as presented above.

As observed in Figure 23, under Horizon 2020, **39% of the EU funding to textiles projects contributed to the digital transition.** In the case of Horizon Europe, **33% of the EU funding** to textiles projects contributes to the digital transition.

Figure 23: Share of Horizon 2020 and Horizon Europe textile projects that contribute the digital transition



Source: Technopolis Group analysis

[74] As identified for the purpose of this project, e.g., projects related to IoT, AI, Cloud, Blockchain, advanced manufacturing etc.

Two examples of a textiles project funded under Horizon 2020 and Horizon Europe supporting the digital transition are showcased in the Box below.

Box 7: Examples of Horizon projects dedicated to textiles

Horizon 2020 and Horizon Europe textiles projects supporting the digital transition

The project **ETexWeld**[75] is funded under **Horizon 2020 under the title** 'Welding of E-Textiles for Interactive Clothing'. The project started in 2014 and it has raised a total amount of EUR 8.89 m.

The **ETexWeld** project focuses on integrating electronics with textiles to create interactive protective clothing and footwear using welding technology. It aims to facilitate knowledge transfer among partners from various countries and disciplines to design innovative e-textile products. The project will develop novel e-textile structures incorporating transmission lines, sensors, actuators, and microprocessors with personalised algorithms for on-body computing and user feedback. Etexweld promotes collaboration between industry and academia, contributing to the emergence of entrepreneurial researchers in the field. Additionally, it aims to enhance researchers' employability and attract young talent to careers in textile electronics.

The project **E-static softSensors** is funded under Horizon Europe under the title "A study on applying industrial manufacturing techniques to develop self-powered triboelectric textile sensors for high-accuracy activity recognition in smart homes". The project started in 2023 and it has raised a total of EUR 9.2 m.

The **ENRICH project** focuses on creating self-powered triboelectric textile sensors using common materials such as wool, polyester, and conductive yarns for accurate activity recognition in smart home applications. Triboelectricity, generated from friction between materials like human skin and synthetic fabrics, offers an eco-friendly solution for sensing activities such as fall detection, indoor navigation, and sports tracking. While recent advancements in textile-based triboelectric nanogenerators (tTENG) show promise for powering low-energy devices, their sensing capabilities are currently limited to single repetitive movements and are not yet scalable for manufacturing. This project aims to address these limitations by employing industrial techniques like weaving, tufting, and embroidery to create high-performance self-powered sensors.

Source: Technopolis Group based on CORDIS

3.2.3. Skills underpinning the digital transition

The textile industry is grappling with significant workforce challenges[76]. An aging workforce poses a major concern, as experienced professionals retire without enough skilled replacements. Additionally, younger generations show limited interest in textile careers, often perceiving the industry as traditional and lacking innovation. The growing demand for digital transformation creates a shortage of ICT professionals, making it difficult for companies to integrate advanced technologies[77]. In this regard, the EU Pact for Skills[78] aims to enhance skills development in the textiles sector.

To provide insights into the skills demand and skills supply in the textiles industrial ecosystem related to the digital transition, this study builds upon two exploratory data sources, namely the Cedefop Skills-OVATE database and LinkedIn respectively[79]. The following definitions have been adopted:

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[75] https://www.gemtex.fr/collaborative-projects/curent-projects/etexweld/

[76] European Commission (2023). Transition pathway for the Textiles ecosystem. https://single-market-economy.ec.europa.eu/system/files/2024-03/Report%20on%20stakeholder%20pledges%20and%20commitments.pdf

[77] European Commission (2023). Transition pathway for the Textiles ecosystem. https://single-market-economy.ec.europa.eu/system/files/2024-03/Report%20on%20stakeholder%20pledges%20and%20commitments.pdf

[78] https://pact-for-skills.ec.europa.eu/about/industrial-ecosystems-and-partnerships/textiles_en

[79] More information on the data sources, the approach taken, and the limitations of the data, is found in the methodological report.

Moderate digital skills have been defined following Cedefop[80] notably including "*five types of skills under the digital skills umbrella such as information processing (e.g. using a search engine and storing information and data); communication (including teleconferencing and application sharing); content creation (such as producing text and tables, and multimedia content); security (e.g. using a password and encrypting files); and, problem solving (e.g. finding IT assistance and using software tools to solve problems)*". (The list of keywords that have been used to track LinkedIn is included in Appendix B).

Advanced digital skills have been defined as a specific group of digital skills in the context of the main digital technologies captured in this project notably in Artificial Intelligence, cloud computing, connectivity, robotics, Internet of Things, augmented and virtual reality and blockchain (the list of keywords that have been used and are possible to track with the algorithm of LinkedIn is included in Appendix B). LinkedIn data have to be interpreted in the light of its representativeness for textile and across the EU. An analysis of representativeness is provided in Appendix B and in the related methodological report.

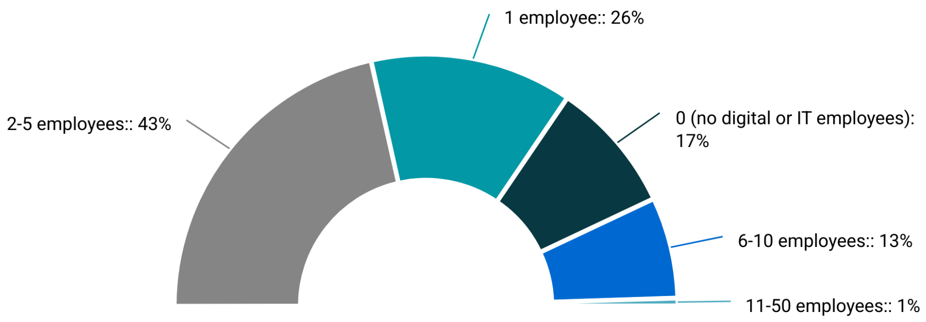
As outlined earlier, 1.3 million professionals registered in the textiles ecosystem on LinkedIn in October 2024 and 431 000 professionals in textile and apparel manufacturing. Comparing these results with Eurostat data on employment, this represents around 26% of textile manufacturing professionals, most including professionals with higher education degrees and more relevant positions.

3.2.3.1. Supply of skills relevant for the digital transition

In 2024, **43% of textiles companies had 2-5 full-time employee in roles directly related to the digital transition, while 26% of respondents reported employing 1 person in digital roles**, according to the results of the EMI Enterprise Survey. Moreover, 17% of companies did not have any employees in digital transition related roles. It is important to note that the survey primarily captured companies with 10-99 employees, rather than very small businesses, which also play a significant role in the industry but are less likely to have dedicated digital staff.

These findings reflect the integration of digital technologies into the business processes and in roles such as IT infrastructure, supply chain and logistics systems and e-commerce and online marketing. Through digitalisation, many textiles businesses have embraced in particular online marketing strategies to enhance their reach, engage customers, and drive sales in an increasingly digital landscape.

Figure 37: Share of full-time employees working in jobs relevant for the digital transition



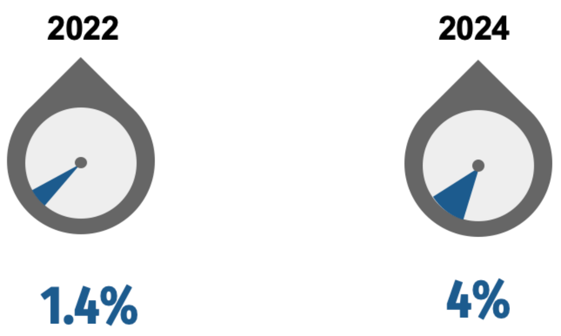
Source: EMI Enterprise Survey 2024

The share of professionals registered on LinkedIn and employed in the textile industrial ecosystem with advanced digital skills reached 4% in 2024, showing an increase from 2022 (see Figure below), however still below the average of all industrial ecosystems. This rise

[80] https://www.cedefop.europa.eu/en/data-insights/digital-skills-challenges-and-opportunities

signals the growing importance of digital expertise in the industry but shows also weaknesses.

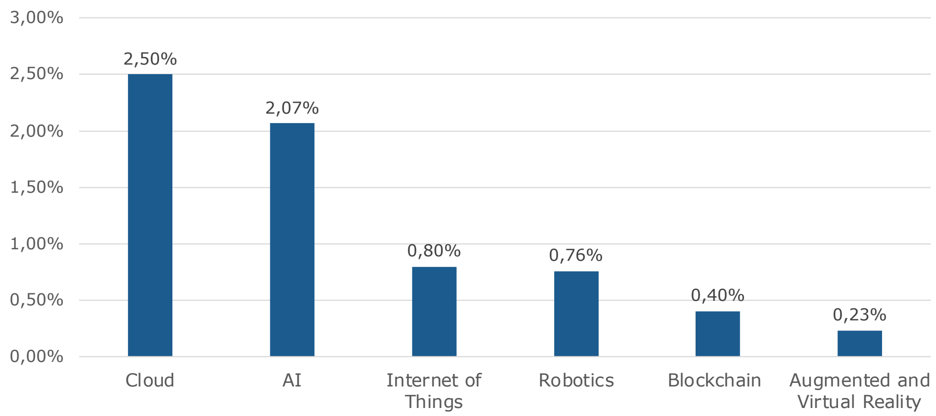
Figure 38: Share of professionals in textile with skills relevant for the digital transition in the EU27



Source: Technopolis Group based on LinkedIn

The most prevalent advanced digital skills include cloud technologies, followed by Artificial Intelligence also due to the broader definition of the textiles industrial ecosystem that includes also brands. However, the overall percentages remain modest, and while there has been some increase, it is not substantial. The share of advanced digital skills is even lower in the case of textiles manufacturing only and decreasing to 0.94% in the case of AI skills for example.

Figure 39: Share of professionals with a specific digital skill within the textiles industrial ecosystem in the EU27 and with a profile on LinkedIn



Source: Technopolis Group based on LinkedIn, data download October 2024

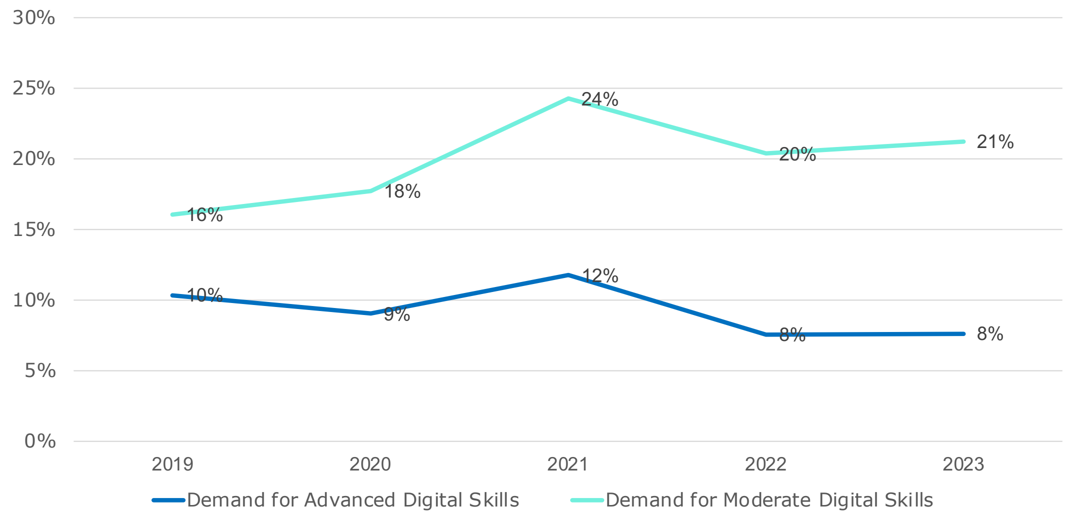
3.2.3.2. Demand for skills relevant for the digital transition

Skills demand has been analysed following the skills intelligence insights of Cedefop, the European Centre for the Development of Vocational Training[81].

The share of online job advertisements requiring skills related to the digital transition in 2023 was moderate, 21% for moderate digital skills and 8% for advanced digital skills. The total number of job ads referring to digital skills showed an increase until 2021 but were more moderate since then.

[81] https://www.cedefop.europa.eu/en/tools/skills-online-vacancies

Figure 40: Share of online job advertisements with a requirement for environmental skills



Source: Technopolis Group based on analysis of Cedefop data, please note that the results are slightly different compared to the 2023 EMI report on textiles due to adaptations in the methodology, for further details please see the methodological report

Job protection and a strategic investment plan for upskilling and reskilling are essential to future-proof the workforce. Establishing strong partnerships between companies and vocational education and training (VET) providers fosters continuous skills development and lifelong learning, ensuring workers can adapt to evolving industry demands and technological advancements[82].

3.2.4. Consumer demand for digital services in textiles

Consumer demand for digital services in the textile industry is experiencing rapid growth as digital transformation continues to shape consumer behaviour[83]. One of the main drivers of this trend is the rise of **e-commerce[84]**, where online platforms enable consumers to access a wider range of textile products, including clothing, home textiles, and accessories. The convenience of browsing, comparing products, reading reviews, and completing seamless transactions has become an integral part of the consumer experience. As more consumers turn to online shopping, companies are investing heavily in optimising their digital presence to meet the increasing demand for user-friendly, fast, and efficient shopping platforms.

Another key trend is the increasing demand for **personalisation and customisation[85]**. Consumers now expect more than just standard products and seek unique, tailored items that reflect their individual tastes and preferences. According to some interviews, the industry is trying to respond to this by integrating digital tools that allow customers to design their own fabrics, clothing, and accessories, however, these examples remain still rare. The tools are available to make advancements in digital printing and online design platforms and maje it easier for brands to offer personalised products at scale.

Linked to the green transition, sustainability and transparency are also gaining momentum as significant factors influencing consumer demand for digital services. With

[82] ILO (2024). Workshop report of ILO on Threading the future of the Textile sector: skills development for a Just Transition, 10 December 2024
[83] https://heuritech.com/fashion-industry-digital-transformation-innovation/
[84] https://www.mckinsey.com/industries/retail/our-insights/fashions-digital-transformation-now-or-never
[85] https://www.fibre2fashion.com/industry-article/10139/the-future-of-customisation-and-on-demand-manufacturing-in-fashion

growing awareness about environmental and ethical issues in the textile industry, consumers are increasingly looking for products that are sustainably sourced and produced. The upcoming Digital Product Passport that will enable traceability in the supply chain, and provide information on the environmental impact of products, is to help consumers make informed decisions. As more brands commit to transparency and sustainability, the demand for digital services that can provide real-time data on a product's environmental footprint is becoming an essential part of the consumer journey.

The adoption of **virtual try-on technologies and augmented reality**[86] **is still** in early stage of development, however, there is a growing demand for consumers to interact with textile products online according to some interviews. These tools allow customers to digitally visualise how clothing or home textiles will look before making a purchase, which improves the overall shopping experience. It also reduces the rate of returns, as consumers feel more confident in their purchasing decisions. Additionally, **digital showrooms** and **virtual events** can provide consumers with an immersive way to experience textile products remotely.

[86] https://www.uphance.com/blog/virtual-augmented-reality-in-fashion/

3.3. Impact of digital technologies on industrial competitiveness

What is the impact of digital technologies on competitiveness?

- The adoption of advanced digital technologies increased **productivity 10% in the case of robotics among those that adopted this technology and around 1-5%** in the case of other digital technologies.

- The largest share of respondents witnessed an increase in productivity clearly due to the introduction of **Robotics** among all advanced digital technologies.

- **Artificial Intelligence (AI)** is driving productivity gains by enabling automation, data analysis, and process optimisation.

- **Cloud computing**, on the other hand, offers scalable computing resources and data storage over the internet, which allows textiles companies to store and access vast amounts of data without the need for significant on-site infrastructure.

This section analyses the extent to which companies perceive digital technologies as enhancing their competitiveness, both for their business and the industry. It also explores the reasons why investing in digital technologies is worthwhile and identifies which ones are particularly advantageous for the textiles industry.

The EMI Enterprise Survey conducted with textile companies indicates that the adoption of advanced digital technologies increased productivity 10% in the case of robotics and around 1-5% in the case of other digital technologies. The largest share of respondents witnessed an increase in productivity as a result of robotics followed by big data (see Table below). Robotics is transforming textile manufacturing by enhancing automation, precision, and efficiency. It can streamline processes such as automated cutting and sewing, fabric handling, and quality control. The impact includes not just higher productivity but cost efficiency by minimising waste and labour costs, and greater customisation[87].

Artificial Intelligence (AI) follows big data and is driving productivity gains by enabling automation, data analysis, and process optimisation. Cloud computing offers scalable computing resources and data storage over the internet, which allows textiles companies to store and access vast amounts of data without the need for significant on-site infrastructure. It also enables seamless collaboration across different departments and geographical locations, improves flexibility, and reduces operational downtime. Cloud-based platforms allow companies to implement advanced analytics and integrate AI tools more easily, further enhancing productivity.

Table 1: The impact on productivity of advanced digital technologies as expressed by the share of respondents that adopted this technology

[87] Lázár, K. (2024). Industrial Robots in the Textile and Clothing Industry. International Journal of Industrial and Manufacturing Systems Engineering. 2024, Vol. 9. 1-9. 10.11648/j.ijimse.20240901.11.

	Increased	No change	Decreased
Robotics	100%		
Big Data	75%	25%	
Artificial Intelligence	68%	32%	
Cloud computing	67%	26%	7%
Internet of Things	50%	50%	
Blockchain	25%	75%	
Augmented and Virtual Reality		100.00%	

Source: EMI Enterprise Survey, 2024, note:

Digitalisation has a profound impact on textiles companies, reshaping their operations and strategies in response to both opportunities and challenges[88]. On one hand, the rapid growth of e-commerce has dramatically altered consumer shopping habits and expectations. On the other hand, digitalisation has also provided textiles companies with the tools and technologies to enhance their competitiveness in an increasingly dynamic and global market. By leveraging advanced technologies such as AI, the Internet of Things, cloud computing, and automation, textile businesses can streamline operations, improve efficiency, and better meet consumer demands, giving them a competitive edge.

Digital tools allow for better management of production processes, reducing waste, improving supply chain visibility in the textiles industry, and increasing overall efficiency. Digital technologies enable textiles companies to offer more personalised and innovative products. Tools like 3D printing and computer-aided design (CAD) allow for rapid prototyping and customisation, giving companies the flexibility to meet consumer demand for unique, high-quality items[89]. The ability to offer tailor-made solutions helps companies differentiate themselves in a crowded market. With digital tools companies can enhance transparency, traceability, and accountability in their supply chains. This reduces risks, ensures compliance with regulations, and builds trust with consumers who are increasingly concerned about ethical sourcing and sustainability. A more resilient and transparent supply chain can help textiles companies navigate disruptions and maintain a competitive advantage.

[88] See: https://www.mckinsey.com/industries/retail/our-insights/fashions-digital-transformation-now-or-never; https://www.fibre2fashion.com/industry-article/9622/impact-of-digital-technologies-on-the-textile-industry

[89] See also: https://www.factry.io/blog/overcoming-market-challenges-of-the-textile-industry/

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Appendix B: Methodological notes

Startup data and venture capital data analysis

Selected fields from Crunchbase and Net Zero Insights: Textiles, Fashion, Lingerie, Shoes and additional keyword search in the business descriptions.

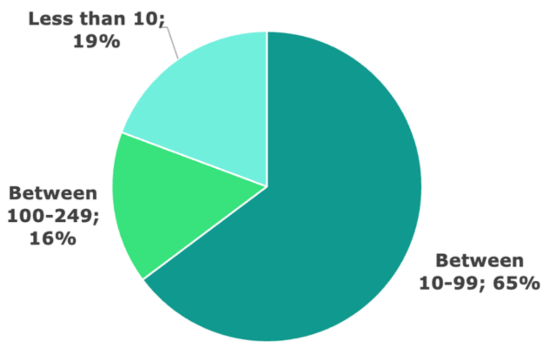
CORDIS data analysis

Scivoc and key terms:
textile, apparel, clothing, cotton, yarn, leather, textile machinery, shoe, embroidery, fibre, biofibre, weaving, polymer, biopolymer, dyeing, filament, polyester, knitting, enzymes, textile, apparel, clothing, cotton, yarn, leather, textile machinery, shoe, embroidery

EMI Enterprise Survey

The EMI Enterprise Survey sample included 578 textiles companies including brands. The distribution of the respondents according to company size is indicated below.

Figure 41: Share of respondents according to company size



Source: Technopolis Group

LinkedIn data analysis

Table 2: Concordance between NACE and LinkedIn

NACE		LinkedIn industry categories
C13	Manufacture of textiles	Textile manufacturing
C14	Manufacture of wearing apparel	Apparel manufacturing
C15	Manufacture of leather and related products	Apparel manufacturing
		Apparel and fashion

Source: Technopolis Group based on LinkedIn

Green skills – keywords used: Cleantech, Sustainability, Sustainable Development, Sustainable Business, Energy Efficiency, Clean Energy Technologies, Renewable Energy, Wind Energy, Biomass, Biomass Conversion, Solar Energy, Solar Power, Urban Forestry, Forest Ecology, Sustainable Communities, Organic Farming, Organic Gardening, Urban Agriculture, Organic Food, Waste Management, Waste Reduction, Recycling, Water Treatment, Water Resource Management, Water Purification, Green Marketing, Green Printing, Environmental Biotechnology, Environmental Science, Environmental Engineering, Environmental Management Systems, Environmental Protection, Wastewater Treatment, Ecology, Circular Economy, Zero Waste, Waste to Energy, Plastics Recycling, E-Waste, Carbon Reduction Strategies, Carbon Footprinting, Carbon Neutral, Energy Retrofits, Biodiversity, Biodiversity Conservation, Nature Conservation, Advanced Materials, Nanomaterials, Biomaterials, Reuse, Separation Process, Sorting, Equipment Repair, Natural Resource Management, Sustainability Reporting, Green Development, Sustainable Cities, Energy Conservation, Energy Management, Environmental Awareness, Environmental Impact Assessment, Environmental Compliance, Leadership in Energy and Environmental Design (LEED), Environmental Policy, Green Technology, Sustainable Design, Sustainable Architecture, Environmental Consulting, Maintenance and Repair, Solar PV, Solar Cells, Wind Turbines, Wind Turbine Design, Carbon Capture, Low Carbon Technologies, Low Carbon, Renewable Fuels, Renewable Energy Systems, Renewable Resources, Integrated Water Resources Management, Natural Resources, Biodiesel, Bioplastics, Waste Treatment, Waste Water Treatment Plants, Electric Vehicles, Hybrid Electric Vehicles, Multi-modal Transportation, Energy Efficiency Consulting, Recycled Water, Adaptive Reuse, Ecodesign, Life Cycle Assessment, Energy Optimisation, Alternative Fuels, Green Building, Green Infrastructure, Green Purchasing, Biodegradable Products, ISO 14001, EMAS, Environmental Standards

Digital skills – keywords used: data analytics, tourism flow management, online platforms, digital payment, online ticketing, Cybersecurity, Intrusion Detection, Malware Detection, Cloud Security, Cybercrime Investigation, Cyber Threat Intelligence (CTI), Cryptography, DLP, Malware Analysis, IDP; Vulnerability Assessment, Certified Information Security Manager (CISM), Computer Forensics, Cloud Infrastructure, Cloud Services, Google Cloud Platform (GCP), SAP Cloud Platform, SAP HANA, Everything as a Service (XaaS), Software as a Service (SaaS), Platform as a Service (PAAS), Infrastructure as a Service (IaaS), Private Clouds, Hybrid Cloud, Cloud Computing, Edge Computing, High Performance Computing (HPC), Serverless Computing, Robotics, Robot, Robotic Surgery, Human-robot Interaction, Drones, Connected Devices, Internet of Things (IoT), Robotic Process Automation (RPA), Wireless Sensor Networks, Embedded Systems, Cyber-Physical Systems, Smart Cities, Artificial Intelligence (AI), Biometrics, Cognitive Computing, Computer Vision, Deep Learning, Machine Learning, Natural Language Processing (NLP), Natural Language Understanding, Natural Language Generation, Reinforcement Learning, Speech Recognition, Supervised Learning, Unsupervised Learning, Big Data Analytics, Hadoop, Real-time Data, Yarn, Teradata Data Warehouse, Blockchain, Ethereum, Bitcoin, Cryptocurrency, Crypto, Distributed Ledger Technology (DLT), Hyperledger, Augmented Reality (AR), Virtual Reality (VR), Mixed Reality, Computer-Generated Imagery (CGI), Connectivity, M2M, 5G, SD-WAN, Home Automation, Flexible Manufacturing Systems (FMS), Smart Manufacturing, Smart Materials, Quantum Computing, Smart Devices, Intelligent Systems, Big Data, Computer-Aided Design (CAD), Computer Science, MATLAB, C (Programming Language), Python (Programming Language), Digital Strategy, Digital Printing, Digital Marketing, Online Journalism, Revit, Building Information Modeling (BIM), JavaCard, R (Programming Language), Digital Imaging, Digital Media, C++, Collaborative Robotics, Industrial Robotics, Medical Robotics, Mobile Robotics, AutoCAD, Automation, Autodesk 3ds Max, Lumion, Data Analysis, Data Mining, 5G Core, Integrated Security Systems, Cloud Applications, Cloud Computing IaaS, Cryptocurrency Mining, CryptoAPI, Automated Machine Learning (AutoML), Machine Learning Algorithms, Virtual Reality Development, Virtual Data Rooms, Intelligence Systems, Robot Programming, Predictive Analytics, Data Lakes, Blockchain Analysis, Digital Publishing, Enterprise Software, Software Development, SAS (Software), SAP Products, SAP ERP, Online Payment, Online Payment Solutions; Online Travel, Online Marketing, Online Business Management, Online Advertising, Online Gaming, Web Services, Mobile Applications, Mobile Marketing, Java Database Connectivity (JDBC), Data Warehousing, Statistical Data Analysis, Data Modelling, Databases; Electronic Data Capture (EDC), Data Centers, Oracle Database, SAP Solution Architecture Data Entry, Data Management, Data Mapping, Web Applications, GIS Applications, Oracle Applications, Visual Basic for Applications (VBA), Computer Hardware, Computer Maintenance, Computer Network Operations, Computer Networking, Computer Graphics, Online Communications, Social Media Marketing, Digital Direct Marketing, Digital Illustration, Digital Video, Digital Photography, Xero, GPS Applications, GPS Devices, GPS Tracking, GPS Navigation, Microsoft Power Apps, Social Networking Apps, Google Apps Script, Social Media, E-Commerce, Data Intelligence, Online Platforms, Mobile Payments

Exiobase

Exiobase is a time series of environmentally extended multi-regional input-output tables. Its coverage is by country and industry from 1995 to 2021 and has EU and extra rest of the world coverage. Source: Stadler, Konstantin, Wood, Richard, Bulavskaya, Tatyana, Södersten, Carl-Johan, Simas, Moana, Schmidt, Sarah, Usubiaga, Arkaitz, Acosta-Fernández, José, Kuenen, Jeroen, Bruckner, Martin, Giljum, Stefan, Lutter, Stephan, Merciai, Stefano, Schmidt, Jannick H, Theurl, Michaela C, Plutzar, Christoph, Kastner, Thomas, Eisenmenger, Nina, Erb, Karl-Heinz, … Tukker, Arnold. (2021). EXIOBASE 3 (3.8.2) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5589597

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