A Zero Waste Vision for Textiles

Chapter 2: Circular and toxic-free material flows

Policy Brief

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Executive Summary

This second chapter of the two-part series 'A Zero Waste Vision for Textiles' sketches out what a truly circular and toxic-free system for textiles looks like. The report investigates the current barriers to circularity, identifies solutions, and makes recommendations for policy measures in the EU.

The European textile sector, characterised by its staggering waste generation and significant environmental impact, is at a crossroads and requires immediate action to transition towards the circular economy. Key challenges include the environmental impact of production and health risks for consumers posed by the use of harmful chemical substances, fossil fuel-based synthetic fibres, and the release of microplastics. Furthermore, the low rates of local reuse, repair, and upcycling of textiles as well as the insufficient separate collection capacity hamper circularity. Another significant obstacle is the insufficiency capacity for recycling in Europe; operations are often not economically viable due to a lack of design for recycling, investments in technologies for closed-loop recycling, but also the slow uptake of recycled content. Finally, the negative social and environmental impacts of exported second-hand textiles pose a huge challenge to regulators.

Key recommendations for policymakers are:

- **Strengthen the legislative frameworks** to curb the environmental impact of textiles, including bans on hazardous chemicals and implementation of circularity requirements under the Ecodesign for Sustainable Products Regulation (ESPR) Delegated Act for textiles;
- Ensure that when virgin materials are used for **production**, they come from bio-based and certified sources, while the principle of the cascading use for biomass must be enforced for bioplastics—meaning the use of material for durable products that are reusable and recyclable. Also, recycled content requirements must ensure that safe recycled content is always preferred over virgin input;
- Increase demand for **local reuse** by introducing economic incentives for repair or labour cost reductions for repair and upcycling businesses. The role of social economy actors must be recognised by, e.g., ensuring priority access to public tenders for collection and combining social and circular benefits. Also earmarking Extended Producer Responsibility (EPR) fees to support a fund for change and justice that allocates funds to reuse and repair operations can make the sector more profitable;
- Ensure better regulation of textile **waste exports** by amending the current EU Waste Framework Directive (WFD) and Waste Shipment Regulation (WSR) as well as the Basel Convention, including the introduction of Prior Informed Consent (PIC) procedure. Sorting for reuse must be enforced before exporting while support for the waste management capacity in recipient countries remains necessary;
- Introduce **recycled content requirements** and recyclability criteria under the EU ESPR and waste management performance targets under EPR schemes. Particular focus should be placed on 'closed-loop-recycling', including a new definition in EU-legislation as well as recycling targets.

The report concludes that the current lack of coherent policy measures must be overcome in the next few years to allow the sector to move towards operating within planetary boundaries. Still, the projected growth of the sector outpaces the shift towards circularity, risking to nullify circular advancements. Sufficiency and circularity must, therefore, work in tandem to alleviate pressure on resources and the environment.

Acronyms

(CH_4) Methane

(CMR) Carcinogenic, mutagenic or toxic for reproduction

(ECHA) EU Chemicals Agency

(EEA) European Environmental Agency

(ED) Endocrine disruptors

(EPR) Extended Producer Responsibility

(ESPR) Ecodesign for Sustainable Products Regulation

(ESPR DA) ESPR Delegated Act

(EoW) End-of-Waste criteria

(JRC) European Commission's Joint Research Center

(LCA) Life-cycle-assessment

(MRBT) Material recovery and biological treatment

(MWS) Mixed waste sorting

(PA6) Polyamide 6

(PAHs) Polyaromatic hydrocarbons

(PBT) Persistent, bioaccumulative and toxic

(PET, polyester) Polyethylene terephthalate

(PFAS) Per- and polyfluoroalkyl substances

(PHA) Polyhydroxyalkanoates

(PIC) Prior informed consent

(PLA) Polylactic acid

(PPWR) Packaging and Packaging Waste Regulation

(PROs) Producer Responsibility Organisations

(REACH) EU Regulation on the registration, evaluation, authorisation and restriction of chemicals

(RED) Renewable Energy Directive

(SMEs) Small and medium-sized enterprises

(SVHC) Substances of very high concern

(vPvB) Very persistent and very bioaccumulative

(WFD) Waste Framework Directive

(WSR) Waste Shipment Regulation

Introduction

The persistence of Europe's high levels of waste generation becomes particularly obvious when looking at textile waste: every year, Europeans discard around 11 kilos of textiles on average. Currently, only a fraction of used clothes are collected for reuse or recycling, while recycling of textiles into new fibres is at approximately 1%, resulting in huge volumes of used clothes being exported from Europe to the Global South, or incinerated or landfilled.[1] European consumption of textiles is responsible for, on average, the **fourth largest pressure on environment and climate change** (after housing, food and mobility) and the fifth largest material resource use, estimates the European Environmental Agency based on a global lifecycle perspective.[2]

In the first chapter of this two-part series, '**A Zero Waste Vision for Fashion – Chapter 1: All We Need Is Less**',[3] **we outlined that without a shift to sufficiency in the fashion sector, the industry is on track to exceed several planetary boundaries.** Without a drastic change in production and consumption patterns, the sector will fail to become circular since the waste it produces simply exceeds reuse and recycling capacities. ZWE has, therefore, outlined a list of entry points for the transition towards sufficiency and urges governments to take proactive steps and adopt best practices. The paper suggests the following measures:

- A more stringent legal framework banning the destruction of unsold goods, setting a target for textile waste reduction and resource use, as well as transforming EU waste legislation (the Waste Framework Directive[4]) into a 'Material Framework Directive'[5] in line with a 1.5-degree target;
- Governments must not rely on so-called consumer behaviour 'nudges' to cut down on fashion over-consumption and must instead address the cause of the current waste crisis: the fast fashion business model that relies on selling large volumes of trendy and cheaply-made items. A promising measure to create financial incentives for businesses is the introduction of Extended Producer Responsibility (EPR) schemes that go beyond cost coverage of waste treatment. Instead, such schemes would levy fees based on the volumes of products placed on the market while rewarding businesses embracing circular activities—such an initiative is currently ongoing in France.[6] Moreover, environmental taxes, especially on the use of virgin plastics, could also play an important role, given the dominant role of synthetic fibres in the rise of fast fashion;
- Supporting a culture of sufficiency by disincentivising overconsumption through public awareness campaigns as well as more impactful interventions such as taking certain products off the market ('choice editing'). Protecting consumers from misleading advertisements and reigning in

[1] European Parliament (2024) *The Impact of Textile Production and Waste on the Environment (Infographics)*.
[2] EEA (2022) *Textiles and the environment: the role of design in Europe's circular economy*.
[3] ZWE (2023) *A Zero Waste Vision for Fashion – Chapter 1: All We Need Is Less*.
[4] European Commission (2024) *Waste Framework Directive*.
[5] Eunomia (2024) *Managing materials for 1.5°C*.
[6] The Guardian (2024) *France's lower house votes to limit 'excesses' of fast fashion with environmental surcharge*.

advertisements altogether could be impactful levers. Moreover, promoting local repair and reuse can stifle the want and need for new garments while creating local jobs.

The textile sector's transformation is a critical milestone, yet it's only part of a broader economic shift towards sufficiency, well-being, and resilience within planetary boundaries.

The objective of this second chapter on circular[7] and toxic-free textile flows is to take stock and sketch out a holistic vision for a circular textiles sector from a zero waste perspective. A perspective conscious of the current overuse of resources transgressing planetary boundaries[8] and social injustice. It should lay out the pathway for a toxic-free and truly circular economy.

This paper draws upon a rich pool of policy expertise gained by ZWE over many years, including on chemicals and health, plastics and recycling, as well as waste management and prevention solutions. The vision for the future of the sector presented here is inspired by our work with municipalities striving towards zero waste and our European and global network of grassroots organisations.

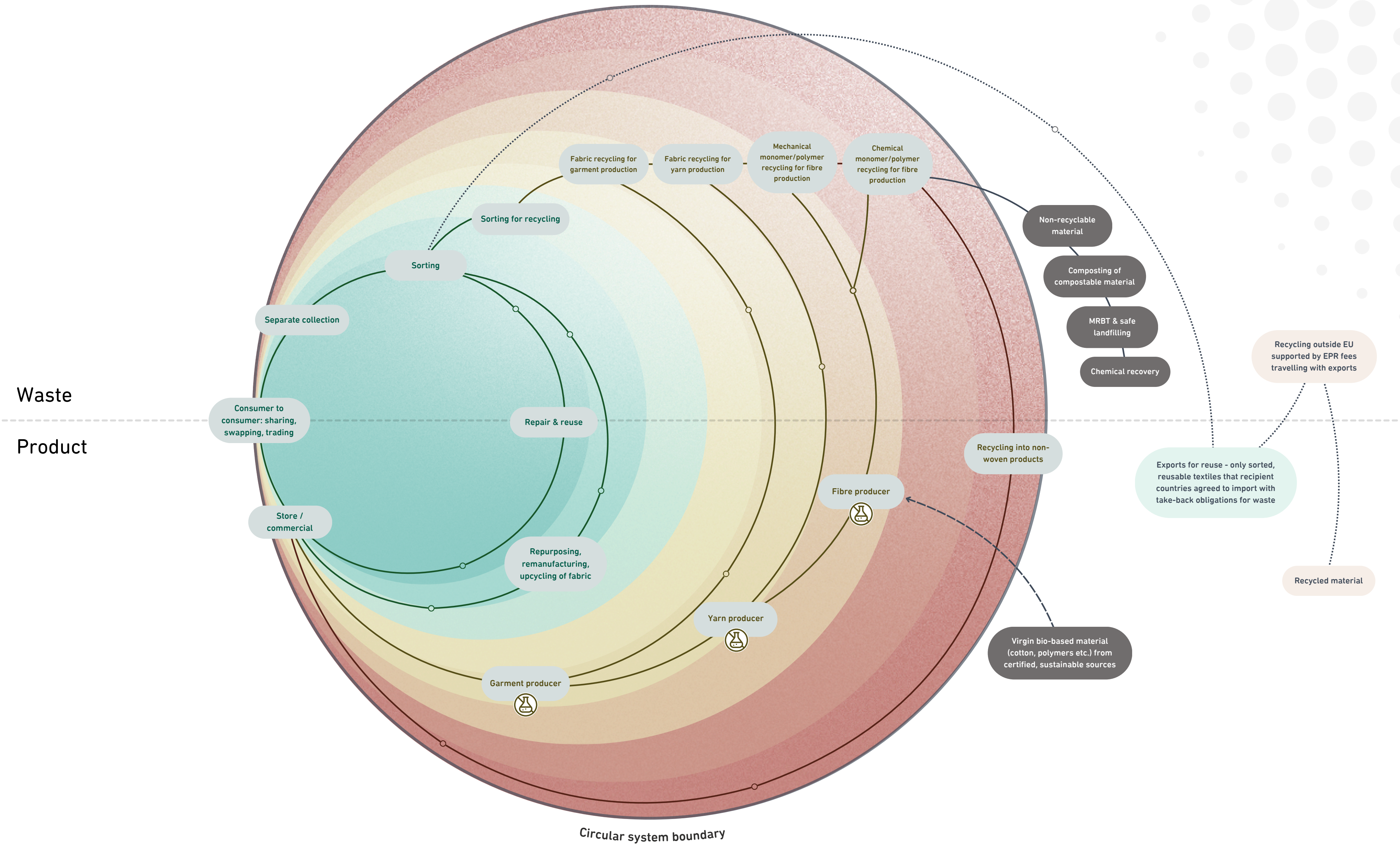
The structure of the paper will follow the circular textile value chain: from design, use, collection, reuse, recycling, waste trade, and all the way to the integration of recycled materials into new products.
Key challenges identified to realise the zero waste vision are:

- the environmental impact of production and health risks for consumers posed by the use of fossil fuel-based synthetic fibres, harmful chemical substances, and microplastic pollution;
- the low rates of local reuse, repair, and upcycling of textiles as well as the insufficient separate collection capacity;
- the insufficient recycling capacity in Europe, affected by a lack of separate collection, design of textiles, technologies for closed-loop recycling, as well as slow uptake of recycled content and price of virgin material;
- the high volumes of exported second-hand goods of low quality that negatively affect the environmental and human health in recipient countries in the Global South.

On the next page, ZWE has illustrated our vision of a circular and zero waste system for textiles.

[7] i: ZWE's definition of 'circularity' is: 'The circular economy is a model of production and consumption which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible; and tackling the presence of hazardous chemicals along the whole value chain. In this way, the lifecycle of products is extended in a toxic-free environment. In practice, it implies designing safe and sustainable products, and right systems, to reduce waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used over and over again within non-toxic material cycles, thereby creating further value.'
[8] Stockholm Resilience Centre (2024) *Planetary boundaries*.

Figure 1: A zero waste vision for a circular textiles sector, inspired by JRC 2023[9] and ZWE's work[10]



State of play of textile circularity in the EU

Of the approximately 12 million tonnes of textiles placed on the EU market in 2019, about **33% were produced domestically**.[11] In Europe, the textile ecosystem comprises all steps of the production value chain, from converting natural and synthetic fibres into yarns and fabrics, manufacturing yarns, home and medical textiles, industrial filters, technical textiles, carpets, apparel, footwear and leather. It is worth noting that the textile value chain is one of the most globally interconnected systems today. Interestingly, the majority of this ecosystem based in the EU is comprised of small and medium-sized enterprises (SMEs), which make up 99.5% of the companies involved in this sector, employing a workforce of over 70% women. Germany, Spain, France, Italy, and Portugal are the main production locations. There is a strong connection to other sectors, such as healthcare, construction, agriculture, and automotive.[12]

Valorising post-consumer textile waste, the largest fraction of textile waste by a margin (Figure 2), remains challenging: textile recycling continues to be a small sector in Europe while reuse of second-hand clothing is more established. However, as the market for second-hand garments is saturated, large quantities of second-hand textiles are exported outside the EU. The majority of reuse operations are run by charities and social economy actors, but also businesses and municipalities collect, sort, and reuse textiles in Europe.[13] Recent data by the European Commission's Joint Research Centre shows that circular options such as reuse and recycling (inside EU) only make up a total of around 0.73 million tonnes or 6.6% of the total post-consumer waste generated in 2019 (Figure 4).[14] While the fate of exported textiles remains difficult to trace, a recent report by the European Environmental Agency (EEA) found that Africa and Asia are the main destinations; and although the purpose of these imports is the reuse of textiles, it is likely that large fractions are not reused for various reasons (quality, demand, suitability for context), exacerbating adverse environmental and social impacts. Exports to Asia are more likely to result in sorting and processing for reuse and recycling.[15]

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[9] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[10] i: This infographic is an attempt to capture a complex system in a simplified manner. It presents a holistic vision of textiles' circularity and highlights which activities are preferable (green background) or less preferable (yellow or red). It also defines the boundaries of the circular system (i.e., the border around the circle) and indicates which activities are not considered circular (i.e., dark boxes outside of the circle—input of virgin material and residual waste treatment). The dark lines indicate the path textile products and waste travel from one step to the next. Placing waste exports in the circular system is still challenging due to the lack of data on the benefits and harm of this practice. If well-regulated, reuse and recycling outside the EU can contribute to circularity.
[11] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[12] European Union (2023) *Transition pathway for the textiles ecosystem*.
[13] ZWE (2023) *How to collect, sort, and reuse textile waste locally?*
[14] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[15] EEA (2023) *EU exports of used textiles in Europe's circular economy*.

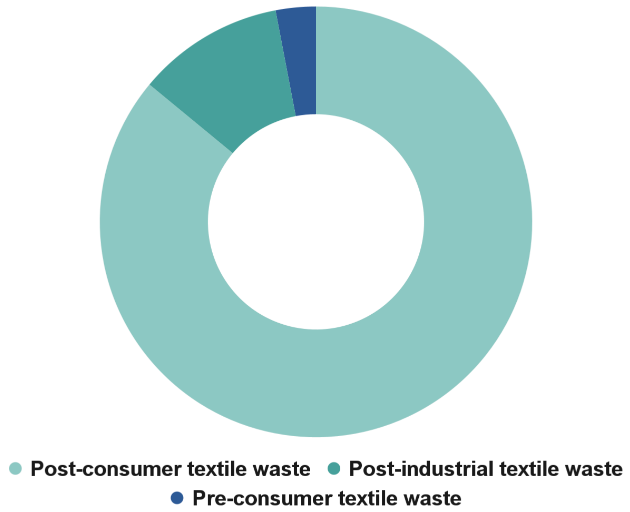

Figure 2: Textile waste generated in the EU in 2019[16]

Data shows that the EU's capacity to separately collect and sort textile waste is insufficient to cover all waste generated (Figure 3). In the coming years, **separate collection of textiles is bound to rise across the EU**, especially in areas with low rates of collection due to the mandatory separate collection from 2025 onwards, as regulated under the Waste Framework Directive (WFD).[17] Moreover, the EU will make the introduction of national Extended Producer Responsibility (EPR) schemes to cover the costs of waste management of textiles mandatory from around 2027.[18]

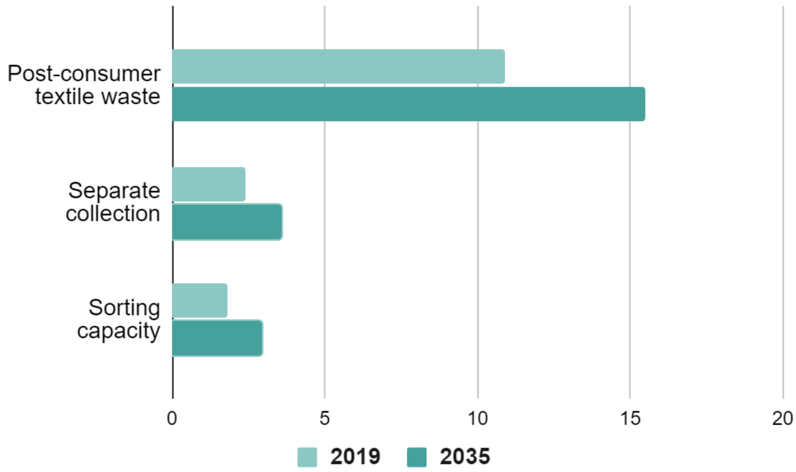

Figure 3: Post-consumer textiles waste generation compared to collection and sorting capacity in million tonnes (Mt) for 2019 and projected for 2035[19]

[16] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union.*
[17] European Commission (2024) *Waste Framework Directive.*
[18] European Commission (2023) *Proposal for a targeted revision of the Waste Framework Directive.*
[19] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union.*

A staggering amount of textiles ends up in incineration or landfills. Annually, more than 8 million tonnes (Mt) of post-consumer textile waste are being incinerated or landfilled in the EU,[20] more than all the water it takes to fill up 3 Olympic-size swimming pools. Even with the projected improvements in collection, reuse, and recycling, the picture for 2035 is bleak (Figure 4).

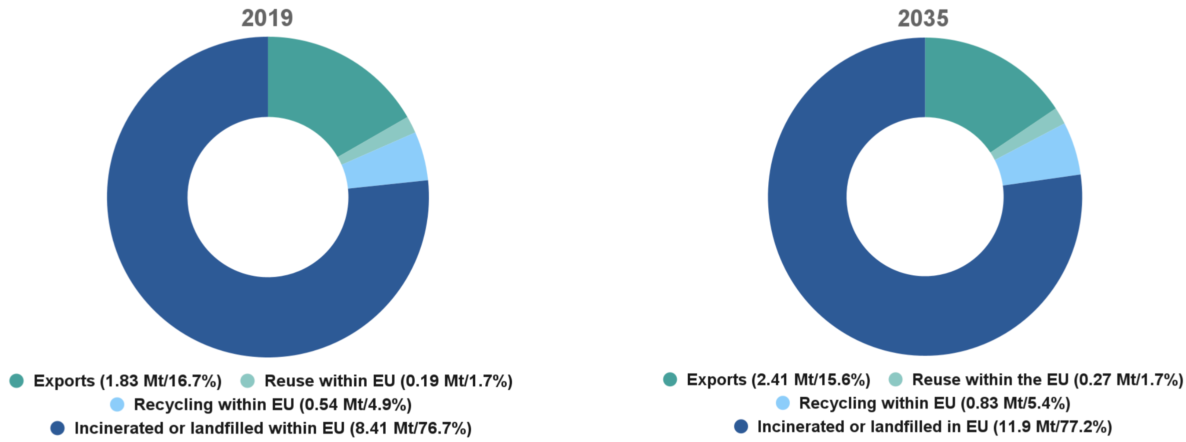

Figure 4: Estimations of end-of-life-destinations for post-consumer textile waste in the EU-27 for 2019 and projected for 2035 in million tonnes (Mt)[21]

When zooming in on different regions across Europe, it becomes obvious that in some places, **circular options are more advanced than in others**. Figures from the **French PRO Refashion** for 2022 show that the French collection rate is higher than the EU average (2019); however, the data is not directly comparable due to the different scope and reverence years. While the recycling rate in France is significantly higher than the EU average, a majority of sorted textiles are recycled in 'open-loop' systems, meaning the material is used in lower-quality (non-woven) applications. Another problem that becomes obvious here is that only 10% of what is considered reusable is sold in France while the rest is exported (top recipient countries are Pakistan and Tunisia).[22] [23]

[20] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[21] i: Figures based on approximation of textile production and waste management in the EU-27 for the reference year 2019 in Mt yr-1, and represent best estimates based on available data; based on JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[22] Refashion (2023) *2022 Activity Report*.
[23] i: Products covered by the PRO Refashion are clothing, household linen, and footwear.

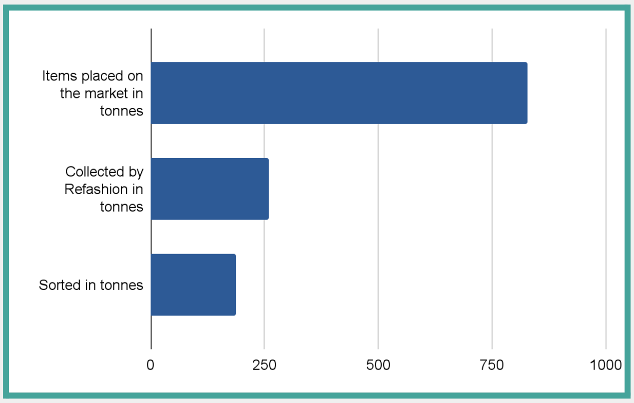

Figure 5: Comparison of items placed on the market, collected, and sorted in France in 2022 in tonnes[24]

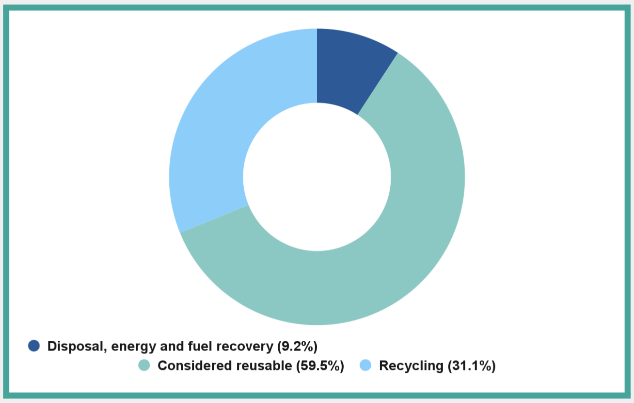

Figure 6: Recovery methods of sorted textiles in France in 2022[25]

Another study on textile flows in **Latvia,** a country without EPR for textiles,[26] shows that only 10% of used textiles collected by waste management companies in textile containers are reused in Latvia, while 82% are exported. Several initiatives, such as Texroad,[27] are currently working towards measuring material flows and improving the compatibility of textile data across Europe. However, this is still a work in progress.

Pre-consumer waste makes up a far smaller fraction of overall textile waste, yet, recent studies have underlined the scale of destruction of returned and unsold goods. This has become a common practice and according to the EEA, amounts to 4-9% (between 264,000 and 594,000 tonnes) of textiles placed on the EU market being destroyed. The average return rate for garments sold online is estimated at 20% and therefore three times higher than for products bought in highstreet stores. Approximately one third of all returned online purchases end up being destroyed. The GHG emissions caused by processing and destroying those returned or unsold items are estimated to be only slightly lower than Sweden's net emissions in 2021.[28] Whether the newly introduced ban on the destruction of unsold goods *via* the Ecodesign for Sustainable Products Regulation (ESPR) will be effective in tackling this practice remains to be seen.[29]

Following this sobering overview of the state of play of circular material flows in the textiles sector, the paper will now turn toward analysing each stage of the value chain to identify obstacles to circularity and formulate recommendations for policymakers.

[24] Refashion (2023) *2022 Activity Report.*
[25] Refashion (2023) *2022 Activity Report.*
[26] Waste To Resources Latvia (2023) *Study on the sorting and use of household textiles in Latvia*.
[27] TEXroad Foundation (2024).
[28] EEA (2024) *Many returned and unsold textiles end up destroyed in Europe.*
[29] European Parliament (2023) *Deal on new EU rules to make sustainable products the norm.*

Circular and toxic-free material flows

What does a zero waste system for textiles look like?

Design for circularity

The textile manufacturing sector requires a multitude of fibres, man-made and natural (including fossil-based, plant-based, and animal-based), which are often blended in the final product. Material blends—such as cotton and elastane commonly blended in jeans—are currently difficult to recycle into new garments, and it is often not indicated correctly which materials are woven into the fabric.[30] The future EU-wide Extended Producer Responsibility (EPR) schemes for textiles, financial incentives, and the Ecodesign for Sustainable Products Regulation (ESPR)[31] will play an important role in adjusting this. Moreover, textile manufacturing currently uses enormous quantities of harmful and potentially harmful chemicals. Large quantities of dyes, additives, and stabilisers are used to treat textiles, which then enter the environment through wastewater. Textile production is estimated to be responsible for about 20% of global clean water pollution from dyeing and finishing products.[32] The human health and environmental impact of chemical production, the application of chemicals in textile materials, and the subsequent use, recycling, and disposal of such products is a growing global concern.

Health risks

It has been reported that **more than 8,000 chemical substances are used in the textile industry**[33] and that approximately 25% of global chemical output originates from the sector.[34] Since we are in contact with textiles all day, every day, the safety of these products is vital. The following table provides an overview of functional and auxiliary chemicals commonly used in textiles to give the product certain functions or technical properties:

Functional chemicals	**Auxiliary chemicals**
Dyestuffs and pigments	Organic solvents
Crease resistant agents	Surfactants
Anti-shrinking agents	Softeners

[30] Online Clothing Study (2020) *Why is it Difficult to Recycle Your Clothes*.
[31] European Parliament (2023) *Deal on new EU rules to make sustainable products the norm*.
[32] European Parliament (2024) *The impact of textile production and waste on the environment*.
[33] Kant (2012) *Textile Dyeing Industry and Environmental Hazard*, Natural Science 4 (1): 22-26.
[34] China Dialogue (2018) *Textile industry under pressure to detox fashion*.

Functional chemicals	Auxiliary chemicals
Oil, soil, and water repellents	Salts
Plasticizers	Acids and bases
Biocides for defined functionalities in articles, e.g. antibacterial agents	Biocides as preservatives in the process or during storage and transport
Flame retardants	
Stabilisers	
Stiffening agents	
Reactive resins for various finishing treatments	

Figure 7: Overview of functional and auxiliary chemicals[35]

While we are still lacking any kind of assessment for many of the chemicals used in textiles, the Swedish Chemicals Agency found that in a sample of 2,450 substances, 750 were classified as hazardous for human health and 440 as hazardous for the environment.[36] **These chemicals are, among others, probable carcinogens, skin irritants, and endocrine disruptors**. Toxic chemicals, such as alkylphenols and per- and polyfluoroalkyl substances (**PFAS**) are particularly problematic as they cannot be removed by wastewater treatment plants. Flame retardants, including brominated and chlorinated organic compounds, are another particularly hazardous class of chemicals used in some textiles. Moreover, many dyes contain **heavy metals**—such as lead, cadmium, mercury, and chromium (VI)—known to be highly toxic due to their irreversible bioaccumulative effects, while azo dyes contain carcinogenic amines.[37]

Some of these hazardous chemicals have been identified as additives in textiles for past or current use in Stockholm Convention risk profiles, including PFOS, PFOA, PFHxS, hexabromobiphenyl (HBB), tetra- and pentabromodiphenyl ether (c-pentaBDE), hexa- and heptabromdiphenyl ether (c-octaBDE), decaBDE, hexabromocyclododecane (HBCD), and short-chain chlorinated paraffins (SCCPs).[38] In addition, the textile

[35] Plastic Soup Foundation (2022) *Do clothes make us sick? Fashion, fibers and human health*.
[36] Swedish Chemicals Agency (2014) *Chemicals in textiles. Risks to human health and the environment*.
[37] Natural Resources Defense Council (2021) *A review of PFAS as a chemical class in the textiles sector*.
[38] POPs Review Committee of the Stockholm Convention, United Nations Environment Programme *Reports*.

industry is the largest user globally of a newer (short-chain) type of PFAS that has been linked to liver and immune system damage.[39]

Evidence shows that many textiles placed on the market contain chemicals classified as harmful to humans and the environment under the EU Regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH).[40] For example, tests on 47 SHEIN[41] products found that seven contained hazardous chemicals breaching EU regulatory limits, with five of these products exceeding the limits by 100% or more. A total of 15 of the products contained hazardous chemicals at levels of concern.[42] A recent EU-wide enforcement project by the EU Chemicals Agency (ECHA) found that in the case of fashion products such as bags, jewellery, belts, shoes and clothes, 15% of these products were found non-compliant due to the phthalates, lead, and cadmium they contained.[43] Researchers in Italy examined 93 samples of recycled wool, cashmere, cotton, and synthetic fibres and found PFAS in 100% of the recycled material.[44]

Notably, most garments and fashion products are now entirely or partially made from petrochemical-based synthetic fibres (e.g. polyester, acrylics, nylon, and spandex).[45] From a toxicological point of view, synthetic fabrics have higher environmental costs for the environment in comparison to natural ones as they undergo multiple chemical procedures that require additives to manipulate/functionalise the material for production. While natural fibres usually require fewer chemicals during production, they are often still not free from harmful substances and incur other environmental impacts, such as land and water use. **Some chemicals, including in their nanoforms, are used to give the product certain functions**: biocides to prevent mould, dyes, chemicals for wrinkle-free clothing, water repellents for outdoor wear, or bacteria-killing agents to combat bad odour.[46] [47]

The outlined evidence underlines that **the safe use, reuse, recycling, and export of textiles may be undermined by the presence of harmful chemical substances—hampering the transition towards a circular system.**[48] Producers will be reluctant to mix recycled content into their products that potentially contain harmful substances and therefore compromise the quality of their products. Likewise, consumers aware of the scale of contamination will be less likely to shop second-hand.

Consumers can be exposed to hazardous chemicals in textiles through skin contact, inhalation or unintentional ingestion of dust released from the materials. The oil and water-repellent properties of PFASs, widely used in technical fabrics, have been linked to liver damage, thyroid disease, obesity, fertility issues, and

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[39] Natural Resources Defense Council (2021) *A review of PFAS as a chemical class in the textiles sector*.
[40] i: Examples of most frequently detected chemicals: Formaldehyde, heavy metals, phthalates (DIBP, DIDP, DBP, DEHP), nickel.
[41] SHEIN (2024) *About us*.
[42] Greenpeace International (2022) *Taking the Shine off SHEIN: a business model based on hazardous chemicals and environmental destruction*.
[43] ECHA (2023) Forum for exchange of information on enforcement. *REF-10 project report on: Integrated chemical compliance of products*.
[44] TEXtalks (2023) *Restricting PFAS chemicals in recycled textiles demanded* .
[45] EARTH DAY (2022) *A closer look into the material drivers of the clothing industry*.
[46] Swedish Chemicals Agency (KEMI) (2022) *Chemical substances in textiles*.
[47] European Chemicals Agency (ECHA) *Clothes and textiles*.
[48] EEA (2023) *Investigating Europe's secondary raw material markets*.

cancer.[49] There is a growing concern about skin sensitisation (i.e. allergic response following skin contact) due to exposure to chemicals in textile and leather articles. The number of individuals already sensitised to chemical substances present in finished textile and leather articles in the European general population is estimated to be between 4 and 5 million.[50] Children and pregnant women are most vulnerable and may experience more adverse health effects.[51]

The EU REACH Regulation covers chemicals relevant to the textile ecosystem. [52] The EU-wide restriction, which applies from November 2020, limits the use of 33 substances classified as carcinogenic, mutagenic or toxic for reproduction (CMR).[53] These substances may be used in production processes or to give specific properties to the product, as outlined above. The restriction applies to both EU-made and imported clothing and covers substances from the following groups: cadmium; chromium; arsenic and lead compounds; benzene and polyaromatic hydrocarbons (PAHs); certain PFAS; flame retardants; chlorinated aromatic hydrocarbons; formaldehyde; phthalates; polar aprotic solvents; azo-dyes and acrylamines; and quinoline. Moreover, a number of chemicals have been identified as skin sensitisers.[54] However, despite recommendations issued by ECHA in 2020, the European Commission has unfortunately still not prepared a restriction proposal for those substances in textiles and leather products. Some substances in textiles and recycled content are also regulated under the **Persistent Organic Pollutants (POPs) regulation,** which aims to protect human health and the environment from chemicals that persist in the environment, bioaccumulate and pose a risk of causing significant adverse effects.[55]

The text of the **Ecodesign for Sustainable Products Regulation (ESPR),** agreed upon during interinstitutional negotiations,[56] establishes a framework to set ecodesign requirements for specific product groups to significantly improve their circularity, energy performance and other environmental sustainability aspects.[57] This framework will allow for setting a wide range of requirements for textiles, including the presence of substances of concern and their traceability. The definition of substances of concern under ESPR covers a broader range of hazards compared to the REACH substances of very high concern (SVHC), which will allow for more stringent regulation of textile products. A substantial review of REACH remains necessary nonetheless, and must align with the more stringent restrictions under ESPR. Five EU countries recently proposed banning all per- and polyfluoroalkyl substances (PFAS), and ECHA is currently considering how best to evaluate the proposal. Finally, future restrictions on PVC and its additives, as well as on flame retardants in textiles, can be expected as well.

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[49] EEA (2024) *What are PFAS and how are they dangerous for my health?*

[50] ECHA (2020) Committee for Risk Assessment (RAC) Committee for Socio-economic Analysis (SEAC) *Background document to the Opinion on the Annex XV dossier proposing restrictions on skin sensitising substances*.

[51] ECHA (2024) *Substances we don't want in our clothes*.

[52] European Commission (2020) *Transition pathway for the textiles ecosystem*.

[53] EU (2018) *Regulation (EU) 1513/2018 that modifies Annex XVII to REACH Regulation (EC) No 1907/2006 by including a new entry (Entry 72).*

[54] ECHA (2021) *Registry of restriction intentions until outcome: Skin sensitising, irritative and/or corrosive substances*.

[55] EU (2029) *Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants (recast)*.

[56] European Parliament (2024) *Ecodesign for Sustainable Products Regulation*.

[57] European Commission (2024) *Ecodesign for Sustainable Products Regulation*.

Since July 2011, Greenpeace has secured **voluntary commitments from international brands, retailers, and suppliers to eliminate hazardous chemicals**, including support to trigger policy changes in Europe and Asia.[58] An assessment of progress made by 80 companies that took the pledge to phase out these chemicals from their production line by 2020 concluded that good progress had been made.[59] The Detox campaign was able to raise industry awareness and encouraged several brands to work towards the same requirements in their supply chains.

Moreover, leading brands, including fast fashion companies Inditex (Zara) and H&M, along with Puma, Nike, and Adidas, committed to ending the release of harmful substances from their supply chains by 2020. A Zero Discharge of Hazardous Chemicals Foundation (ZDHC) was set up to encourage and guide change in the sector. The world's largest database for hazardous chemicals in the textile value chain[60] was created to enable safer choices of chemical products available to the textile, apparel and footwear industry.

Although the majority of major fashion brands have started to take this action, the fashion industry as a whole is still far from using chemicals safely and sustainably. One of the reasons given for the shortfall is that the sector is dominated by small firms supplying lesser-known brands and/or producing cheap unbranded clothing that have not followed suit.[61]

Preventing the use of hazardous chemicals and limiting toxic emissions at all life cycle stages must be incorporated into product design. Textile products must indicate on the label and Digital Product Passport the materials and chemicals they contain and whether they are pure or mixed to facilitate recycling and prevent toxic chemicals from re-circulating.[62] The textile industry should also provide transparency and traceability across its value chain, allowing buyers to make more informed choices. Green Public Procurement and the EU Ecolabel criteria[63] for Textile Products may be an extra factor in pushing for positive change. The EU must act more urgently and restrict the use of hazardous chemicals (classified as substances of concern) in clothing and textile products. The awaited revision of REACH chemical regulation should address better textile specificities and improve enforcement. Detoxification of supply chains would happen most effectively if both regulation and industry initiatives moved in the same direction.

[58] Greenpeace (2024) *Detox My Fashion.*
[59] Greenpeace (2018) *Destination Zero.*
[60] Roadmap to Zero (2024) *Who we are.*
[61] China Dialogue (2018) *Textile industry under pressure to detox fashion.*
[62] EEA (2022) *Textiles and the environment: the role of design in Europe's circular economy.*
[63] i: Other certifications: Oeko-Tex, Bluesign, AFIRM, the Nordic Swan, Global Organic Textile Standard (GOTS) and equivalents.

Synthetic fibres: fossil, bio-based and recycled plastics

Synthetics are the dominant material in textiles today, and their availability at a low price point has driven the development of fast fashion considerably.[64] Around 2010, global polyester production overtook the production of all other fibres combined.

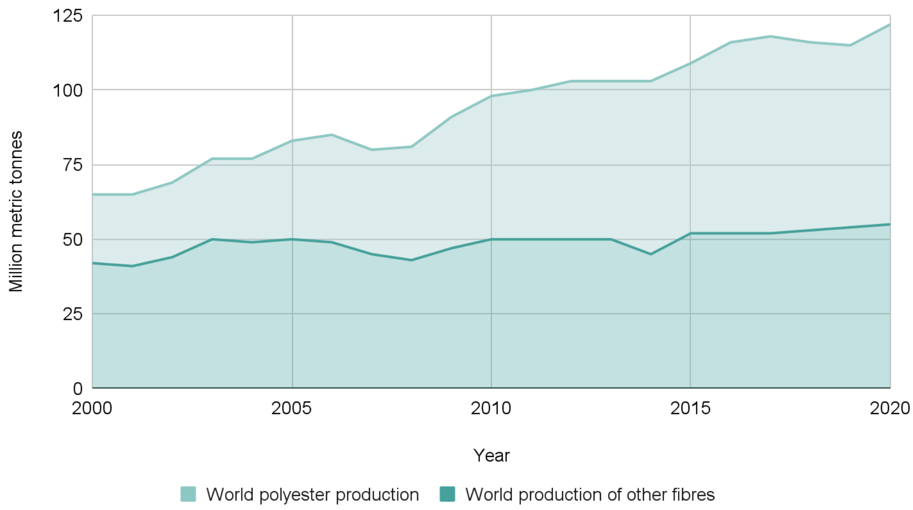

Figure 8: World polyester production and world production of other fibres in million metric tonnes (including Polyamide, Acrylic, Polypropylene, Cellulosic, Cotton, and Wool)[65]

Due to increased public awareness of the negative impacts of fossil plastics, including GHG emissions, oil leaks, and pollution from microplastics,[66 67 68] many producers have started to turn to substituting fossil-based with bio-based polymers. **Global production capacity of bioplastics is projected to increase significantly** from around 2.18 million tonnes in 2023 to approximately 7.43 million tonnes in 2028; however, this will still only amount to 0.5 percent of the overall global production of plastics. **Fibres are the second largest market segment for bioplastics after flexible packaging**[69 70] and claims about the use of bio-based plastics in

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[64] Changing Markets Foundation (2021) *Fossil Fashion*.

[65] McKinsey and Ellen MacArthur Foundation (2017) *A New Textiles Economy: Redesigning fashion's future*; and Changing Markets Foundation (2021) *Fossil Fashion*.

[66] Our World in Data (2023) *How much of global greenhouse gas emissions come from plastics?*

[67] IEA (2024) *Global Methane Tracker 2024*.

[68] EEA (2022) *Microplastics from textiles: towards a circular economy for textiles in Europe*.

[69] European Bioplastics (2023) *Bioplastics market development update 2023*.

[70] i: fibres are mainly made from PTT, PLA, PA, CR.

textiles are proliferating, with especially footwear brands as early transitioners, as they are increasingly replacing the material in the soles of their products.[71] [72]

Methods to assess the impacts of bio-based plastics in comparison to fossil-based ones from a life-cycle (LCA) perspective are still being developed, and data is often either not comparable or confidential—making it difficult to use standardised LCA methods.[73] [74] The environmental impact of bioplastics depends on their feedstock, production process, and the final composition of the product (polymers and additives).[75] However, it is important to recognise the **contribution of bio-based plastics towards phasing out fossil fuel production** since fossil-based plastics are a derivative from crude oil and natural gas.[76] There is nonetheless a high risk that bioplastics will not substitute fossil-based material but rather add to the overall plastic production, as **fossil plastic production is expected to continue to grow significantly** in the coming years due to the shift away from fossil fuels in the energy sector.[77] Regrettably, as long as fossil-based plastic production continues to grow faster than the production of bio-based plastics, the overall environmental impact will not decrease.

A recent study highlighted that **in order to reach the global climate targets, it is necessary to achieve a 50% reduction in plastic demand, a complete phase-out of fossil-derived plastics, and 95% recycling rates**.[78] In light of these findings, it is important to note that bioplastics are not inherently circular but have to be reusable, and recyclable, and actually recycled in practice to be considered circular. Increasing the use of new polymers (both bio- and fossil-based) therefore requires the scaling of recycling infrastructure. From a circularity and carbon-neutrality perspective, **recycled content (bio-based or fossil-based) is always preferable over virgin material**.

To ensure transparency for consumers, generic claims on plastic products such as 'made from bioplastics', 'bio-based', or 'recycled content' must be avoided. Instead, **exact measures of the percentage of bio-based or recycled content in products following chains of custody models and ensuring a high level of physical and chemical traceability must be mandatory**.[79] Moreover, evidence of the sustainable sourcing of bio-based feedstock should be provided, as outlined in the non-binding policy framework for bio-based, biodegradable and compostable plastics published by the EU Commission in 2023.[80]

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[71] Braskem (2028) *Braskem launches new renewable bio-based EVA resin in Allbirds shoes*; Ecocult (2023) *Acetate Sunglasses: Eco-Friendly or Just Greenwashing?*

[72] Paris Good Fashion (2022) *Can Bioplastics Really Make Fashion More Sustainable, Biodegradable, or Recyclable? #319*.

[73] European Commission (2022) *Report on the Community of Practice workshop: Prospective LCA for Novel and Emerging Technologies for BIO-based products – Planet BIO*.

[74] European Bioplastics (2021) *Using LCA to compare bio-based and fossil-based plastics is not that simple*.

[75] European Commission (2022) *Communication – EU policy framework on biobased, biodegradable and compostable plastics*.

[76] BPF (2024) *How Is Plastic Made? A Simple Step-By-Step Explanation*.

[77] OECD (2022) *Global Plastics Outlook.*

[78] Vidal, F., van der Marel, E.R., Kerr, R.W.F. et al. (2024) *Designing a circular carbon and plastics economy for a sustainable future*. Nature 626, 45–57.

[79] i: More information available under the section on recycled content on page 37.

[80] European Commission (2022) *Communication – EU policy framework on biobased, biodegradable and compostable plastics*.

The political debate on **land use** was dominated for many years by the food vs. fuel dilemma,[81] highlighting the risk of diverting farmland or crops for biofuel production, endangering the food supply. Could the focus soon shift towards **food vs. plastics**? While production volumes are increasing, some researchers reject the idea of a 1:1 replacement rate of fossil-based with bio-based material due to the higher market price. They also underline the untapped potential of biobased materials that are currently discarded as waste.[82] Estimates by European Bioplastics show that only 0.021% of the global agricultural area is being used for bioplastics production in 2024,[83] yet, not taking into account a fossil phase-out.

A legal framework to guide the transition from fossil to sustainable production of bioplastics is therefore necessary. The EU policy framework for bioplastics already states that '*in line with the circular economy principles, producers should prioritise the use of organic waste and by-products as feedstock, thus minimising the use of primary biomass and avoiding significant environmental impacts. When primary biomass is used, it is important to ensure that it is environmentally sustainable and does not harm biodiversity or ecosystem health.*'[84] These provisions should be adopted into a legally binding framework.

Moreover, the Renewable Energy Directive (RED) includes the **principle of the cascading use of biomass** (Article 3, paragraph 3),[85] with the aim to prioritise applications that offer the highest environmental added value, mainly those which preserve the carbon stored in biomass for as long as possible. Making use of biomass resources for the longest time possible by giving products multiple lives and avoiding short-lived applications can support the reduction of demand for primary biomass and reduce the rate of extraction. Adopting this principle for the use of bioplastics could bring substantial environmental benefits.[86] In addition, the RED stipulates sustainability criteria for biofuels. While these criteria are well-intended, they currently are not fit for purpose as they don't prevent companies from placing biofuels on the market that do not match the criteria.[87] Instead, the EU should enforce sustainability criteria for biomass sourcing (including for bioplastics) at company level, together with mandatory due diligence requirements.

Another possible instrument is the EU Regulation on Deforestation-free products, which was introduced to prevent products placed on the EU market from contributing to deforestation and forest degradation in the EU and globally; the regulation, however, does not currently include plastics.[88]

More generally, all materials used by the textiles sector, like in all other sectors, should be subject to a future Material Application Hierarchy, which we propose to introduce in a new Material Framework Directive, replacing the WFD. This hierarchy will guide the use of materials to the applications that are desirable and have the most societal benefit. The hierarchy could be implemented in practice through ESPR product rules.[89]

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[81] Transport and Environment (2022) *Food vs fuel: Vegetable oils in biofuels*.
[82] Clothing Research (2022) *Feedback to the EU Textile Strategy*.
[83] European Bioplastics (2019) *Bioplastics market development update 2029*.
[84] European Commission (2022) *Communication – EU policy framework on biobased, biodegradable and compostable plastics*.
[85] *Directive (EU) 2023/2413*.
[86] WWF (2017) *Cascading Materials Vision and Guiding Principles*.
[87] Client Earth (2021) *Unsustainable and Ineffective: Why EU Forest Biomass Standards won't stop destruction*.
[88] European Commission (2024) *Regulation on Deforestation-free products*.
[89] Eunomia (2024) *Managing materials for 1.5°C*.

Finally, the fact that polymers are **bio-based does not mean they are biodegradable,**[90] raising questions about consumer confusion and pollution with microplastics, as outlined in the following sections.

Preventing pollution from microplastics

An emerging environmental concern for the pollution of terrestrial and freshwater ecosystems is the release of microplastics/microfibres, shed by synthetic (fossil- or bio-based) textiles. They leak into the environment through wastewater and aerial deposition.[91] The EEA estimates that around **8% of European microplastics released into the oceans stem from synthetic textiles** (13,000 tonnes of textile microfibres, or 25 grams per person); globally, this amounts to around 16-35% (200,000-500,000 tonnes) every year. EU consumption also underpins microplastics release in other parts of the world since production is mostly based in Asia, while the main destinations for exports are Africa and Asia. Most microplastics are released into the environment during the first few washes but also during manufacturing, wearing, and disposal.[92] The EU's zero pollution action plan aims to reduce microplastics released from all sources into the environment by 30% by 2030.[93]

Plastic fibres are constantly released into the air - around 33% of fibres in indoor environments are synthetic.[94] **People breathe in 13,000 to 68,000 plastic microfibers from clothing, carpets, curtains, and other textiles every year**. Scientists found 39 microplastic particles within 11 of 13 lung tissue samples, with polypropylene and polyethylene terephthalate (PET, polyester) fibres being the most prevalent.[95] Research raises strong concerns about the damage nylon and polyester microfibres could cause to human lungs.[96] The World Health Organisation (WHO) assessed the potential health risks associated with exposure to microplastics *via* inhalation and concluded that there is some evidence of specific lung pathology in occupational settings.[97] Moreover, the *'Breathing Plastic: The Health Impacts of Invisible Plastics in the Air'* report concluded that possible adverse effects along the respiratory tract and beyond, range from irritation to the onset of cancer in cases of chronic exposure.[98] In conclusion, although research on the respiratory health effects of microplastics remains scarce, the negative effects that microplastics can have on respiratory health are clearly evident and may pose a threat to patients with existing lung diseases.[99] Finally, it has been found that nano- and microplastics inhaled *via* the airways can be transferred to other organs through blood circulation.[100]

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[90] ECOS (2022) *The million-euro question: do bioplastics truly ensure environmental benefits?*
[91] EEA (2023) *ETC/CE Report 2023/5 The role of bio-based textile fibres in a circular and sustainable textiles system.*
[92] EEA (2022) *Microplastics from textiles: towards a circular economy for textiles in Europe*.
[93] European Commission (2021) *EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" (and annexes)*.
[94] Dris et al. (2017) *A first overview of textile fibers, including microplastics, in indoor and outdoor environments* Environmental Pollution 221: 453-458.
[95] Jenner et al. (2022) *Detection of microplastics in human lung tissue using μFTIR spectroscopy* Science of The Total Environment 831: 154907.
[96] Song et al. (2024) *Inhalable textile microplastic fibers impair airway epithelium* Am J Respir Crit Care Med 209(4):427-443.
[97] WHO (2022) *Dietary and inhalation exposure to nano- and microplastic particles and potential implications for human health*.
[98] CIEL (2023) *Breathing Plastic: The Health Impacts of Invisible Plastics in the Air*.
[99] Lu et al. (2022) *Microplastics, potential threat to patients with lung diseases*.
[100] Ali et al. (2024) *The potential impacts of micro-and-nano plastics on various organ systems in humans* eBioMedicine 99: 104901.

While the long-term effects of microplastics on human health, ecosystems, and agriculture remain largely unknown, one major concern is the **release of potentially toxic additives in plastics** and other chemicals.[101]

Measures to **prevent the release of microfibers** are, firstly, more sustainable design choices, like the use of natural fibres, alternative manufacturing, and pre-washing at the manufacturing plant. Secondly, controlling microplastic emissions during use, such as new filter technologies in washing machines, mild detergents, and longer use of textile products. Lastly, better management of textile waste, wastewater treatment, treatment of wastewater sludge, and proper end-of-life processing.[85] When testing the release of microfibres during washing, there is also a need for additional standardisation.[85] The Nordic Swan Ecolabel, for example, applies the precautionary principle and strives to limit the use of microplastics and microfibres wherever possible, depending on whether technical solutions are available.[102] [103]

Some actors advance the idea of using **biodegradable synthetic fibres** to ensure that the shedded fibres break down in the environment similar to natural fibres like cotton or wool. Several bioplastics, like Polylactic acid (PLA) and Polyhydroxyalkanoates (PHA) are biodegradable.[104] However, biodegradable plastics don't necessarily decompose in all environments. A study by UC San Diego's Scripps Institution of Oceanography looked into the effect of marine environments on the degradation of biodegradable plastics (PLA) and found that they did not disintegrate after 428 days.[105] This highlights the difference between biodegradability in the environment vs. in industrial composting plants. Biodegradable plastics are therefore not automatically preferable but producers would have to demonstrate that their fibres decompose in nature.

Recommendations

Shifting to circular design:

- Implementation of circularity requirements under the ESPR Delegated Act for textiles;
- Taxation in combination with fee modulation under the future EU-wide Extended Producer Responsibility (EPR) schemes on the use of virgin material must be introduced to support the uptake of recycled content;
- A review of the EU EPR rules to allow more effective fees; currently, fees cannot induce design change as they are based on the limiting concept of 'necessary costs' and seek to minimise the costs resulting in fees too low to encourage producers to change design.[106]

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[101] EEA (2022) *Microplastics from textiles: towards a circular economy for textiles in Europe*.
[102] i: The Nordic Ecolabelling has the following requirements: firstly, fibre fragment loss from synthetic microfibre cloths and mops must not exceed a set limit; secondly, synthetic clothes and home textiles must be tested for loss of microfibre fragments by standardised methods. When the industry has collected enough data for a rating scale to be developed, Nordic Ecolabelling will set a limit value, and thirdly, textile services (laundries) are rewarded if they have installed filters that collect microplastics. See: Nordic Swan Ecolabel: *Reducing release of microplastic fibre fragments from textiles*.
[103] Nordic Swan Ecolabel: *Reducing release of microplastic fibre fragments from textiles*.
[104] European Bioplastics (2023) *Bioplastics market development update 2023*.
[105] Royer S-J, Greco F, Kogler M, Deheyn DD (2023) *Not so biodegradable: Polylactic acid and cellulose/plastic blend textiles lack fast biodegradation in marine waters*. PLoS ONE 18(5): e0284681.
[106] Röling J (FRF), Darut A (Minderoo) (2023) *LET'S RESHAPE EPR*.

Avoiding health risks:

- The ESPR Delegated Act on textiles must allow harmful chemicals only in exceptional cases where there is no alternative, like for PPE;
- All chemicals used to produce textiles should be proven safe and sustainable before they are used, in line with the EU's Safe and Sustainable by Design criteria. Hazardous substances recognised as carcinogenic, mutagenic and toxic for reproduction (CMR), endocrine disruptors (ED), persistent, bioaccumulative and toxic (PBT), and very persistent and very bioaccumulative (vPvB) should be restricted from use during production, use, and disposal of textiles;
- A legal requirement on the declaration of chemicals in textiles to inform stakeholders with specific needs (allergenic consumers, recyclers etc.);
- Circular material flows can only be safe if they are free from hazardous chemicals or if hazardous chemicals that cannot be phased out are strictly regulated. When mandatory requirements for recycled content are introduced, the same restrictions on toxic chemicals should be ensured for virgin and recycled fibres;[107]
- Strict enforcement of rules is needed, in particular in online sales.[108]

Synthetic fibres:

- Adopt a roadmap to phase out fossil plastics in the EU market and support a phase-out in the UN Plastics Treaty;
- Adopt and enforce the principle of the cascading use for biomass in bioplastics—meaning use of material for durable products that are reusable and recyclable;
- Ensure the use of recycled content over virgin input *via* strict recycled content requirements in the ESPR Delegated Act (DA) for textiles;
- Ensure proper labelling of bioplastics and recycled content in the implementation of the Empowering Consumers in the Green Transition Directive[109] and the Green Claims initiatives[110] and make this information available in the DPP for textiles;
- Update the EU Regulation on Deforestation-free products to include bioplastics.

Preventing the release of microplastics:

- Use the ESPR Delegated Act on textiles to set design criteria for microplastics prevention;
- Include the release of microfibers in all sustainability assessments of garments;[111]
- Use the Global Plastics Treaty to address microplastic pollution, including textile-related pollution outside of Europe;

[107] Wardrobe Change (2021) *Recommendations for the EU Strategy for Sustainable Textiles*.
[108] EEB (2021) *Online sales of unsustainable products will dodge EU environmental rules, warn NGOs and industry*.
[109] *Directive (EU) 2024/825*.
[110] European Commission (2023) *Proposal for a Directive on Green Claims*.
[111] Henry, Laitala, Grimstad Klepp (2019) *Microfibres from apparel and home textiles: Prospects for including microplastics in environmental sustainability assessment*, Science of The Total Environment, Volume 652, Pages 483-494, ISSN 0048-9697.

- Biodegradability of synthetic fibres in the natural environment must be certified by third-party assessment before any sustainability claim can be made on products.

From separate collection to local reuse

A recent life cycle assessment, as well as cost analysis by the JRC, have underscored that **reuse and preparing for reuse are the best options for textile waste when it comes to cost-effectiveness and environmental performance**.[112] It is, therefore, paramount that the reuse of textiles is facilitated at a much larger scale and done much closer to the source of waste generation.

Collecting as much as possible of post-consumer waste but also taking into consideration post-industrial waste is the first step when moving from a linear to a circular approach. Two factors impacting the collection in the near future are the 2025 mandatory separate collection and the requirement to introduce EPR schemes across the EU from around 2027 (the WFD is still under revision by the time this paper is published).

Given the lack of separate collection capacity demonstrated in the introduction of this paper, ZWE has previously investigated the state of play in the field and identified some good practices to effectively collect, sort and reuse post-consumer textiles at the local level.[113] One key finding is that **good governance is central when setting up a successful system**. Authorities, both local and national, should ensure there is alignment between the local governance structure, national laws, and the wider policy framework, assuring that all actors can act confidently within a high-performing system. For example, the system could be run by a public waste agency, social enterprise, or private company, depending on the local context. Therefore, clarity on the roles and responsibilities, established within a clear governance structure, is paramount. With the incoming requirement of textile separate collection from 2025, municipal waste management companies will become increasingly active in spaces where thus far, charities and commercial operators were dominant. However, municipalities could contract charities and commercial collectors to continue handling the collection.

In some good practices, social policies were successfully linked to circular economy objectives to create employment opportunities and boost local reuse, for example, in Flanders, Belgium.[114] As separate collection *via* EPR systems are designed in the coming years, policymakers should test the options for greater social economy support and integration of social enterprises in the system, e.g. make sure public tenders use the possibility of including social criteria to create a level playing field for social economy actors.

Policymakers should also consider the future introduction of EPR schemes for textiles and the subsequent cost-coverage by producers. For example, it can be expected that some retailers will introduce or expand in-store collections, which has the potential to disrupt existing models.[115] Data collection by any actor involved is key to improving the system in the long run and preventing mismanagement. Policymakers at national and

[112] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union.*
[113] ZWE (2023) *How to collect, sort, and reuse textile waste locally?*
[114] Kringwinkel (2024) *About Kringwinkel.*
[115] EuRIC (2023) *LCA-based assessment of the management of European used textiles*

local levels should consider setting targets for collection and coordinating all actors involved, as this has shown benefits for the transparency and simplicity of the system and for engaging with citizens.

Collection systems are immature and only just emerging in many EU countries. Therefore, getting it right now, during the initial system design phase, can save a lot of time later on for local authorities. Evidence shows that textile collection should be provided *via* branded containers, preferably in dry, clean, safe, and supervised environments that are convenient for citizens and provide clear information on what to donate. Different reuse actors could even share one branded collection system, which can help increase citizen engagement.[116] One good example of coordinated collection is 'De Collectie' in Antwerp.[117] Trialling alternative collection systems can be worthwhile, too: for example, introducing deposit-return-systems for textiles or door-to-door collection models has proved effective in some contexts.[118] [119]

ZWE found that the best models offer collection first and then follow this up by **sorting for reuse conducted by professionally trained personnel**. Despite technological advancements, manual sorting still remains important to correctly judge the reusability of a garment. Clear sorting guidelines should be established and harmonised across the state or region. Sorting for local reuse is preferable, reducing the emissions from transporting textiles and the risk that these materials will end up being exported outside the EU. This would require a change of business model for some actors that are heavily export-dependent. Including textile recyclers in the sorting process can have benefits for the recycling of non-reusable textiles (outlined in more detail in the section on recycling).[120]

When taking a closer look at end-markets for reusable textiles, it becomes obvious that more traditional reuse markets are declining due to increased **pressure from cheap new products** from Asia and increasing use of C2C platforms by consumers (e.g. Vinted). The shrinking proportions of high quality or 'crème' part of collected textiles impacts how profitable manual textile sorting is for operators. Moreover, **non-reusable used clothing typically accounts for at least 20% of collection, while it has very little value for the operator's income when sent for recycling (less than 3%).**[121] It is, therefore, important to boost the profitability of reuse operators.

Most reuse actors today are charities and social enterprises; municipalities should therefore seek to increase the capacity of the existing system rather than starting from scratch. Simultaneously, municipalities should prioritise looking for ways to further **promote a culture of local reuse** by, for example, providing space and funding for more reuse stores, repair, and upcycling activities and bringing textile reuse to existing social spaces. As reuse competes with cheap fast fashion clothes, communication campaigns should be utilised to

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[116] ZWE (2023) *How to collect, sort, and reuse textile waste locally?*
[117] *De Collectie*.
[118] New Optimist (2024) *Statiegeld*.
[119] ACR+ (2023) *Recommendations and good practices for local used textile management*.
[120] ZWE (2023) *How to collect, sort, and reuse textile waste locally?*
[121] EuRIC (2023) *LCA-based assessment of the management of European used textiles*

raise awareness of the benefits to the local community. Granting preferential access to collection contacts *via* **public procurement to social economy actors**, as is the practice in Spain,[122] supports those actors.

Another option to alleviate the financial burdens of the reuse sector is a smart design of **EPR schemes for textiles**: EPR for textiles, as proposed by the European Commission,[123] is supposed to finance collection, sorting, and information campaigns, but it can also play a more active role in funding reuse. In France, for example, a fund for reuse supports social enterprises.[124] Moreover, the introduction of targets for reuse and local reuse can contribute towards channelling resources from the Producer Responsibility Organisations (PROs) to the infrastructure for local reuse. The Dutch and French EPR systems already introduced reuse targets; e.g., the Netherlands introduced a 75% target for preparation for reuse and recycling by 2030, of which at least 25% needs to be prepared for reuse; and 15% for local reuse.[125] [126]

Defining and harmonising what is considered a product and what is 'waste' in legislation will be key for more efficient handling of used textiles. The **End-of-Waste (EoW) criteria for reusable textiles** is an important tool for this. The WFD defines waste as '*any substance or object which the holder discards or intends or is required to discard*, 'however, this is interpreted very differently across Member States. For example, in Austria, Germany and the Netherlands, collected textiles from bring banks are considered waste while other member states define those as a product. Handling waste often requires a special permit and the waste status affects under which conditions it can be shipped across borders.[127] Some important considerations for this process are, firstly, that social enterprises operating collection and sorting of textiles must be respected. Secondly, EoW for reuse should only be granted after sorting and preparation for reuse has been completed by a certified preparation for reuse operator, ensuring that the items can be reused safely. Thirdly, the introduction of a clear definition of donations and, lastly, sorting and preparation for reuse must include predefined steps, including a final manual check instead of relying entirely on automated sorting.[128]

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[122] Spanish 'Law on Waste and Contaminated Soil for the Circular Economy' - Ley 7/2022, de 8 de abril, de residuos y suelos contaminados para una economía circular (Available here).
[123] European Commission (2023) *Proposal for a targeted revision of the Waste Framework Directive.*
[124] RREUSE (2020) *France to create a Solidarity Re-use Fund (and other re-use friendly measures)!*
[125] Government of the Netherlands (2023) *Infographic: extended producer responsibility for textiles.*
[126] i: Targets in the French EPR scheme: Collection: 60% by 2028 (based on volumes put on the market, in tonnes); Recycling: 70% by 2024, 80% by 2027 (based on volumes collected, but not reused - in tonnes); Specific recycling target for garments that have at least 90% plastic composition: 50% by 2025, 90% by 2028; Disposal should not exceed 0,5% of the volumes that are collected (in tonnes); Repair target: +35% by 2028 compared to 2019 (based on the number of repair actions apart from guarantee); Reuse target: 120 k tonnes by 2024 (unsold items excluded); Local reuse target (less than 1500 km from the collection point): 8% by 2024, 15% by 2028 (based on the total reuse volumes, in tonnes).
[127] European Commission (2022) *The Commission starts to develop end-of-waste criteria for plastic waste.*
[128] RREUSE (2024) *Guiding Principles on textiles collection and management.*

Circular business models to boost reuse, repair and upcycling

Social economy actors play a key role when it comes to supporting labour-intensive circular activities, like sorting, repair, and upcycling. The EU Social Economy Action Plan acknowledges this and aims to enhance social investment and support social economy actors in starting and scaling up.[129] In the absence of those actors, the commercial sector also holds important levers to contribute to reuse. Vintage shops, C2C platforms, and brands' take-back initiatives can contribute to increasing reuse and raising consumer awareness, albeit without creating social impact. They also have to be scrutinised carefully on a case-by-case basis to ensure they have the effect of an overall reduction in consumption of new garments.

Vinted, Europe's most popular second-hand market for clothes, has increased its revenue from 10 to over 370 million U.S. dollars between 2017 and 2022.[130] In 2022, Vinted saw 51% more sales than the year before. The global second-hand clothing market is projected to double in size by 2027, outpacing the overall market three times.[131]

Facilitating reuse *via* resale of fast fashion textiles can drive further purchasing of new garments. Major brands have already launched their own resale platforms to secure a piece of the growing resale business cake[132], but some brands offer store credits instead of cash, tying resale to continued consumption.[133] Take-back schemes for vouchers can increase collection but do not contribute towards a zero waste textiles sector as it is questionable whether this will replace new purchases.[134] However, the brand's own take-back scheme also holds the opportunity to make pre-owned clothes more attractive to consumers with reservations against second-hand buying.[135] [136] [137] If brands choose to take back without vouchers, offer repairing, redying, remodelling and/or recycling of their own clothes, following the waste hierarchy, they should be rewarded *via* sustainability classifications, like the EU Taxonomy.[138]

Promoting **repair** remains a key circular strategy.[139] Since repair is frequently disregarded by consumers due to its higher costs compared to purchasing new items,[140] economic incentives are needed. This can include repair

[129] European Commission (2024) Social Economy Action Plan.
[130] Statista (2024) Second-hand e-commerce in Europe - statistics & facts.
[131] The Guardian (2023) Online marketplaces report surge in sales of secondhand goods.
[132] ThredUp (2023) Resale Report 2023.
[133] Good on you (2022) Fast Fashion Brands Launching Resale Platforms: Circular or Cynical?
[134] Armedangels (2024) Recycling with Benefits.
[135] Armedangels (2024) Second Hand.
[136] COS (2024) COS Resell.
[137] Zara (2024) About Zara Pre-owned.
[138] European Commission (2024) EU taxonomy for sustainable activities.
[139] Eco Ege (2024) THE MOST COMMON WAYS TO MEND YOUR CLOTHES; Fixing Fashion; Repair What You Wear; Re/make.
[140] ADEME (2014) Perceptions et pratiques des Français en matière de réparation des produits.

funds *via* eco-contribution, like in France,[141] repair bonuses or vouchers, like in Germany and Austria, but also VAT and labour cost reduction for repairs, as implemented in Sweden.[142] Some brands have already started offering free repairs for their own products—a circular business model that should receive support where possible.[143] Moreover, additional funding allocated to training individuals to become repairers, whether within social economy enterprises or other informal settings, can help meet the increasing demand for repair expertise in the labour market. Similarly, training citizens and raising awareness *via* public education, training programs, and school curricula can contribute to keeping materials in the loop.

Lastly, so-called '**upcycling**' is a good alternative to recycling the fibres. '*Upcycling refers to the practice of turning one final product into a new one with a new purpose giving it the same or even higher value (therefore upcycling). The emphasis here lies on 'new purpose'; it is not about repairing or refurbishing an item to give it back (some of) its original functionality.*' according to Texroad.[144] 'Remanufacturing' is another term to describe a non-destructive way of repurposing material and will be defined in EU law under ESPR.[145] Some good examples are brands like UNBEGUN, 1-OFF PARIS, and RE/DONE.[146] Provided the difficulties of recycling, outlined in the next section, upcycling materials holds significant benefits for circularity.

Recommendations

- Introduce **economic incentives** like repair bonuses or vouchers and VAT or labour cost reductions for repair and upcycling businesses;
- Ensure priority access for **social economy actors** to public tenders for collection;
- Mainstream the **best practices** identified for local collection, sorting, and reuse;
- Increase demand for **local reuse;**
- Design the **EU taxonomy**[147] for the textiles sector in accordance with the above-mentioned activities to channel investments towards businesses making a contribution to repair, reuse or upcycling/remanufacturing and excluding businesses that risk fuelling further consumption of new garments; e.g. classifying take-back schemes against vouchers as non-circular;
- Define **EoW criteria** for reuse of textiles in line with the waste hierarchy;

[141] Bonus Réparation (2024) *TOUT SAVOIR SUR LE BONUS RÉPARATION.*
[142] i: The Swedish government has proposed a reduction to 6% VAT from July 2022.
[143] *Nudie Jeans.*
[144] *Texroad Foundation (2022) Upcycling.*
[145] European Parliament (2023) *Deal on new EU rules to make sustainable products the norm.*
[146] *1/offParis; Unbegun; Re/done.*
[147] i: The taxonomy is a classification system that defines criteria for economic activities that are aligned with a net zero trajectory by 2050 and the broader environmental goals other than climate. See: European Commission (2024) *EU taxonomy for sustainable activities.*

- Mandate that all EPR schemes in the EU set **reuse targets**, inspired by the newly introduced EPR for textiles in the Netherlands,[148] as well as the long-standing French EPR scheme.[149] France already set a 60% separate collection target for 2028, and the Netherlands have a 75% preparation for reuse and recycling target by 2030, of which at least 25% needs to be prepared for reuse; including a specific sub-target for local reuse of 15% by 2030 that requires reuse within less than 1500 km from the collection point;
- Earmark EPR fees to support a **fund for change and justice** that allocates at least 10% of the EPR fees to reuse (5%) and repair operations (5%) to make this sector more profitable and create local jobs, similar to the fund in France that targets social economy actors.[150]

Global circularity vs. textile waste exports

As already outlined above, a large fraction of reusable clothing is exported from Europe, with Africa and Asia being the main destinations. Large fractions of the textiles are likely not reused and therefore contribute to adverse environmental and social impacts. **Between 2000 and 2019, textile exports from Europe almost tripled**. Before being exported, textile waste is traded between EU Member States, making it very difficult to trace from where the exported textiles originate.[151]

The international commodity codes for textiles are 6309 (worn textiles and clothing) and 6310 (sorted and unsorted used rags and textile waste). EU exports have mainly been classified as 6310, however, whether the exported goods actually correspond with the classification is unknown. Without a code for waste, it remains challenging to track exports.[152] Data from the UN shows that EU exports have steadily increased up to the COVID-19 pandemic (2020) while the value has peaked in 2013 and since declined (Figure 9). This decline in value was caused by the surge of fast fashion, i.e. cheap and low-quality garments, but also by the fact that the so-called 'cream' fraction of the collected textiles are resold in Europe, while lower-value items are exported, reinforcing post-colonial inequalities.[153] [154]

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[148] Government of the Netherlands (2023) *Infographic: extended producer responsibility for textiles.*

[149] i: Targets in the French EPR scheme: Collection: 60% by 2028 (based on volumes put on the market, in tonnes); Recycling: 70% by 2024, 80% by 2027 (based on volumes collected, but not reused - in tonnes); Specific recycling target for garments that have at least 90% plastic composition: 50% by 2025, 90% by 2028; Disposal should not exceed 0,5% of the volumes that are collected (in tonnes); Repair target: +35% by 2028 compared to 2019 (based on the number of repair actions apart from guarantee); Reuse target: 120 k tonnes by 2024 (unsold items excluded); Local reuse target (less than 1500 km from the collection point): 8% by 2024, 15% by 2028 (based on the total reuse volumes, in tonnes).

[150] REEUSE (2020) *France to create a Solidarity Re-use Fund (and other re-use friendly measures)!*

[151] EEA (2023) *EU exports of used textiles in Europe's circular economy*.

[152] Waste Management World (2023) *Bye bye bye: Europe's problem with used textiles exports*.

[153] Greenpeace (2023) *How fast fashion is fuelling the fashion waste crisis in Africa*.

[154] EEA (2023) *EU exports of used textiles in Europe's circular economy*.

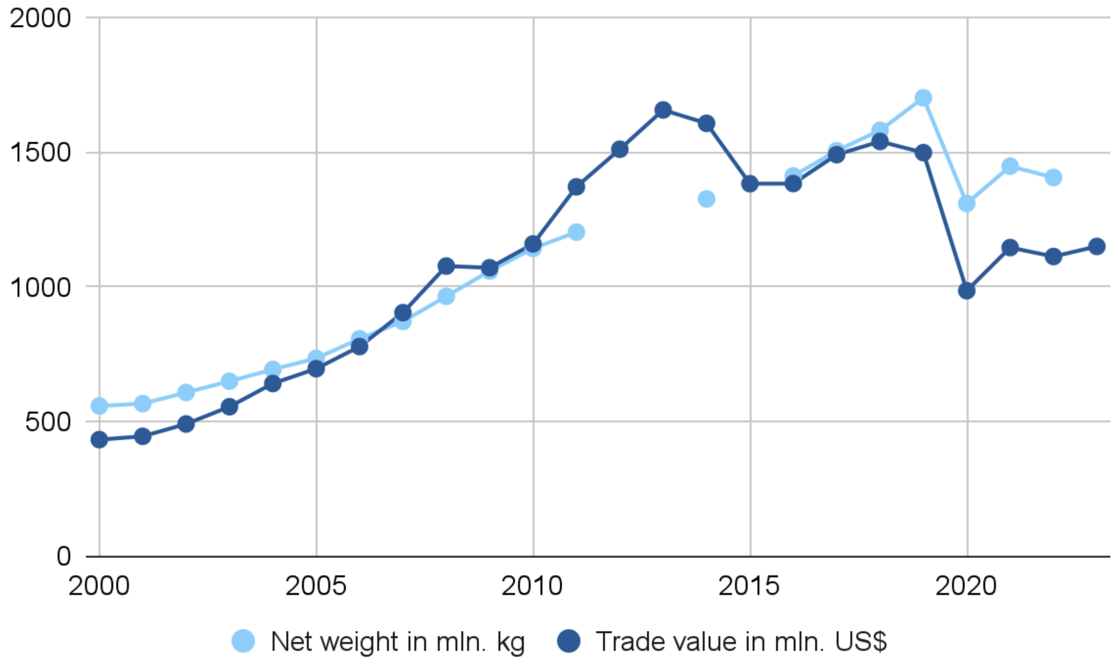

Figure 9: Data from UNcomtrade database for EU-27-extra exports for codes CN 6309 and CN 6310 in net weight (kg) and trade value in US$ (data not available for every year)[155]

The demand for imported second-hand clothes in recipient countries is driven by the value for the local reuse economy. However, volumes not sold for reuse end up burned, in landfills, or discarded in the environment. The EEA recently estimated that **40% of what arrives in Africa for reuse is actually waste** going mainly into landfills. In comparison, in Asia, imports for reuse are restricted to protect the local garment production. Most textiles arriving in Asian countries are sorted and downcycled into rags, while the remaining material is landfilled or re-exported.[156] [157]

When trying to determine the environmental benefits of European textile exports, we still face **many unknowns, and significant research needs** become obvious. If exports do not replace new consumption, the environmental benefits are slim; however, data on the use-time of second-hand garments is still scarce. The EEA raised the concern over exports eventually causing more environmental damage than recycling waste in Europe.[158]

Reports from recipient countries in the Global South have highlighted the devastating impact of the high volumes of imports that end up mismanaged. In **Ghana**, campaigners have raised concerns about the pollution of water, soil, and ecosystems caused by mismanaged imported textiles. Kantamanto Market in Ghana's capital, Accra, is the main importing hub for used clothing from the West and has been overwhelmed for some time by low-quality fast fashion items that do not meet local demand. The share of good-quality items that can be

[155] UN *Comtrade Database*.
[156] EEA (2023) *EU exports of used textiles in Europe's circular economy*.
[157] Tony Blair Institute for Global Change (2021) *Tackling Ghana's Textile-Waste Challenge*.
[158] EEA (2023) *EU exports of used textiles in Europe's circular economy*.

resold in the imported bales has been decreasing for years. The unsold clothes become waste and often get washed into the sea or other water bodies, endangering marine life and leaching microplastics and chemicals into drinking water.[159 160]

Reports from **Kenya** show that one in three pieces of used clothing shipped to Kenya contains plastic, exposing a double standard in the treatment of plastic waste—which is restricted under EU law—compared to textiles. Evidence also shows that the waste causes pollution of local ecosystems from microplastics and toxic chemicals.[161]

In **Chile**, illegal dumpsites and open burning of textile waste have spread across the Atacama Desert, with the practice continuing until this day without government intervention. An investigation into the origins of imported textiles to Chile under customs code 6309 revealed that almost 50% of the imported textiles do not specify a country of origin (only country of acquisition), underlining the intransparent trade routes textile waste takes.[162]

One climate impact often overlooked is the **significant methane emissions from mismanaged landfills including textile waste, where** methane (CH4) is released when the biodegradable parts in textiles decompose.[163 164]

Several countries have enacted **import bans** for textile waste. The East African Community agreed on a complete ban on imports of used clothing by 2019, yet Rwanda was the only country to implement it. The United States reacted in 2018 by suspending Rwanda from exporting clothing duty-free to the United States.[165] To protect their own local textile industry, Uganda has enacted a ban in 2023.[166] Illegal imports, however, remain difficult to trace and prevent, while reuse traders and customers in Uganda opposed the ban.[167 168]

How to ensure that recipient countries benefit from European exports? Second-hand clothing imports can create local jobs and cater to local demand for affordable clothing. However, civil society campaigners have long called for an end to the current form of 'waste colonialism' in Africa, making demands for waste streams beyond textiles.[169] Demands are for more waste prevention, the right to refuse shipments through the Prior Informed Consent (PIC) mechanism, enforcing existing legislation like the Basel and Bamako conventions,[170] recognising the role of waste pickers, and promoting measures under the Global Plastic Treaty.[171]

[159] DW (2022) *Used clothes choke Ghana's markets, ecosystem.*
[160] The or foundation (2024) *Mission.*
[161] Changing Markets (2023) *Trashion: The stealth export of waste plastic clothes to Kenya.*
[162] GAIA (2023) *III Reporte.*
[163] Faircade (2023) *The Environmental Impact of Textile Waste: 5 Ways It Impacts Our Planet.*
[164] Moazzem, Wang, Daver, Crossin (2021) *Environmental impact of discarded apparel landfilling and recycling,* Resources, Conservation and Recycling, Volume 166, 105338, ISSN 0921-3449.
[165] DW (2018) *East Africa pushes second-hand clothing ban.*
[166] Reuter (2023) *Uganda bans imports of used clothing from 'dead people'.*
[167] Africa News (2023) *Ban on Second-Hand Clothing Threatens Livelihoods in Uganda.*
[168] Le Monde (2023) *How is Uganda trying to revamp its textile industry? By banning used-clothes imports.*
[169] GAIA (2023) *Stop Waste Colonialism.*
[170] UNEP (2024) *The Bamako convention.*
[171] UNEP (2024) *Intergovernmental Negotiating Committee on Plastic Pollution.*

Relevant EU legislation addressing textile exports are the **Waste Framework Directive (WFD)**[172] and the **Waste Shipment Regulation (WSR).**[173] To ensure that only high-quality, reusable garments are exported, the proposal for a review of the WFD stipulates that Member States shall ensure that, in order to distinguish between used and waste textiles, products suspected of being waste may be inspected by the competent authorities for compliance with the minimum requirements for the shipments of used textiles, and evidence of a prior sorting operation must be provided.[174] Professional sorting should hence allow for a clear distinction between waste and used textiles suitable for reuse. However, whether the exported textiles that underwent prior sorting and are reusable in theory are reused in practice remains uncertain and depends heavily on the local context. The shipments of waste textiles (destined, for example, for recycling or preparing for reuse, such as further sorting or repair) will remain subject to the WSR.[175] The text of the revised regulation does not stipulate specific restrictions for the export of textile waste; however, it introduces a ban on exports of non-hazardous plastic waste to non-OECD countries unless they declare their willingness to import waste and meet waste management standards.[176] A measure that should also be considered for textile waste exports due to the prevalence of plastic material in textiles. The incoming **EoW criteria for textiles** are likely to have a huge impact on shipments, as textiles that obtained the EoW status will be able to be shipped as products instead of waste.

However, even with the described changes to the WFD and WSR, textile waste can continue to be exported freely under the **Basel Convention,** which regulates the global Transboundary Movements of Hazardous Wastes and their Disposal.[177] Unlike plastic and electronic waste, exporters are not obliged to obtain prior informed consent (PIC) from the importing state, nor are there requirements to ensure capacity to manage the textile waste in an environmentally sound manner. A few EU Member States have therefore called on the European Commission to put forward a proposal on subjecting textile waste to the control mechanisms of the Basel Convention; the proposal should follow the same approach taken to regulate electronic waste and require PIC to be obtained and banning the export of hazardous textile waste.[178]

One idea to facilitate the management of textile waste in an environmentally sound manner outside the EU is to introduce a **global EPR scheme for textiles.** The proposed mandatory EPR for textiles in the EU under the revised WFD[179] could be updated to include a fund for scaling waste management capacities in recipient countries. Campaigners have also put forward the idea of EPR fees travelling with the exported garment to ensure global accountability of producers and internalise waste management costs that otherwise are borne by municipalities.[180] Yet, such an initiative must not lead to perverse incentives to export more waste to save waste management costs in Europe and can, therefore, only be successful if introduced in tandem with

[172] European Commission (2024) *Waste Framework Directive.*
[173] European Commission (2024) *Waste shipments.*
[174] European Commission (2023) *Proposal for a targeted revision of the Waste Framework Directive* (Article 22d 7-9).
[175] Council of the EU (2024) *Presidency note with questions for Ministers.*
[176] European Council (2024) *Waste shipments: Council signs off on more efficient, updated rules.*
[177] *Basel Convention.*
[178] Council of the EU (2024) *Information from the Danish, French and Swedish delegations.*
[179] European Commission (2023) *Proposal for a targeted revision of the Waste Framework Directive.*
[180] The Or Foundation (2023) *STOP WASTE COLONIALISM!*

pre-sorting for reuse and PIC for waste exports. To achieve **global circularity,** it is important to feed recycled material back into the manufacturing process only when the recycled materials meet safety requirements. However, the '**principle of proximity**'[181] must always apply in the waste management sector, therefore, requiring waste to be recycled close to the source. If international standards and independent third-party certification schemes for recycled content are enforced in the future, recycled material from outside the EU could be placed on the EU market.

Recommendations

- Amend the Basel Convention to include a code for textile waste and require textile exports to follow the same approach taken for electronic waste, i.e., Prior Informed Consent (PIC) to be obtained and a ban on the export of hazardous textile waste;
- Stringently enforce existing legislations like the Basel and Bamako conventions and undertake swift return-to-sender actions on illegal shipments;
- Countries that choose to restrict imports must not be pressured into reopening their borders;
- Support waste management capacity in recipient countries either *via* a global EPR fee or other funds;
- Adopt national systems that allow waste pickers to be part of all decision-making processes in waste management;
- Ensure that the Global Plastic Treaty reflects the local plastic pollution realities and addresses the problems of plastic across its entire value chain, especially through a strict cap on the production of new plastic;
- Ensure proper monitoring of the new WFD requirements of pre-sorting and future EoW criteria for reuse. Increase the minimum number of regular inspections before shipment and enforce penalties for non-compliant operators.

Recycling

Recycling further enhances the circularity within the textile industry and should happen after waste prevention and reuse in line with the waste hierarchy. It is estimated that less than 1% of textiles is recycled back into textiles.[182] Currently, the EU's recycling capacity is approximately 0.70-0.85 Mt per year, with cleaning wipes and non-wovens as the main output. Capacity could climb to a total of 1.5-2.0 Mt yr by 2035.[183] The following section will take stock of different technologies, barriers to scale recycling, and lay out a zero waste vision for textile recycling.

[181] EEA (2024) *principle of proximity*.
[182] Ellen MacArthur Foundation (2017) *A New Textiles Economy - Full Report*.
[183] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.

Sorting and pre-treatment for recycling

Textile recycling starts with a preparatory phase, including sorting and removal of any potential disruptors like buttons and zippers. The more uniform the input enters into the recycling process, the better quality the process will deliver.[184]

The sorting process involves categorising textiles according to their material composition to achieve a more consistent input to simplify the recycling process.[185] Technological developments are directed towards automating textile sorting to streamline recycling procedures. One example is the company Tomra, which operates the first automated sorting machines for textiles in Malmö (Sweden). Automation offers advantages such as efficiency and cost-effectiveness compared to manual sorting for recycling and can better identify fibre types.[186]

For contaminated textiles like post-consumer clothes, carpets, and unwashed textiles, the pretreatment step includes a cleaning step as a prerequisite, which is not the case for industrial and pre-consumer textile waste.

Different technologies

The following section aims to provide an overview of the different technologies for textile recycling, assessing the input and outputs and underlining the differences between mechanical recycling, chemical recycling, and chemical recovery.[187]

Mechanical recycling of textile waste relies on consecutive physical and mechanical actions, meaning that the chemical composition of the garment remains unchanged throughout the process. Mechanical recycling can process any kind of textile waste, material type (synthetic, natural, or blends), types of textile products (carpets, yarns, fabrics, used garments) and structures (knitted, woven, or non-woven). However, to guarantee high quantity and quality, the input should be as homogeneous as possible. Therefore, textile waste is preferably sorted by material and colour as this process cannot separate blends or filter out dyes.[188]

The process starts when textile waste is cut into smaller pieces, which are later fed into a tearing machine. The latter 'opens' the garment under the rotating cylinder's action, resulting in individual textile fibres.[189] Once fibres are opened, they are blended to ensure a more consistent output, which can be spun into new yarn afterwards. Mechanical action affects the quality of the fibre, leading to a reduction in its length and strength. It has been estimated that tearing technologies only generate between 25% and 55% of fibre longer than 10 mm[190] while

[184] Tex-Med Alliances (2022) *A Study on technologies for recycling and re-use of textile scraps*.
[185] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[186] Tomra (2024) *Textiles.*
[187] Similar classification and the reasoning is available here.
[188] Tex-Med Alliances (2022) *A Study on technologies for recycling and re-use of textile scraps*.
[189] i: This process is described under different terminologies - opening, tearing, pulling and unravelling.
[190] Tex-Med Alliances (2022) *A Study on technologies for recycling and re-use of textile scraps*.

the preferred fibre length for spinning is longer than 15 mm. Fibres with lengths between 10 to 15 mm are spinnable but they will not or rarely contribute to the yarn strength. The shorter fibres cannot serve as input for a spinning process, however, they can be used as filling materials for insulation or the automotive industry. The output from mechanical recycling is, therefore, strongly linked to the input fed into the system. This also means that if textiles are contaminated with chemicals during use, contaminants will remain after recycling. This recycling process has the lowest environmental footprint in comparison to the following ones, as it requires a small amount of resources to operate and is already fully functional.[191] Only mechanical recycling retains the original properties of the fibre, meaning that the immediate reprocessing into a new fibre is possible if the length and strength requirements are met. Research and development are now focusing on increasing the amount of spinnable fibre and improving the quality of the fibres that are recycled.

Chemical recycling of textile waste relies on the use of chemicals to modify the chemical composition of textile waste input to a different degree (polymer, monomer). This can cover different processes, such as the pulping process or depolymerisation.
The **pulping recycling process works with cellulose fibre garments like cotton and requires a high level of purity**. Chemicals and water are needed in addition to the cotton for bleaching, washing, and pulping steps. The process starts with cotton cellulose in a liquid with chemicals to depolymerise the fabric, resulting in a so-called 'dissolving pulp' which can be reprocessed back into man-made cellulosic fibres through a spinning process.[192] The cellulose recovery process can be repeated several times, however, the polymer chain degrades with each repetition, requiring blending the outcome with wood pulp, to be processed into traditional, custom spinning processes for man-made cellulosic fibres.[193]
There is a diversity of pulping processes using various solvents which can involve toxic chemicals, leading to different environmental impacts. Recycling textile waste through a pulping process should not involve the use of hazardous chemicals and aims to operate in a closed-loop system. For a cellulose-based garment, recycled content from other cellulose materials such as wood or paper/cupboard is added resulting in so-called 'downcycling' of paper. This is the case for the Ioncell® technology[194] that transforms paper waste into new textile fibres through dissolving pulp which is afterwards used to create new garments.

The **depolymerisation process is supposed to work with any synthetic fibre** made from Polyethylene terephthalate (PET) and Polyamide 6 (PA6). However, in reality, technology holders request a minimum of 80-90% of PET or PA6 with only light contamination from other materials.[195] More concretely, eligible inputs for PET for fibres are mostly post-consumer food packaging materials and industrial waste. Recycling of PET-based textiles is still nascent.[196] For PA6, eligible inputs are carpets, fishing nets, and industrial waste.[197]

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[191] EuRIC (2023) *LCA-based assessment of the management of European used textiles*.
[192] Duhoux, T. and all, (2021) *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling*.
[193] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[194] Finix (2024) *We need a sustainability revolution in how we make, use and dispose of textiles.*
[195] Tex-Med Alliances (2022) *A Study on technologies for recycling and re-use of textile scraps*.
[196] Duhoux, T. and all, (2021) *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling*.
[197] Tex-Med Alliances (2022) *A Study on technologies for recycling and re-use of textile scraps*.

The process works based on a solvent and various elements such as temperature, pressure, time, and catalysts, creating different reactions. Different components are introduced depending on the chemical composition of either PET or PA6. In the case of PET, the most common technique is based on glycolysis, with glycol used as a solvent, while for PA6, hydrolysis uses water as a solvent.[198] Another method based on a biochemical reaction through the use of enzymes is now available. The process works at room temperature under atmospheric pressure and without solvents.[199] One company using this process is Carbios.[200]

A third category of **technologies focuses on processing fibre blends**, which are typically made from cotton and PET, resulting in materials with multiple components (such as polycotton). These technologies aim to separate the different chemical components of garments, like cellulose and synthetic fibres. This separation process can be achieved through dissolution using solvents, although careful monitoring of material input is necessary. Another method involves a hydrothermal process working in an aqueous system with one or more acids under pressure and increased temperature.[201] Enzymatic recycling is a third approach for blended garments, where the fungus is cultivated on textile waste and recovered for use in textile waste hydrolysis.[202] The cellulose part of the garment is hydrolysed into cellulose and soluble glucose, while PET (or any other non-biodegradable material) remains intact and is separated as fibre *via* filtration.[203]

For the above-mentioned processes falling into the category of chemical recycling, **efficiency depends massively on the purity of the input material; the more uniform, the better.** In other words, many pretreatment steps are necessary to ensure a consistent material input. It should also be noted that **additional technical challenges arise with the presence of certain materials like elastane,** making material blends less desirable. A notable difference with mechanical recycling is that the type of input textile (knitwear, woven, non-woven) does not affect the output quality and that recycled material can be purified and separated, resulting in a colourless output.[204] However, from an environmental point of view, chemical recycling performs worse than mechanical recycling, notably due to the high impact of additives, chemicals, and energy input needed and/or solvents required by the process to work.

Chemical recovery of textile waste relies on a combusting process that heavily affects the chemical composition of the garment. Technologies falling under this category are pyrolysis and gasification.[205] In theory, any textile waste can be processed, regardless of the contamination and its quality, granting more flexibility than the technologies described above. However, in reality, the process conditions limit the input that

[198] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[199] Tournier. V., (2020) *An engineered PET-depolymerase to break down and recycle plastic bottles*.
[200] Carbios (2024) *Enzymatic recycling: removing the constraints of current processes*.
[201] Duhoux, T. and all, (2021) *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling*.
[202] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[203] Tex-Med Alliances (2022) *A Study on technologies for recycling and re-use of textile scraps*.
[204] Duhoux, T. and all, (2021) *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling*.
[205] DUH, ECOS, ZWE (2023) *Analysis from an environmental perspective of the proposed EU legal framework for pyrolysis and gasification*.

can be fed into the system. It is also important to know the composition of garments, which must be mostly made of synthetic fibres.[206]

The two processes are similar and divert from the traditional combustion process due to the low level of oxygen required.[207] Gasification occurs usually at 700-1100°C, while pyrolysis reaches 350-700°C.[208] Due to the combusting nature of these processes, a large amount of the input fed into the system is lost. In the case of pyrolysis, there is a significant leakage of plastic materials; around 53% of the carbon content is lost in the process or turned into fuels. This loss should be considered leakage of material from the circular management perspective.[209]

The output from this process is an intermediate of the chemical value chain, which is mainly used as fuel or can be used as basic chemicals requiring subsequent processing steps or diluting practices to upgrade the quality of the product to meet the system requirements in the case of pyrolysis.[210]

In comparison to mechanical and chemical recycling, pyrolysis and gasification processes have more flexibility in terms of the quality of the input while remaining dependent on the chemical composition of garments. However, due to the nature of the output, there is a risk of greenwashing when making claims about these technologies, **as the majority of the output material is used as a fuel rather than for the production of new textile products.**[211] In addition, the high environmental impacts, limited efficiency, and high energy requirements of these technologies should be used to make a clear distinction to ensure that more circular and environmentally sound processes are not mixed with these technologies under the same category of recycling.

Barriers to recycling

Various barriers, both economical and technological, are hindering the very much-needed systematic change towards textile recycling.

For the recycling process to work efficiently, the textile waste input has to be consistent in terms of type, i.e., woven or knitted, but also in chemical composition to prevent contamination. The way garments are produced is intrinsically problematic for the recycling process, as the widespread use of elastane mixed with other fibres blocks recycling if the concentration is higher than 10%.[212] Adequate knowledge and consistent quality of input are paramount for the output. In addition, access to feedstock remains key to enable scaling the technologies and is today one of the most important barriers for post-consumer textile waste recycling, which constitutes the majority of textile waste as outlined at the beginning. The obligation of separate waste collection as of 2025 introduced under the WFD should act as a lever to increase the amount of sorted textile waste sent to recycling.

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[206] Eunomia (2022) *Feedstock Quality Guidelines For Pyrolysis Of Plastic Waste*.
[207] Rollinson, A., Oladejo, J., (2020) *Chemical Recycling: Status, Sustainability, and Environmental Impacts,*
[208] Tex-Med Alliances (2022) *A Study on technologies for recycling and re-use of textile scraps*.
[209] Öko-Institut (2022) *Climate impact of pyrolysis of waste plastic packaging in comparison with reuse and mechanical recycling*.
[210] Zero Waste Europe (2023) *Leaky loop "recycling": A technical correction on the quality of pyrolysis oil made from plastic waste*.
[211] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[212] Duhoux, T. and all, (2021) *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling*.

However, the availability of separately collected textile waste does not directly mean an increase in recycling, as currently, waste disposal remains the cheapest option. To assess the economic viability, it is also important to consider the cost of recycled material in comparison to the price of virgin material, which is still cheaper, disincentivising the shift to using recycled content. The lack of understanding by producers as well as long supply chains limit the uptake of recycled content. All in all, technical, regulatory, and economic barriers result in a lack of funding for scaling and innovating textile recycling technologies.[213]

End-of-waste (EoW) criteria for recycling

The end-of-waste (EoW) criteria were introduced in the 2008 revision of the WFD to promote recycling while ensuring a high level of human health and environmental protection and define when waste ceases to be waste and becomes a secondary product.[214] **A sound definition of the EoW criteria for recycled textiles is key to promote a safe, truly circular, and harmonised recycling system**. The Commission's Joint Research Center (JRC) has started to work on EoW criteria for plastic and textiles as these sectors have insufficient secondary raw material markets.[215]

Behind the technical discussion on the EoW criteria, the definition of recycling itself is at stake here; in other words, when does the recycling process start, when does it end, and what is the output? From this perspective, it is key to ensure that the same rules apply to all technologies, as this will enable proper comparison both from input and output perspectives.

From an input perspective, it is key to ensure a broader application of the EoW criteria for textiles, meaning that all sources of textile waste should be considered. However, not all textile waste is equal when it comes to circularity and impact towards improving waste management systems in Europe. Indeed, the EoW criteria are closely linked to the issue of recycled content targets as an enabling factor to scale recycling.

From an output perspective, the **EoW criteria should only be granted to an actual textile article or to a fibre that is ready for direct conversion into a new textile product**, i.e. thread or yarn. In other words, it means that the output of all technologies will have a similar application within the textile sector, allowing a proper comparison between output from all technologies, both in terms of quality and quantity. This harmonised approach is technology-neutral and enables comparison in terms of technology and process in terms of efficiency, resources use and environmental impact in general (i.e. GHG emissions, water use, chemical use, etc.). In the case of pyrolysis, for example, such an approach recognises the need to apply the precautionary principle when trading pyrolysis oil, which is recognised as a mutagenic and carcinogenic substance by the ECHA.[216] It also recognises the need to highly dilute pyrolysis oil with virgin feedstock to be fed back into the chemical value chain.[217]

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[213] Duhoux, T. and all, (2021) *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling*.
[214] Joint Research Center (2009) *End-of-Waste Criteria - Final Report*.
[215] European Environmental Agency (2022) *Investigating Europe's secondary raw material markets*.
[216] European Chemical Agency (2023) *Substance Infocard - pyrolysis oil*.
[217] Zero Waste Europe (2023) *Leaky loop "recycling": A technical correction on the quality of pyrolysis oil made from plastic waste*.

Once the textile waste undergoes a recycling process and is granted the EoW status, it is reintroduced within the system as a product replacing virgin material, thus fostering a circular system.

Recycled content

One of the key enabling tools to enhance circularity within different sectors is the introduction of recycled content targets. For the textile industry, an important legislative development is the ESPR[218] and its respective delegated act for textiles[219], which introduce ecodesign requirements, including recycled content for textiles placed on the EU market.

With the introduction of binding recycled content targets, decision-makers are linking the production of new products to their end-of-life treatment, forcing the sector to integrate circular thinking from the production phase onwards. For the textile sector, this would mean introducing recycled content coming from textile waste. However, in practice, the majority of recycled polyester today is derived from PET bottles.[220] Such a practice is a growing source of concern when it comes to the accuracy of green claims on textiles as recognised by the EU Strategy for Sustainable and Circular Textiles.[221] In addition, the same strategy adds that the textile sector should **prioritise efforts to develop fibre-to-fibre recycling to close the loop for textile products**. This means increasing efforts related to design-for-recycling and removing materials that are very problematic for recycling by, e.g., finding alternatives for elastane.[222]

In order to increase circularity, recycled content requirements for textiles should be met primarily with recycled material originating from textile waste. In other words, **only textile waste should be allowed to count towards the recycled content targets for the textile sector.** Recycled content from other sectors—such as using recycled PET packaging into polyester—could be permitted for use in new textile applications but should not count towards recycled content targets. To fulfil the objectives, emphasis must be on post-consumer textile waste to ensure that the separately collected textiles will undergo proper end-of-life treatment other than disposal through incineration or landfilling. An emphasis on post-consumer could ensure that this waste stream can compete with pre-consumer or post-industrial waste, the latter two being easier to recycle because of their uniform composition and reduced amounts of unknown contaminants.

Recycled content claims are made at the product level, reflecting an engagement from brands towards circularity and traceability along the value chain through the use of chain of custody. The latter is used to describe the link between a verified unit of production and the claim about the final product.[223] **When adopting the methodology assessing recycled content for textiles, segregation and controlled-blending models should be prioritised over mass balance, as they ensure the highest level of traceability and**

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[218] Legislative Observatory (2024) *Ecodesign for Sustainable Products Regulation (Article 5).*
[219] European Commission (2024) *Textile products.*
[220] Eunomia (2022) *How circular is PET?*
[221] European Commission (2022) *EU strategy for sustainable and circular textiles.*
[222] Duhoux, T. and all, (2021) *Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling.*
[223] ISEAL (2016) *Chain of custody models and definitions.*

transparency.[224] This is key for consumer-facing companies to enable substantial claims towards consumers and avoid greenwashing.[225] The Dutch Authority for Consumers and Markets already criticised H&M and Decathlon for their misleading claims based on a credit-based system, as it disregards the traceability and damages trust in the environmental claims.[226] From this perspective, **when recycled material results from credit transfer, claims at the product level should not be allowed**.

Traceability along the value chain is not only highly important to avoid greenwashing but also to **ensure that the recycled materials used are as safe as textiles made of virgin materials and meet EU requirements.** However, this is often not the case, as shown in a recent report underlining the discrepancy between recovery substances and safety aspects: one in four substances recovered from waste was non-compliant with REACH.[227] It is of the utmost importance to ensure proper enforcement of the chemical legislation and to prevent any legacy substances from entering the recycling system by acting directly during the production phase. Introducing a product passport for textiles under ESPR would bring more transparency along the supply chain and have a positive impact on the safety of recycled content.

Such an approach should be systematic and apply to all products placed on the market, regardless of where the recycled material originates. **Recycled materials should meet the same requirements wherever they have been produced,** de facto introducing a mirroring clause for imported recycled materials as introduced in the Packaging and Packaging Waste Regulation (PPWR).[228] Such a clause is key for consumers' safety but also for the existing and growing recycling industry in Europe. With the possibility of importing recycled materials from outside the EU, the economic case for recycling in the EU will be much more challenging, especially if recycled content is produced in low-cost economies and with energy mixes that don't underlie carbon pricing similar to the EU.

Composting

As an alternative to recycling, different producers have developed so-called 'compostable textiles'. Companies have claimed that the output is 'Grade A' compost in accordance with the EU classifications, compostable together with food waste.[229] [230] While any such claim must first comply with the appropriate standards for compostability,[231] it is also pivotal to take the operationality of composting textiles into account. **While natural fibres can be composted in theory, we caution against too much optimism here as this path could lead to confusing consumers and contaminating waste streams.** Consumers are likely to not sort their textile

[224] Eunomia (2023) *A Comparative Assessment Of Standards And Certification Schemes For Verifying Recycled Content In Plastic Products*.
[225] ChemSec (2022) *Not quite 100% The Importance of Transparency in Non-Mechanical Recycling*.
[226] Dutch Authority for Consumers and Markets (2022) *Going forward, Decathlon and H&M will provide better information about sustainability to consumers*.
[227] ECHA (2022) *Forum Report on the pilot project on recovered substances exempted from REACH registration*.
[228] Legislative Observatory (2024) *Packaging and packaging waste.*
[229] i: The brand Puma made adjustments to the materials and shoe design to be fully compostable.
[230] Forbes (2023) *Mass Recycling Of Fashion Is Years Away; Is Composting An Alternative?*
[231] Tuv Austria *Ok compost*.

waste correctly and may contaminate bio-waste streams with non-compostable textiles. As long as compostable textiles are produced alongside non-compostable ones, this approach will inevitably cause confusion and risks contaminating household bio-waste with plastics, chemicals and other materials, making it unattractive to use the compost as fertiliser. Other practical obstacles are the presence of buttons, zippers and other accessories. One should also take into account issues occurring during collection: while textiles tend to be bulky, kitchen waste is more dense and heavyweight. Current collection systems are optimised to collect kitchen waste with comparatively small receptacles and lorries. Co-collection of bulky materials, such as textiles (and/or packaging), with kitchen waste, would, therefore, cause problems with the volume of adopted receptacles. Providing extra room in receptacles could lead to overcapacity if textiles are not discarded in them, making collection significantly more expensive. Consumers should, therefore, not be encouraged to discard biodegradable textiles in household bio-waste, but rather, following the waste hierarchy, discard them for separate collection to be sorted for reuse, and only if not reusable, recycled. Some biodegradable polymers can even cause issues for current recycling technologies. Whether composting is possible at an industrial scale depends on the sorting technology and capacity to separate biodegradable fibres from non-biodegradable ones. Similar issues arise due to the proliferation of biodegradable plastics in packaging.[232] In 2023, the EU Commission issued a non-binding policy framework for bio-based, biodegradable and compostable plastics, which states that **biodegradable plastic should only be used for a few very specific appliances**.[233]

Limits to recycling: end-of-life-treatment

There are always limits to material circularity; textile recycling, in particular, faces many obstacles due to the mixed fibre composition and fibre shortening after each recycling round, as outlined above. **Since there will always be leakage of material from the system that cannot be further recycled, residual waste treatment remains unavoidable. Instead of incinerating this material, we propose to opt for material recovery and biological treatment (MRBT) of residual waste**[234] to avoid a lock-in effect into incineration, avoid risking stranded assets,[235] mitigate GHG emissions and pollution.[236] With MRBT, recyclable materials are extracted, and the remaining non-recyclable waste is safely stored to sequester fossil carbon. The prior biological stabilisation of non-recyclable, yet biodegradable, waste is key to preventing methane (CH_4) emissions from textile waste biodegradation in landfills, for example, cotton or wool.[237] [238] This method also complies with the obligation on pretreatment stipulated in the Landfill Directive 99/31.

[232] GAIA (2022) *Bioplastic*.
[233] European Commission (2022) *Communication – EU policy framework on biobased, biodegradable and compostable plastics*.
[234] Zero Waste Europe (2024) *Material Recovery and Biological Treatment (MRBT)*.
[235] Zero Waste Europe (2023) *Enough is enough: The case for a moratorium on incineration*.
[236] Zero Waste Europe (2022) *The True Toxic Toll: Biomonitoring of incineration emissions.*
[237] Faircade (2023) *The Environmental Impact of Textile Waste: 5 Ways It Impacts Our Planet*.
[238] Moazzem, Wang, Daver, Crossin (2021) *Environmental impact of discarded apparel landfilling and recycling*, Resources, Conservation and Recycling, Volume 166, 105338, ISSN 0921-3449.

Instead of landfilling large amounts of incineration ashes, a circular, zero waste strategy applies the sorting of mixed waste so that landfilling is limited to only a few unrecyclable residuals. An essential part of this is the operation of mixed waste sorting (MWS), and some technological solutions have already been presented for textiles.[239]

A zero waste vision for textile recycling

Today, textile recycling remains a niche activity—less than 1% of textiles is recycled back into textiles.[240] For fibre-to-fibre recycling to succeed, change must happen during the initial production process of garments. Firstly, **transparency and traceability of materials and chemicals used in textiles should be expanded through a mandatory declaration of fibre composition and chemical uses** along the value chain. In the case of polyester, such information could improve recycling, as polyester is not only made of PET but also can be of PCDT, which has an impact on the choice of the process. This could be achieved *via* the digital product passport containing information on fibre composition, substances of concern, sourcing, maintenance, and disassembly.[241] Secondly, **recyclability requirements and design for recycling should be essential considerations when developing new products,** and the worst-performing textile products must be removed from the market. Thirdly, removing the non-textile part of the garment is necessary for all technologies, therefore, **easily disassembling the garment** should be ensured.

Currently, the majority of textile waste generated by households ends up in mixed waste, resulting in a high level of contamination. To mitigate this problem, the separate collection requirements for textiles entering into force in 2025 should ensure that this new feedstock source is directed towards recycling and not sent to disposal. Indeed, life cycle analyses show that recycling currently provides environmental benefits compared to incineration and landfilling, yet it also incurs greater operational costs. To leverage the potential of this **post-consumer waste stream, it is key that recycled content targets are put in place** while EPR fees cover all costs of the textile waste management system.

Recycling has a role to play in enhancing circularity, and the priority should, therefore, be to keep materials within the system for the same application for as long as possible. In other words, aiming to **close the loop with a high-quality recycling process**.[242] For the textile sector, it means recycling textiles into new textiles instead of using recycled material from PET bottles. This practice is problematic, as it is not possible to recycle the product back into its first application—PET bottles are 'downcycled' into polyester while it is not possible to

[239] Tomra (2024) *Textiles.*
[240] Ellen MacArthur Foundation (2017) *A New Textiles Economy - Full Report.*
[241] Lewe E., (2022) *What is the digital product passport for textiles?*
[242] i: 'High-quality recycling' means a recycling process ensuring that a product is efficiently and effectively recycled, and the distinct characteristics and quality of the material are preserved or recovered so as to ensure they can be used as a substitute for similar application and re-incorporated in products with the same market value, and allowing further recyclability of the same quality when reaching their end-of-life. Such 'distinct quality' should include, for example, 'fibre-to-fibre recycling'. 'Closed-loop recycling' means a process in which post-consumer waste is collected and recycled, which preserves the value of the material so it can be used again to make the same product category it derives from with minimal loss of quality or function.' More information available here.

produce PET bottles from a polyester garment. The diversity of technologies evolving in the sector and their different environmental impacts must be considered in the waste hierarchy. We therefore propose the following hierarchy in accordance with the most environmentally-sound technologies:[243]

- Mechanical recycling
- Chemical recycling
- Open-loop mechanical recycling
- Chemical recovery
- Disposal

EPR schemes can play a key role in improving the economic incentive for recycling as they finance collection, sorting, and recycling activities. Furthermore, legislators can set targets for collection and recycling that PROs have to meet. For example, the Dutch EPR system set a 50% target for textile products placed on the market to be recycled or reused by 2025 and 75% by 2030.[244] Also, the long-standing EPR scheme in France sets targets for recycling - 70% by 2024 and 80% by 2027 based on volumes collected but not reused.[245] Targets for EPR schemes set at the EU level will be essential to drive improvements of textile management in member states. Studies recommend specific targets for collection, preparation for reuse and recycling, which should be periodically reviewed to ensure that they are sufficiently ambitious.[246]

Moreover, eco-modulated fees could incentivise increased recyclability of textiles, with producers of non-recyclable textiles paying a higher fee.[247] However, the eco-modulation of fees is tied to the cost coverage of waste management under the WFD, resulting in a very small financial burden and, therefore, the fees have had no impact on product design so far.[248] **Targeted product taxation**, coordinated at EU level, could send price signals and help change consumer behaviour in favour of circular products. This measure should reflect the criteria of the ESPR and send strong price signals to the market that have not been achieved through EPR.[249]

Policymakers must, therefore, act decisively to improve the functioning of the secondary raw material market for textiles by improving traceability of materials and chemicals used in textiles, enhancing design for recycling, ensuring access to feedstocks as well as stimulating the demand for recycled fibres.[250]

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[243] 'Physical recycling' means a recycling process not affecting the chemical structure of waste input, which can either work based on mechanical or solvent-based processing. 'Chemical recycling' means the recycling process modifying the chemical structure of waste input, reprocessing polymer back to monomer and oligomer. 'Chemical recovery means an operation converting the polymer structure of waste input into molecules *via* chemical reactions, such as pyrolysis and gasification. More information available here.
[244] Stichting UPV Textiel (2024) *Extended Producer Responsibility for Textiles*.
[245] Zero Waste Europe (2023) *Joint statement on Extended Producer Responsibility for Textiles.*
[246] Eunomia (2022) *Driving a Circular Economy for Textiles through EPR - Final report*.
[247] Changing Market, EEB, ZWE (2022) *A new look for the fashion industry - Eu Textile Strategy and the Crucial Role of the Extended Producer Responsability*.
[248] Röling J (FRF), Darut A (Minderoo) (2023) *LET'S RESHAPE EPR.*
[249] Eunomia (2024) *Managing materials for 1.5°C*.
[250] European Commission (2023) *ERA industrial technology roadmap for circular technologies and business models in the textile, construction and energy-intensive industries*.

Recommendations

- Scale-up of pre-treatment and recycling capacity *via* public support and EPR schemes;
- Develop recyclability and design for recycling criteria for textiles under the ESPR DA and enforce compliance;
- Introduce waste management targets for EPR schemes to incentivise investment in recycling and fibre-to-fibre recycling;
- Create financial incentives *via* eco-modulation of EPR fees or product taxation;
- Adopt new definitions for 'closed loop recycling' and 'high-quality recycling' of textiles and update the definition of recycling and the waste hierarchy accordingly;
- Introduce harmonised EU-wide End-of-Waste criteria for textile recycling to the point where recycled material is ready to be included in a new textile article;
- Introduce recycled content requirements for textiles under the ESPR DA that consider only recycled textile waste as input;
- Ban claims about recycled content at the product level that are not substantiated with chemical and physical traceability;
- Introduce the mandatory declaration of material and chemical composition of textile products;
- Avoid false solutions like composting for textiles, especially when communicating to consumers, and ensure proper collection, sorting and treatment of material in line with the waste hierarchy;
- Ensure minimising material leakage and emissions from residual waste treatment by applying MRBT.

Conclusion

This paper has taken stock of textile circularity today and painted a sobering picture. More than 8 Mt of post-consumer textile waste are being incinerated or landfilled in the EU every year,[251] reuse and recycling of textiles are marginal, and exports from Europe to the Global South have been on the rise for over two decades.

However, this paper also aimed to identify the way ahead and outline a holistic vision for a truly circular textiles sector from a zero waste perspective. While being conscious of the current overuse of resources transgressing planetary boundaries, as outlined in the first chapter of this series,[252] we identified key barriers to a circular textile system but also many promising solutions.

Key barriers and solutions

- In order to shift to a **circular design and avoid health risks**, the implementation of circularity requirements under the ESPR Delegated Act for textiles is paramount. The current persistence of hazardous chemicals is endangering human health and hampering circularity. The ESPR Delegated Act must, therefore, ban the use of harmful chemicals in textiles and allow exemptions only for essential uses. Moreover, all chemicals used to produce textiles must be proven safe and sustainable before they are utilised, in line with the EU's Safe and Sustainable by Design criteria. Finally, strict enforcement of current and future regulation is needed, in particular for online sales.
- The current overreliance on **fossil-based synthetic fibres** has to be addressed; when virgin materials are used for production, they must come from bio-based and certified sources only. The EU must, therefore, adopt and enforce the principle of the cascading use of biomass in bioplastics—meaning the use of material for durable products that are reusable and recyclable. This measure must be applied in tandem with strict recycled content requirements, ensuring that safe recycled content is always preferred over virgin input. More generally, the textiles sector, like all sectors, should be subject to the Material Application Hierarchy.[253] Changing input materials can also contribute to addressing the health and environmental risks posed by microplastics pollution, alongside the use of design requirements under ESPR Delegated Act for textiles.
- **Local reuse** is currently hampered by a lack of local demand for second-hand clothing. The decline in quality and fast-changing fashion trends make it difficult for second-hand operators to compete with fast fashion retailers. It will therefore be paramount to increase demand for local reuse by introducing economic incentives like repair bonuses or vouchers, as well as VAT or labour cost reductions for repair and upcycling businesses. Recognising the role of social economy actors and ensuring priority access to public tenders for collection for social enterprises can combine social and circular benefits and increase local reuse rates. Lastly, earmarking EPR fees of current and future EPR schemes for textiles

[251] JRC (2023) *Techno-scientific assessment of the management options for used and waste textiles in the European Union*.
[252] ZWE (2023) *A Zero Waste Vision for Fashion – Chapter 1: All We Need Is Less*.
[253] Eunomia (2024) *Managing materials for 1.5°C*.

to support a fund for change and justice that allocates funds to reuse and repair operations can make the sector more profitable and create local jobs.

- To ensure **exports** of textile waste from Europe do not lead to social and environmental harm in recipient countries, it will be necessary to amend current EU legislation and the Basel Convention. An amendment to the Basel Convention should introduce a code for textile waste and require textile exports to follow the Prior Informed Consent (PIC) procedure. Moreover, sorting for reuse before exporting as well as the development and enforcement of End-of-Waste criteria for textiles are paramount. Since it remains contextual whether reusable textiles are reused, it remains important to invest in waste management capacity in recipient countries, either *via* a global EPR scheme or other funds.
- The **recycling** of textiles remains challenging due to the quality of input and garments made of blended fibres and additives, nascent technologies, and the unstable economic viability. Crucial measures to improve the economic viability will be the introduction of recycled content requirements and recyclability criteria under the ESPR. The introduction of waste management performance targets under EPR schemes is another important leaver to create incentives for investments into fibre-to-fibre recycling. Furthermore, the waste hierarchy is to be strictly applied but also requires updating to account for technological developments — new definitions of closed-loop-recycling and high-quality recycling have become necessary. Another measure is the introduction of harmonised EU-wide End-of-Waste criteria for recycling, set at the point where recycled material is ready to be included in new textiles. Finally, false solutions like composting for textiles should be avoided, while proper treatment of non-recyclable material remains key due to the continued leakage from the system.

The complexity of achieving a toxic-free and circular system for textiles has become evident and, therefore, poses significant challenges to policymaking. Further research and development is needed to scale recycling, but also to determine the environmentally preferable way of discarding textiles—particularly given the global nature of the system. The current lack of coherent policy measures must be overcome in the next few years to allow the sector to edge back into operation within planetary boundaries before we reach tipping points.

Above all, the measures outlined above are not complete without a substantial reduction of material input into the system. Particularly the overconsumption and short lived-nature of many fashionable garments today hampers scaling a circular textile system. The growth in garment production outpaces the acceleration of circular measures. **Sufficiency and circularity must therefore work in tandem to bring the sector back within planetary boundaries**.[254]

[254] ZWE (2023) *A Zero Waste Vision for Fashion – Chapter 1: All We Need Is Less*.

Zero Waste Europe (ZWE) is the European network of communities, local leaders, experts, and change agents working towards a better use of resources and the elimination of waste in our society. We advocate for sustainable systems; for the redesign of our relationship with resources; and for a global shift towards environmental justice, accelerating a just transition towards zero waste for the benefit of people and the planet. www.zerowasteeurope.eu

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