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Research and Innovation

CORDIS Results Pack on the future of textiles

Achieving a circular economy for the textile sector

A thematic collection of innovative EU-funded research results

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SECOND EDITION

Contents

Editorial

The textile industry, while being fundamental to the economy, is both a major consumer of resources and significant emitter of greenhouse gases and pollution. This CORDIS Results Pack on the future of textiles highlights how the EU is tackling this challenge, funding research and innovation to create a sustainable, climate-neutral and circular textile sector.

Textiles are an intrinsic part of modern life, providing us not only with clothing and footwear but also carpets, curtains and fabrics for homes, offices and public buildings. The textiles industry is one of the world's largest industrial sectors and forms an important part of Europe's manufacturing base.

Within the EU, the sector employs 1.3 million people with a turnover of EUR 170 billion and over EUR 64 billion in exports. Every European citizen uses on average 26 kg of textiles each year and throws away 11 kg. While the market for second-hand clothes in the EU is growing – and some are exported for reuse outside the EU – a significant portion still ends up being incinerated or sent to landfill.

Currently, in the EU, textile production and consumption have the highest negative impact on the environment and climate change after food, housing and transport. These impacts include overusing natural resources, water, land and chemicals, and releasing greenhouse gases and pollutants.

In 2022, the EU adopted an overarching strategy, the EU strategy for sustainable and circular textiles, which focuses on eco-design, waste and pollution prevention, safe and bio-based materials, circular material flows and responsible supply chains. The strategy also covers new business models such as renting clothes, designing products in a way that would make reuse and recycling easier, and convincing consumers to buy clothes of better quality that last longer.

The revised Waste Framework Directive focused on the separate collection of textile waste by ensuring textiles are reused, recycled and ultimately given a new life, thereby promoting a circular economy. Meanwhile, in the first work plan for the Ecodesign for Sustainable Products Regulation (ESPR), textiles apparel was selected among the priority product groups for developing the ecodesign criteria.

In response, the EU has funded a growing number of research and innovation projects on textile sustainability and circularity. Different Horizon calls have been launched to further develop technologies and processes to scale up repair; improve collection and sorting; scale up textile recycling capacities of the EU industry; and increase fibre-to-fibre recycling and the uptake of recycled fibre content. This is a result of the EU's growing focus on the sustainable transition of the EU economy and society as part of the European Green Deal.

The European Community of Practice for a Sustainable Textile Ecosystem network (ECOSYSTEX) shares among participating projects the latest developments and results of EU research and innovation. It also organises dissemination activities to ensure that the interested public expert community is informed about latest developments, plus results of EU research and innovation projects.

The second edition of this CORDIS Results Pack showcases nine Horizon research projects focused on optimising resource use and minimising waste across the entire textile production and consumption cycle.

Piloting advanced reuse, repair and recycling approaches in a circular textiles ecosystem

Digital tools and semi-automation and recycling technologies together with consumer engagement are accelerating the transition to a sustainable, circular textile industry.

Global clothing consumption is rising, driven by lower costs and rapidly changing trends. Simultaneously, consumers are discarding items much faster with minimal options for circularity. In specialty sectors such as workwear, personal protective equipment and active goods including backpacks and tents, few options are available for reuse, repair and recycling.

The EU-funded CISUTAC project is addressing the pressing need for textile circularity, focusing on polyester and cotton which together account for almost 90 % of textile fibres. Through new processes, business models and value chain collaboration, CISUTAC is showing how textiles can be reused, repaired and recycled at scale.

Putting textile circularity to the test

The transition to circular textiles faces persistent barriers. CISUTAC developed and successfully implemented solutions to address several of these through three semi-industrial-scale pilots. Repair is time-consuming, costly and dependent on skilled operators. CISUTAC developed semi-automated approaches that augment human skill and aim to make repair economically viable at scale.

"Semi-automated repair and disassembly workstations featuring 'modular machine augmented assistance' and visual support were piloted in both a for-profit company and a social enterprise. Zipper repair proved highly promising, consistently completed in under 10 minutes," explains project co-coordinator Guy Buyle of Centexbel. Disassembly of end-of-life firefighter suits for recovery of high-value aramid fibres was also demonstrated.

Consumers' low donation rates and negative attitudes towards second-hand goods limit reuse, as do inefficient sorting approaches. The project's consumer awareness campaigns and AI-supported decision tools address these barriers.

"The sorting pilot equipped human sorters with a decision support tool and 'digital product passport' (DPP) data retrieved via radio-frequency identification (RFID) tags. It highlighted the practical value of the future DPP and pointed to AI-supported damage detection as an important next step for accurately routing textiles to reuse, repair or recycling," says project co-coordinator Lien Van der Schueren, also of Centexbel. CISUTAC's Open Data Guide outlines minimum data requirements to prepare for the forthcoming DPP.

[The sorting pilot] highlighted the practical value of the future DPP and pointed to AI-supported damage detection as an important next step for accurately routing textiles to reuse, repair or recycling.

Historically, poor feedstock quality has made textile-to-textile recycling impractical. CISUTAC's fibre-to-fibre pilot demonstrated the project's thermo-mechanical recycling technology for

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recycling polyester and its hybrid yarn technology for recycling cotton and cellulosic fibres. The former improved quality, with potential for nearly 100 % pure polyester waste textiles. The latter enabled short, recycled cotton fibres – unsuitable for conventional spinning – to be made into good-quality yarns.

Navigating the circular textile revolution

The landscape for a circular textile economy shifted considerably over the course of the project. "Acceptance and uptake of reuse practices accelerated more quickly than anticipated, enabling earlier validation of circular business models. Furthermore, we addressed a clear need to update our AI capabilities, reflecting rapid advances in the field since the project began," note Buyle and Van der Schueren. On the downside, the bankruptcy of several textile collection and sorting companies underscored that technical progress alone is insufficient without viable business conditions.

Sustainable future for the textile circularity ecosystem

CISUTAC explored four scenarios for a textile ecosystem of 2035 to help stakeholders in planning. Furthermore, it played a key role in establishing ECOSYSTEX (the European Community

of Practice for a Sustainable Textile Ecosystem), which grew out of CISUTAC's work to align dissemination and policy recommendations across similar EU projects.

As CISUTAC wraps up, its legacy is clear. It has elevated repair as a critical pillar of circularity, delivered open tools and resources for informed decision-making and recognised social economy organisations as essential actors in textile circularity. ECOSYSTEX will carry this work forward, enabling long-term collaboration towards a truly circular textile ecosystem in Europe.

PROJECT
CISUTAC – Circular & Sustainable Textiles & Clothing

COORDINATED BY
Scientific and Technical Centre of the Belgian Textile Industry (Centexbel) in Belgium

FUNDED UNDER
Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment

CORDIS FACTSHEET
cordis.europa.eu/project/id/101060375

PROJECT WEBSITE
cisutac.eu/

Taking the circular path to sustainable clothing and fishing industries

The Glaukos project finds a circular solution for bio-based textile and fishing gear production using marine-friendly polymers.

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Named after the mythical Greek sea god of sailors and fishermen, the EU-funded Glaukos project was launched in 2020 to set up a circular approach to the clothing and fishing industry. As part of its goal, it developed alternative polymers that could help slash the microplastic pollution caused by clothing and fishing gear.

From biomass to yarn

Glaukos used a fermentation process developed through microbial strain selection and strain engineering to convert industrial sidestreams containing sugars into polymer building blocks. With these building blocks, the team created new bio-based polymers that were tested for spinnability. The resulting polymers were then used to produce yarn and yarns for clothing, fishing nets and fishing net coatings with a low carbon and plastic footprint.

"Glaukos established assessments and technologies concerning biodegradation, mechanical degradation and ecotoxicity, covering the various impacts of plastics on marine life to ensure a healthy marine environment," states Zsófia Kádár, Glaukos project coordinator and bioengineer at Bio Base Europe Pilot Plant in Belgium. "They can be used in the future to assess new polymers produced by our partners, or in the context of new materials development."

Glaukos established assessments and technologies concerning biodegradation, mechanical degradation and ecotoxicity, covering the various impacts of plastics on marine life to ensure a healthy marine environment.

The circular way to added value

End-of-life plastic must first be depolymerised before it can be turned into value-added chemicals or materials. The researchers therefore searched for and developed enzymes that break down the developed polymer. By engineering bacteria to grow on these plastic hydrolysates, they can be converted into value-added chemicals or materials through biotechnological processes.

This bio-upcycling would be especially suitable for composites or mixed waste streams that are currently not recyclable due to their complexity. "Our bio-recycling aims at a new outlet for plastic waste: to use it as a feedstock for biotechnology," explains Nick Wierckx of project partner Forschungszentrum Jülich, Germany.

Glaukos has also developed a new methodology for life-cycle assessment, circularity and plastic leakage. Additionally, it has created a multidimensional model to map the challenges to be addressed for unlocking the potential of bio-based and biodegradable plastics.

The Glaukos project's key results were presented at the final Glaukos meeting in Brussels in May 2024 and are now available online. Policymakers and other stakeholders benefited from sharing the project's main exploitable knowledge, methodologies, successes and failures.

Besides presenting controversial topics and technical challenges for the clothing and fishing industries, project partners also made recommendations for future research programmes and on how marine-friendly biopolymers could be integrated into innovative market applications in fashion and fishing.

For more information, please see: Glaukos project website.

Note: This article was last updated on 3 October 2024.

PROJECT
Glaukos – Circular solutions for the textile industry

COORDINATED BY
Bio Base Europe Pilot Plant in Belgium

FUNDED UNDER
Horizon 2020 – FOOD

CORDIS FACTSHEET
cordis.europa.eu/project/id/887711

PROJECT WEBSITE
glaukos-project.eu/

Closing the loop with bio-based garments

Manufacturing that is circular, local and bio-based leverages emerging sustainable technologies to produce clothing from man-made cellulose and biopolymers.

In general, textile industries create pollution and over-consume resources. Clothing produced from cotton uses a huge amount of water in cultivation, and polyester clothing is a petroleum-based product. Additionally, most clothing is produced in countries offering low-cost production, often under poor working conditions and far from the brands that order them. To reduce the environmental impact of clothing manufacturing, sustainable solutions that prioritise circularity are needed. The EU-funded HEREWEAR project has a vision for creating bio-based clothing within regional networks.

Emerging technologies

The project targeted cotton and polyester fibres for replacement with bio-based solutions because these materials are widely used and negatively affect the environment. To produce man-made cellulosic (MMC) fibre that can be used instead of cotton, HEREWEAR focused on valorising three waste streams: seaweed, manure and straw.

Whereas cotton is a mechanically spun fibre, HighPerCell® – the MMC fibre produced by the project – makes fibres through chemical transformation. A biorefinery process produces a cellulose pulp which then undergoes ionic liquid-based wet spinning to create high quality filaments. The solvents used in production as well as the filaments themselves are reusable and recyclable.

To replace polyester, HEREWEAR used polylactic acid (PLA) as a base material, adding other biopolymers to increase comfort. The resulting product has a similar profile to its oil-based counterpart. Polyester clothing is a major source of microplastics in the environment, and PLA blends with other bio-based materials that have the potential to reduce this environmental impact.

In addition to making new eco-friendly fabrics, the project developed aftertreatment processes as well. HEREWEAR developed bio-based alternatives for coating, printing and dyeing, including polylactic acid-based printing.

HEREWEAR achieved its goal of producing corporate and streetwear clothing from bio-based fibres. Regarding the final products, project coordinator Lien Van der Schueren says: "HEREWEAR's bio-based textiles show promising features such as soft and shiny materials that can be easily recycled."

Regional networks

The project consortium includes several research organisations as well as small and medium-sized enterprises (SMEs). Experts in the fields of polymer chemistry, biorefinery, the textile value chain, fashion design and environmental science all contributed to the production of bio-based garments for the EU market.

Making the textile industry more circular and bio-based goes hand in hand with working at a more regional scale.

The HEREWEAR team models the network of local partners the project envisions for successful implementation of a circular, bio-based clothing industry. As Van der Schueren notes: "Making the textile industry more circular and bio-based goes hand in hand with working at a more regional scale. To make this possible, we need to gather local actors active along the value chain, working at a smaller scale but via networked microfactories."

Keeping the value chain local reduces transportation costs – both financial and environmental. It also increases transparency and gives the consumer greater confidence in the sustainability of the product. Data-driven labelling designed by HEREWEAR confirms the authenticity of the bio-based garment.

© Vretena

An encouraging aspect of the project is that all processing of bio-based materials was done with equipment similar to what is used for producing conventional textiles. This fact will enable rapid market uptake of the project's achievements.

By offering both design and materials for recyclable and reusable bio-based garments and building a community of environmentally concerned SMEs, HEREWEAR proposes multiple solutions to sustainability problems in the textile industry.

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PROJECT
HEREWEAR – Bio-based local sustainable circular wear

COORDINATED BY
Centexbel in Belgium

FUNDED UNDER
Horizon 2020 – FOOD

CORDIS FACTSHEET
cordis.europa.eu/project/id/101000632

PROJECT WEBSITE
herewear.eu/, herewear.tcbl.eu/

Bringing materials made from mycelium fibres to market

With applications in the fashion and automotive industries, fully bio-based materials made from fungi make the fashion industry more eco-friendly.

Modern consumers are looking for socially responsible products that reduce damage to the environment by adhering to the principles of the circular economy. To meet this growing demand, the EU-funded MY-FI project brought together a consortium of scientists, manufacturers and market specialists to produce high-quality next-gen material with low environmental cost.

Making the most of fungi

Most textiles used in contemporary clothing – such as cotton, linen and wool – are plant or animal-based. The resources used to produce these textiles are costly, and the processes for treating them can have negative impacts on the environment. As an alternative to these conventional materials, one grown with mycelium offers an attractive array of characteristics.

Fungi grow in branching structures called hyphae, which are mainly composed of chitin, a polysaccharide. Chitin closely resembles cellulose, a polysaccharide frequently used in textiles. A versatile and adaptable material, chitin is non-toxic and biodegradable.

Innovative technologies and the circular economy

MY-FI employed two fermentation processes for growing mycelium. Dynamic liquid fermentation uses stirred tanks to grow the fibres. Following an alkaline process, a solid is removed, yielding a flexible and semitransparent material. Surface liquid fermentation begins with a substrate on which the fungi grow

© MOGU

under specific conditions. Once the material has dried, what remains are soft white sheets of pure mycelium.

Growing mycelium fibres in this way presents many ecological advantages. The fermentation processes can use different side-streams from the agro-food industry or even other industries, such as textile residues and spent grains from breweries, thus contributing to intersectoral circularity. Also, the fermentation processes produce minimal CO2 emissions and require limited energy. Since fermentation can be managed locally, nearshoring of production is feasible, reducing transportation costs and enabling shorter supply chains.

The Surface Liquid Fermentation process, developed by MOGU, is the most promising method established during the project. Its implementation at an industrial scale will be the focus of the coming years.

Not only are mycelium products better for the environment, but they are better for people too. MY-FI prioritised safety in manufacturing materials, and the processes and products are non-toxic for producers as well as consumers.

With these encouraging results, MY-FI sees market adaptation in the near future. According to project coordinator Annalisa Moro: "The Surface Liquid Fermentation process, developed by MOGU, is the most promising method established during the project. Its implementation at an industrial scale will be the focus of the coming years."

Material characteristics and applications

Mycelium-based next-gen materials are smooth, durable and high-performing. They make an ideal alternative to leather in high-end fashion products, such as wallets, belts, handbags, footwear and accessories. The nature of the material also lends itself well to certain automotive features, like cushions, headrests and steering wheels.

In the final stage of the project, MY-FI achieved prototypes of four nonwoven textiles made from mycelium fibres. Moro shares: "Project partners were able to manufacture various prototypes for the fashion and automotive industries, including bags, two dresses, a skirt, a bodysuit, a jacket, various wallets, as well as two headrests and a dashboard fascia for cars."

Such applications of next-gen material made from mycelium are just the beginning. As these materials enter the market, other sectors will find new applications for them. The work of MY-FI is only the start of a green transformation in the fashion industry.

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PROJECT
MY-FI – Reinventing a smart, circular and competitive textile industry with advanced myco-fibres

COORDINATED BY
MOGU SRL in Italy

FUNDED UNDER
Horizon 2020 – FOOD

CORDIS FACTSHEET
cordis.europa.eu/project/id/101000719

PROJECT WEBSITE
my-fi.eu/

Textile waste becomes new cotton

EU-funded researchers have pioneered a revolutionary method to convert discarded textiles into a unique new textile fibre that looks and feels soft and natural – like cotton.

Every second, the equivalent of a rubbish lorry of textiles is either sent to landfill or burned, causing tremendous environmental and societal damage. The textile industry alone emits 1.2 billion tonnes of CO2 annually, surpassing the emissions from international flights and shipping combined.

With global apparel consumption projected to reach 102 million tonnes by 2030 – equivalent to over 500 billion t-shirts – the need for sustainable production and consumption is critical. Industry leaders, government officials, environmental organisations and consumers agree that change is imperative.

Unfortunately, current recycling solutions are limited in their ability to recycle the growing piles of discarded textiles. Affordable and sustainable alternatives that also meet functional requirements are highly sought after. The EU-funded New Cotton project was established to transform the textile industry through a circular production model for commercial garment production.

An eco-friendly alternative

Our cellulose carbamate technology transforms textile waste that would otherwise be burned or landfilled into high-quality fibres that resemble cotton.

Throughout the project's course, the consortium worked to collect, sort and convert textile waste into a new, man-made, high-quality cellulose fibre that looks and feels like cotton. This new cotton material was based on the textile fibre regeneration technology pioneered by Infinited Fiber Company in Finland.

"Our cellulose carbamate technology transforms textile waste that would otherwise be burned or landfilled into high-quality fibres that resemble cotton. This patented process can efficiently break down cotton-rich textile waste, including mixed fibres and other cellulose-based materials," notes Elias Veijola, project coordinator and process development engineer at Infinited Fiber Company. "By using various feedstocks, this technology significantly reduces the need for virgin raw materials, offering substantial environmental benefits." The fibres are then used to create various types of fabrics for clothing – designed, manufactured and sold by global brands like adidas and H&M.

Turning textile waste into high-quality fibres

Using advanced recycling technologies, sorted waste was transformed into high-quality fibres called Infinna™. These fibres, which are made entirely from 100 % textile waste, were spun into yarns, woven into fabrics and crafted into garments. The cellulose carbamate process used to create Infinna™ fibres

is significantly more environmentally friendly than traditional viscose production, avoiding toxic chemicals like carbon disulfide.

Throughout the transformation process, rigorous testing ensured the quality and performance of the new fibres and fabrics, leading to the successful release of circular-designed apparel to the market. "Unlike many recycled fibres, Infinna™ has a unique feel and appearance that allow it to be used on its own to create 100 % recycled garments," outlines Kirsi Roine, chief customer officer at Infinited Fiber Company.

New Cotton demonstrated the feasibility of large-scale textile recycling and fostered collaboration within the fashion industry. By uniting fashion brands, textile manufacturers and researchers, it championed circular fashion and provided valuable insight and lessons to promote sustainable practices and innovation across the industry.

An exemplary model for sustainable practices

New Cotton is poised to make a significant impact by substantially reducing textile waste and decreasing reliance on virgin materials. This should lead to less deforestation and help preserve biodiversity. Furthermore, by establishing a new market for recycled textiles, the project not only adds sustainability value for fashion brands but also fosters economic growth in the recycling sector.

"Setting a benchmark for sustainability within the fashion industry, New Cotton encourages other brands to adopt circular practices, driving a transformation across the sector. Furthermore, it raises consumer awareness about sustainable fashion choices and the importance of recycling," concludes Tanja Karila, chief marketing officer at Infinited Fiber Company.

Note: This article was last updated on 3 October 2024.

PROJECT
New Cotton – Demonstration and launch of high performance, biodegradable, regenerated New Cotton textiles to consumer markets through an innovative, circular supply chain using Infinited Fiber technology

COORDINATED BY
Infinited Fiber Company Oy in Finland

FUNDED UNDER
Horizon 2020 – FOOD

CORDIS FACTSHEET
cordis.europa.eu/project/id/101000559

PROJECT WEBSITE
newcottonproject.eu/

Recycling textiles: from collection to retail

Technologies for processing discarded fabrics, digital tools and a focus on the consumer perspective improve the circularity of the textile industry.

Textiles and fashion are priority product groups in the EU's Circular Economy Action Plan, which specifies the separate collection of textiles from 2025 onwards. With historically less than 1 % of textile waste recycled into reusable fibres, manufacturers and consumers need to change their behaviours if textiles are to become part of the circular economy. The SCIRT project addressed this emerging problem by exploring all steps in the production chain of recycled garments.

Tools for recycling, sorting and trimming

SCIRT demonstrated a textile-to-textile recycling system for post-consumer materials. This process posed several challenges, notably in effectively separating textiles. According to project coordinator Evelien Dils: "One of the main challenges we started with was the quality of recycled yarns not aligning with the requirements from fashion brands. What has been crucial for this is the improved sorting and dismantling of textile waste before it goes to recycling and improvements in the mechanical recycling process itself."

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Different paths to recycling were tested in labs and in pilot studies, exploring enzymatic approaches, thermo-mechanical and mechanical methods. Project partner Valvan developed two mechanical technologies for accurately sorting and trimming textiles at high speed.

Fibersort separates material based on fibre content and colour using robots and near-infrared technology. Trimclean then takes the separated fibres and cuts them into small segments ranging from 20 mm to 100 mm in size.

The fragments are analysed using cameras and metal detectors to remove non-fibre elements such as tags, buttons and zips. With ongoing development, these automated sorting and dismantling procedures have lowered the cost of textile recycling and increased the recyclability of garments to 90 %.

Tools to improve circularity

The SCIRT system was designed to address all aspects of the production chain. This structure revealed many challenges, but as Dils says: "This really strengthened the understanding of the involved value chain partners of the importance of collaboration beyond company borders, a crucial point in the transition towards a more circular system."

One of the tools created for value chain partners is the True Cost Calculator, developed to give stakeholders a clear assessment of a garment's real societal cost, taking into account financial, ecological and social concerns. To date, 670 users have made 830 calculations using the tool, and project partner VITO has launched a user survey to guide further development of the calculator.

Centring the consumer

Europe generates more than 15 million tonnes of textile waste each year. Fast fashion trends exacerbate the problem by increasing the rate of disposal and reducing textile quality. Viable solutions to the problem of textile waste must address consumer demands.

Consumers have concerns about the availability and affordability of recycled products and respond well to financial incentives to recycle old clothes. Because of this feedback, project partner Bel&Bo has initiated a successful take-back programme at its stores, where customers earn discounts on future purchases when they drop off unwanted garments. The discarded clothes are then redistributed through second-hand stores.

Technological innovations, educational campaigns and an appreciation for consumer demands are improving the circularity of the textile industry, and SCIRT initiatives have produced several high-quality garments marketed online and in stores. These items include jeans and sweaters available from HNST.

Not only are these items made from at least 50 % recycled textiles, but they are consciously designed for efficient recycling down the line. With such viable products already in the market, SCIRT has demonstrated that the textile industry is ready to participate in the circular economy.

PROJECT

SCIRT – System Circularity and Innovative Recycling of Textiles

COORDINATED BY

The Flemish Institute for Technological Research in Belgium

FUNDED UNDER

Horizon 2020 – ENVIRONMENT

CORDIS FACTSHEET

cordis.europa.eu/project/id/101003906

PROJECT WEBSITE

scirt.eu/

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Closing the loop: a blueprint for textile circularity

A knowledge-based blueprint for the optimised circular flow of textiles leverages tools and technologies for traceability, smart sorting and recycling to reduce waste and enhance sustainability.

Europe generates millions of tonnes of textile waste every year, yet only a fraction is recycled. Household textiles – the sector's largest waste stream – are a complex mix of fibres and materials. Most recycling technologies are fibre-specific, and current sorting remains largely manual. Sustainable and safe circularity will require control over materials flows.

The EU-funded tExtended project is addressing these needs. Over four years, the consortium has been developing a knowledge-based blueprint for the optimised circular flow of textiles. The goal is to demonstrate the potential for up to 80 % reduction in textile waste through extended reuse of textiles and advanced recycling technologies. In addition to waste reduction, it will enable a more sustainable textile ecosystem.

Traceability and smarter routing and recycling

Effective recycling begins with knowing a material's contents. "tExtended has developed and tested tools including hyperspectral imaging, capable of identifying textile composition with high accuracy," notes project coordinator Pirjo Heikkilä of VTT. A scientific publication highlights its performance as a quality control method in sorting. In addition, new quality control concepts are currently being tested in the real-scale demonstration activities.

Complementing this, tExtended's traceability tool is designed to feed directly into the EU's forthcoming digital product passport (DPP), mandatory for textiles by 2030. The legislation will require digital data on a product's origin, composition, repairability and end-of-life options, potentially accessible via a QR code or radio frequency identification (RFID) tag. tExtended's textile traceability and DPP-related tools will support this, ensuring material information is captured at production and remains available to sorters, recyclers and consumers throughout a product's life cycle.

tExtended's textile waste router is a decision-support tool that helps stakeholders identify the most appropriate strategy for different material types. "Our textile waste router will help optimise textile waste flows and understanding of the impacts of different routing options including textile reuse, remanufacturing and various recycling methods," explains Heikkilä. It can also be used to raise awareness of circular strategies suitable for different kinds of textile materials.

Our textile waste router will help optimise textile waste flows and understanding of the impacts of different routing options including textile reuse, remanufacturing and various recycling methods.

Furthermore, the project has developed colour removal processes that increase the value of recovered fibres, separation methods suited to mixed-composition textiles, and a variety of recycling approaches (fibre mechanical, thermo-mechanical and chemical).

Looking to the future through modelling and comparisons

tExtended has applied system dynamic modelling to predict how different interventions – including legislative changes – could affect textile waste volumes and the circular ecosystem.

© VTT

The project has also conducted environmental comparisons of recycling options using a 'safe and sustainable by design' framework. Together, these can help policymakers and industry determine where investment and regulation can have the greatest impact.

Engaging the chain from consumers to industry

"Several industry partners have already integrated new collection, sorting and quality concepts into their operations, with new business opportunities anticipated around products with high recycled-fibre content from post-consumer sources," notes Heikkilä. An e-learning centre hosted on the project

website will offer circularity education for stakeholders from consumers to businesses.

Technical solutions alone cannot drive circularity. tExtended's social innovation workshops have raised consumer awareness and encouraged participation in textile reuse and pre-sorting through community activities in Finland, Latvia, Ireland and Belgium.

The tExtended project is showing that tackling textile waste at scale demands a holistic response – combining sensing technologies, digital infrastructure, optimised recycling pathways, environmental analysis and broad stakeholder engagement. With its blueprint near completion, the project offers a credible roadmap for transforming Europe's textile sector into a circular economy.

PROJECT
tExtended – Knowledge Based Framework for Extended Textile Circulation

COORDINATED BY
VTT Technical Research Centre of Finland in Finland

FUNDED UNDER
Horizon Europe – Digital, Industry and Space

CORDIS FACTSHEET
cordis.europa.eu/project/id/101091575

PROJECT WEBSITE
textended.eu/

Closing the loop on mixed-composition household textile waste

A consortium of actors across the household textile waste value chain has delivered a blueprint for scaling textile-to-textile chemical recycling in Europe with recommendations on how to achieve it at each stage.

In the EU alone, an estimated 6.94 million tonnes of textile waste was generated in 2022. The majority of this – 85 % – ended up in mixed household waste, from which it could not be reused or recycled.

The EU-funded T-REX project set out to demonstrate an EU-based circular textile value chain for post-consumer textile waste. With communication, commitment and coordinated effort across the value chain, T-REX piloted successful recycling of polyester, polyamide 6 and cellulosic materials and delivered a detailed blueprint for integrated textile-to-textile (T2T) chemical recycling in Europe.

Key challenges addressed within T-REX

"Collection systems meeting our requirements did not exist at scale in Europe so we worked closely with partners to organise targeted batches of materials with the necessary feedstock characteristics," notes T-REX technical coordinator Natalia Mena of adidas.

Sorting remains a well-known bottleneck due to the complexity and variability of textile waste streams and largely manual textile sorting methods. T-REX's pilots assessed collected clothing for reusability and then sorted non-reusable items using near-infrared technology to identify fabric composition for routing to recyclers.

"Textile preprocessing emerged as an underestimated challenge," says Mena. Available technologies are not yet developed for textile-specific applications. Sometimes neither sorters nor recyclers were preprocessing, necessitating third-party solutions. "We built expertise in preprocessing, finding solutions for process adaptations according to material type and quality," Mena adds.

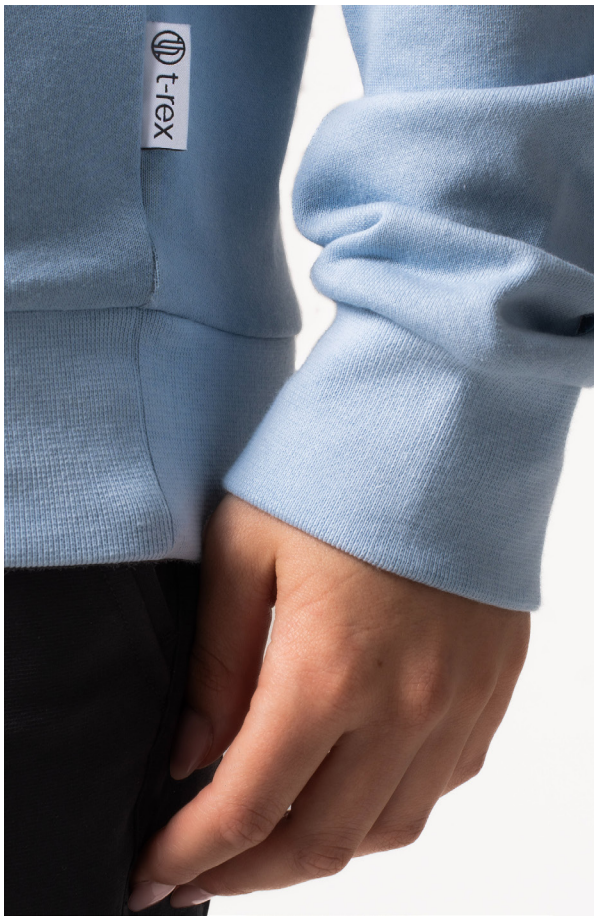
"Data collection and tracking across the value chain proved complex and fragmented. While not fully resolved, the challenge yielded valuable insights documented in a dedicated white paper, underscoring data's critical role in enabling better integration and operational decision-making," notes Mena.

Techno-economic assessment and life cycle assessment

Realising a viable business case remains challenging due to interconnected barriers – limited and expensive high-quality feedstock and insufficient infrastructure at scale. Inefficiencies in textile sorting and preprocessing along with high European energy and labour costs increase operating expenses; increased use of automation and renewable energy sources can address this.

Overall, scaling T2T recycling in Europe will require coordinated financial, regulatory and industrial efforts to stimulate demand, reduce costs and mobilise capital. The environmental life cycle assessment confirmed the strong potential of recycling to reduce the impacts of virgin fibre production, though benefits vary significantly by material type and recycling technology. Energy-intensive stages – both during recycling and in downstream steps such as dyeing – are key impact contributors.

Energy efficiency and cleaner energy sources are priorities throughout the supply chain, while recycling processes should produce fibres



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compatible with advanced, low-impact manufacturing techniques. However, recycling is not a standalone solution: designing for durability and prioritising reuse are essential.

Towards future success and a circular textile economy

"United by a common ambition, major stakeholders across the European textile waste value chain – collectors, sorters, recyclers and spinners as well as universities, data partners and brands – were at the same table, creating a space for open dialogue and better understanding of each other's roles and challenges," notes Mena. Reduced commercial pressure as an EU-funded research project stimulated collaboration.

Importantly, T-REX showed that mixed-composition garments are recyclable and that new products can be successfully created from T2T chemically recycled materials. Technical guidance for designers will support the creation of recyclable garments beyond the 'mono-material' approach.

Many project partners have begun follow-up projects, and T-REX shared best practices and knowledge with other EU initiatives. Overall, T-REX has demonstrated that a coordinated, EU-based circular textile value chain is achievable with partnership, planning and adaptability.

United by a common ambition, major stakeholders across the European textile waste value chain – collectors, sorters, recyclers and spinners as well as universities, data partners and brands – were at the same table, creating a space for open dialogue and better understanding of each other's roles and challenges.

PROJECT
T-REX – Textile Recycling EXcellence

COORDINATED BY
adidas in Germany

FUNDED UNDER
Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment

CORDIS FACTSHEET
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PROJECT WEBSITE
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Digital platform improves circularity for textile industries

Following the guidelines of ecodesign legislation, a new platform improves transparency, traceability and sustainability across the supply chain.

Textile and clothing (TC) industries are considered major drivers of climate change. In the EU, where the average garment is worn only three times before being discarded, there is a critical need to disrupt disposable clothing culture. Citizens are eager for such a change, with 66 % of consumers stating they are willing to pay more for clothing that is sustainably produced.

To meet this growing demand, small and medium-sized enterprises (SMEs) must ensure the eco-friendly nature of their merchandise. The EU-funded TRICK project has established a digital platform to enable reliable data collection about TC traceability, circularity, sustainability, and health and social assessment by blockchain.

Ecodesign requirements

In July 2024 the cornerstone of the European Commission's approach to environmentally sustainable and circular products came into force. The Ecodesign for Sustainable Products Regulation (ESPR) is framework legislation intended to guide rules and regulations on a product-by-product basis.

Aspects targeted by the ESPR include durability, recyclability and energy and resource efficiency. An electronically accessible digital product passport (DPP) shares information about product

performance, the nature and origin of materials and life-cycle environmental impacts, at lot level. The DPP provides manufacturers, retailers and consumers with relevant information about a product's environmental profile, as well as assurance that the product in question has not been subjected to greenwashing.

Supporting the implementation of the ESPR is integral to the TRICK approach. According to project coordinator Alessandro Canepa: "The project's overarching goal is to establish a reliable, accessible platform that supports data collection for traceability, transparency and circularity across the supply chain and in compliance with EU regulations, at single lot level."

A comprehensive digital platform

One of the standout aspects of the platform is its ability to integrate various services into a seamless user experience for SMEs, ranging from traceability and preferential certification of origin to circularity and product environmental footprint, from consumer health protection to social assessment and AI for anticounterfeiting of data.

The platform developed by TRICK was tested in pilot studies involving the TC and food industries. It demonstrated scalability in the TC sector and potential replicability in the food sector. The platform's adaptability across different industries is a promising feature of project results, indicating the possibility for widespread and rapid adoption.

Adaptability is a key feature of the platform. Blockchain enables secure information sharing among many stakeholders and data portability, while AI, used to analyse data, provide business insights and verify the reliability of data declared, prevents greenwashing. As Alessandro Canepa shares: "One of the standout aspects of the platform is its ability to integrate various services into a seamless user experience for SMEs, ranging from traceability and preferential certification of origin to circularity and product environmental footprint, from consumer health protection to social assessment and AI for anticounterfeiting of data."

The services provided on the platform help SMEs meet DPP standards while improving sustainability and circularity in business. In addition to collecting and sharing data across the supply chain, the platform provides circularity assessments, product environmental footprint assessments and services to help SMEs procure preferential certification of origin.

Alessandro Canepa states: "The services developed under the TRICK project align with key EU regulations, including those related to environmental sustainability and health protections, making it easier for SMEs to meet regulatory requirements, including the future DPP for TC."

Creating a secure, sustainable and circular future for TC industries is a complex endeavour. By creating a platform designed for SMEs, TRICK has streamlined the process. The potential replicability of the platform in other industries is a promising indication of Europe's green future. Learn more about TRICK in this video.

Note: This article was last updated on 3 October 2024.

PROJECT
TRICK – PRODUCT DATA TRACEABILITY FROM CRADLE TO CRADLE BY BLOCKCHAINS INTEROPERABILITY AND SUSTAINABILITY SERVICE MARKETPLACE

COORDINATED BY
Fratelli Piacenza in Italy

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