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Executive Summary

This report is delivered as part of SOLSTICE, an EU Horizon project (grant agreement No. 101134989*)*, aiming to test and demonstrate circular economy pilot projects to address the environmental and social challenges of the textile industry in four pilot territories: **Berlin**, **Catalonia**, **Grenoble**, and **Prato**. Building upon a previous analysis of the textile ecosystems in these regions ('territory profiles'), this report aims to provide a preliminary estimate of the **potential environmental impact reductions associated with each circular textile pilot** currently being designed and implemented across the four territories. The study evaluates impact reductions across four key environmental impact indicators: **Global Warming Potential (CO_2e), Non-renewable Energy Consumption, Water Consumption, and Land Use**.

Unlike a conventional retrospective Life Cycle Assessment (LCA), this analysis utilises a **prospective LCA** approach. This method enables the assessment of the potential future impacts of the proposed interventions. Specifically, it evaluates the environmental impacts that could be avoided as a result of the pilots' interventions over the course of the project (12–18 months).

A critical component of the methodology is the concept of **displacement**—the extent to which a circular strategy (such as repair or reuse) actually replaces the production of a new item, rather than simply adding to overall consumption. The study, therefore, estimates the **potential benefits associated with avoiding the production of** new textiles. To account for uncertainty in consumer behaviour, a displacement rate ranging from **40% to 80%** is applied, based on a review of existing literature on circular solutions and consumer behaviour in the textile sector.

The analysis confirms that the circular interventions proposed in the SOLSTICE pilots—ranging from repair bonuses to digital engagement apps—hold significant potential to reduce environmental impact by extending garment lifespans and displacing virgin production. For every garment that displaces a new purchase, there are measurable savings in carbon emissions, water, energy and land use that would otherwise be incurred during the material extraction, processing and manufacturing phases of new textiles. While the **absolute reductions are modest due to the pilot scale** (for example, the Berlin pilot targets approximately 1,000 pairs of jeans out of millions in circulation), they serve as a proof of concept for the environmental impact reduction potential of these circular strategies.

The following key takeaways guide the interpretation of these results:

- The magnitude of the estimated environmental impact reduction is **heavily dependent on the assumed displacement rate**. Circular pilots must actively mitigate potential rebound effects (where consumers use savings to buy more new goods) to ensure genuine impact reduction.
- Although the current pilot volumes represent a small fraction of total textile consumption in the territories, the validated methodologies highlight the considerable **potential of circular economy measures if scaled up** to the city or regional level.

- As a prospective assessment, the results rely on global average data for textile impacts (such as the ecoinvent database) and estimated pilot volumes. Future assessments will **benefit from primary data collected directly from the pilots** and territory-specific supply chains.

This report provides an initial evidence base for the environmental benefits of circular economy solutions—benefits that are often assumed but difficult to quantify—and establishes a baseline for monitoring progress throughout the SOLSTICE project.

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1. Introduction

1.1 SOLSTICE: 5R solutions for textile integrated circular economy

The SOLSTICE project aims to address the key social, environmental and technical challenges posed by the textile industry through a circular economy lens. Funded by the EU's Horizon Europe research and innovation programme under grant agreement No. 101134989, SOLSTICE is advancing a circular textile industry through the implementation of pilot projects in four territories: Berlin, Catalonia, Grenoble, and Prato. The project showcases how circular economy practices can be implemented across the textile industry, decreasing its use of natural resources and generating less waste.

1.2 Goal and scope

Goal and context

In WP2 of SOLSTICE, Circle Economy analysed the textile ecosystem and circular textile practices in the four territories. The resulting so-called 'territory profiles' provided insights into areas requiring immediate action and informed the selection of relevant circular practices in each of the four territories.

The territory profiles used several analysis lenses: first, they described the national and local textile industry context, providing an overview of relevant national and regional textile policies. Then, the profiles analysed the textile ecosystem in each territory, including: (1) a material flow analysis (MFA) to map textile flows across the value chain, (2) a baseline analysis of employment in the territory's textile value chain, (3) a consumer behaviour analysis regarding textile consumption and circular solutions, and (4) an environmental impact assessment of the embedded impacts of the textile flows in each region. Finally, based on the findings, the profiles presented recommendations for the design of circular textile pilots in each territory.

This report is an add-on to the territory profiles. We present a preliminary estimate of the environmental impact reduction from the four pilots, identifying the variables that influence its magnitude. One key variable is the so-called displacement rate. This factor describes the extent to which a circular intervention might lead to the displacement of a new product purchase. Other key factors include the environmental impacts of the different types of textiles targeted by the pilot, as well as the volume of textiles targeted.

Scope and functional unit

As most pilots are still under development at the time of writing, this preliminary assessment examines only the *potential* impacts of the latest pilot concepts. A more comprehensive analysis of the environmental and circularity impacts will be conducted in Work Package 6 (WP6) of the project.

The scope of the study covers consumer clothing, as this is the common focus of all pilots. For the Berlin pilot, the scope is further specified to jeans.

While this is not a formal LCA, the report incorporates selected elements of ISO 14040 ('*Environmental management — Life cycle assessment — Principles and framework*') to ensure methodological transparency and structure. In line with this standard, the functional unit of the study is clearly defined as a measurable reference unit representing the function provided by the product or system under analysis. It serves as the reference against which all inputs and outputs (resources used, emissions, impacts) are quantified, thereby ensuring transparency on the scope and comparability between different products or scenarios.

For each of the four pilots, the functional unit is defined as:

- The estimated volume of textiles (clothing) affected by the pilot's operations during the time of the SOLSTICE project period (12 or 18 months), based on the most recent assumptions regarding pilot design at the time of writing.

Two important considerations apply to the scope and system boundaries:

1. As the pilots have only recently started or are still being designed, it is not yet possible to account for the environmental impacts generated by the pilot activities themselves (such as transport, processing losses, or necessary IT infrastructure). These impacts are therefore excluded from the present analysis but are expected to be included in the full LCA as conducted in WP6.
2. Circular activities have the potential to both avoid the purchase of new products as well as prevent end-of-life treatment. This report focuses exclusively on avoided purchases as the primary benefit of circularity. This choice is justified because:
    - End-of-life prevention effects are often uncertain and difficult to model robustly; and
    - For clothing, the most significant environmental impacts typically occur during material extraction, processing, and product manufacturing, whereas end-of-life treatment generally has a lower impact (depending on the treatment route and selected environmental impact indicators). The avoided end-of-life treatment may be included in the full LCA to be conducted in WP6 of the SOLSTICE project.

This publication is intended for both project partners and external stakeholders. The results are primarily intended to support the four territories currently designing and implementing their pilots by providing estimates of potential environmental impacts.

The results are not intended to compare the estimated impacts of the pilots. Rather, they aim to:

1. Clarify the scale of impact associated with each intervention.
2. Identify the key factors that influence the magnitude of these impacts.
3. Contribute to and disseminate knowledge on environmental impact hotspots along the textile value chain to a wider audience.

2. Methodology

2.1 Introduction

To assess the estimated impact of the four pilots, we apply the 'prospective life cycle assessment' (LCA) method. The LCA method is a scientific approach for calculating the environmental impact of products or services throughout their lifecycle. It includes the extraction and processing of raw materials, the energy and resources utilised in manufacturing, the product's use phase, and the end of its life cycle.

Several types of LCA methods exist. For example, certain LCAs deliberately exclude lifecycle phases, such as a cradle-to-gate LCA, which includes the environmental impacts of a product from the extraction of raw materials ('cradle') to the point where the product leaves the manufacturing facility ('gate'). A cradle-to-gate LCA therefore excludes distribution and transport to customers, the product use phase, and end-of-life processes such as recycling or disposal. A *prospective* LCA is another type of LCA that focuses specifically on *future* products or processes. It answers the question: What could the future impact of a product or process at an early stage of development be? As the pilots are still in development at the time of writing, we selected prospective LCA as a relevant method to estimate the reduction in their environmental impact. Table one lists the key differences between prospective and conventional LCA.

Aspect	Prospective LCA	Conventional LCA
Goal	To assess future environmental impacts of emerging technologies, systems, or scenarios.	To evaluate the current environmental impacts of an existing product or system.
Time horizon	Forward-looking (years to decades into the future)	Present-day or past (usually reflecting current conditions)
Type of data	Uses forecasted or scenario-based data; may incorporate projections.	Uses measured, current, or average data from existing processes and supply chains.
Uncertainty level	Higher uncertainty due to assumptions and future scenarios	Lower uncertainty because data are current and more readily available.
Typical applications	Assessing the impact of emerging technologies and solutions, long-term policy evaluation using scenarios.	Lowering the impact of commercial products, corporate sustainability reporting, eco-labelling, and product comparisons.

Table 1: Differences between prospective and conventional LCA.

2.2 Structure of approach

As defined in the ISO 14040/44 standard, an LCA consists of the following phases:

1. Definition of goal and scope: state the intended application, the reasons for carrying out the study and the intended audience, as well as the study's functional unit and system boundaries.
2. Inventory analysis: the iterative process of collecting the relevant data.
3. Impact assessment: translate the collected inventory data to specific environmental impacts using Life Cycle Impact Assessment (LCIA) methods.
4. Interpretation: draw conclusions from the impact assessment results and develop recommendations for decision-makers, consistent with the study's goal and scope.

This prospective study uses the following steps to arrive at the estimated environmental impact reduction from the four pilots:

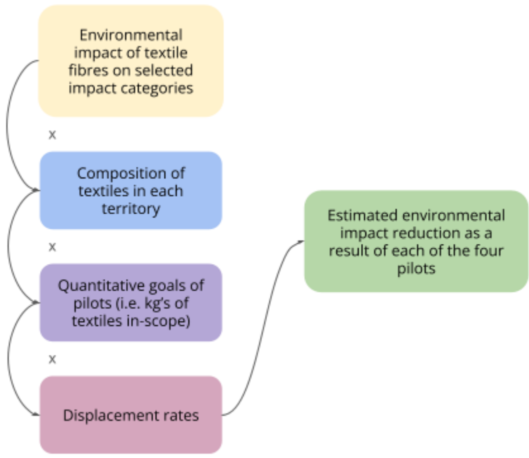

Figure 1: Process to establish the estimated environmental impact reduction of the four pilots.

Step one: Environmental impact of textile fibres

As a first step, we select the environmental impact indicators included in the analysis. Typically, LCA results are complex to interpret, as most conventional impact assessment methods report on many midpoint impact categories. For example, the commonly used ReCiPe method calculates 17 midpoint indicators.[1]

To results that are more easily interpreted and align with policymakers' goals, we select a limited number of impact categories. This selection is based on existing methodologies and references, such as the Higg MSI tool,[2] the work by Quantis,[3] and previous work by Circle Economy, such as the *Circularity Gap Report Textiles*.[4]

The selected impact categories for which we present the general results for the included material types are:

- Climate change, in kilograms of CO_2e per kilogram of material produced (kg CO_2e/kg)
- Non-renewable energy consumption, in megajoules per kilogram of material produced (MJ/kg)
- Water consumption, in cubic meters of water per kilogram of material produced (m^3 water/kg)
- Land use change, in square meter-years of crop land per kilogram of material produced (m^2a crop/kg)

[1] RIVM. (2024). LCIA: the ReCiPe model. Retrieved from: RIVM Website
[2] Higg Index. (n.d.). Introduction. Retrieved from: Higg Index Website
[3] One planet network. (2021). Measuring Fashion: Insights from the Environmental Impact of the Global Apparel and Footwear Industries. Retrieved from: One Planet Network Website
[4] Saliba, M., Keys, A., & Murdie, M. (2024). *The Circularity Gap Report Textiles* (pp. 1-54, Rep.). Circle Economy: Amsterdam. Retrieved from: Circle Economy Website

Step two: Composition of textiles

Textiles consist of different fibre types and blends, most notably cotton, polyester, polycotton, wool, viscose, and polyamide. Since different fibres and materials have distinct environmental impacts due to their distinctive production processes, durability, use characteristics, and end-of-life pathways, establishing a material composition is essential for quantifying the impacts of the textiles in scope. However, there is a lack of data on the composition of textiles on the market in EU countries, as well as on the composition of post-consumer textile streams.[5] Our approach to dealing with this data gap and the resulting textile composition used for the impact estimation is described in Chapter four.

Step three: Quantitative goals of pilots

In the SOLSTICE project, project partner TEXFOR[6] carries out a joint assessment of the four pilots in WP3. This includes setting baseline metrics to measure progress during and after the pilot, based on a methodology co-developed with Circle Economy. While most data on these metrics (that is, the number of participants in the pilots, as well as participant feedback and post-action behaviour changes) will be collected during the pilots' operations, TEXFOR also collected data on the pilots' planned goals. The prospective LCA analysis uses this early-stage data as input. It consists of the estimated volume of textiles that the pilots intend to process over the course of the project (12–16 months).

Step four: Displacement rates

To understand the extent to which textile reuse delivers real environmental benefits, we assess *displacement rates*. A displacement rate represents the proportion of second-hand garment purchases (or garments otherwise 'saved' through R-strategies such as repair) that replace the purchase of a newly manufactured item rather than leading to additional overall consumption. This metric is essential for evaluating the real impact of textile circularity initiatives, as environmental benefits arise only when new production is effectively avoided. This assessment is based on a literature-led desktop review rather than primary consumer survey data. We draw on existing studies and reports from recognised organisations, as well as available statements from second-hand retailers and resale platforms. While these sources provide indicative displacement values that inform our LCA modelling assumptions, we recognise that this is a fairly new field and that further primary research would strengthen precision and robustness. Performance monitoring by TEXFOR in the next stage of the research is expected to generate primary data that may help refine displacement values.

3. Environmental impact of textiles

The environmental pressures associated with textile consumption must be understood within the broader context of consumption footprints, including material and carbon per capita. Across Germany, Italy, France, and Spain, total material footprints range from 18 to 27 tonnes per capita, while carbon footprints range from nine to 13 tonnes per capita.[7] In

[5] Niinimäki, K., Hemberg, H., Bhatnagar, A., & Ghoreishi, M. (2024). *Identifying data gaps in the textile industry and assessing current initiatives to address them* (pp. 1-80, Rep.). European Union: Brussels. Retrieved from: European Parliament Website
[6] Texfor. (n.d.). Home page. Retrieved from: Texfor Website
[7] Circle Economy (2025). Weavebase: Multi Regional Input Output (MRIO) database built upon EXIOBASE and Eora. Documentation available at Circle Economy website

these countries, manufactured goods[8] account for roughly one-fifth of material use (18–22%) and around one-sixth of carbon emissions (14–17%). These figures show that everyday consumer products, including clothing and household textiles, account for a significant share of environmental pressures linked to consumption.

	Material footprint, tonnes/capita	Share from manufactured goods	Carbon footprint, tonnes CO_2e/capita	Share from manufactured goods
Germany	26.5	20%	12.7	16%
Italy	24	22%	11.9	16%
France	21.9	18%	10.3	14%
Spain	18.3	20%	8.5	17%

Table 2: Material footprint and carbon footprint per capita for Germany, Italy, France, and Spain, including the percentage share attributable to manufactured goods.

Textiles are a particularly relevant product group within manufactured goods because of their high resource intensity; producing fibres and textile products requires significant raw material inputs (such as plant-based or petroleum-based inputs), auxiliary inputs such as a variety of chemicals and dyes, water, land (for the cultivation of cotton), and energy (primarily during the wet processes stages).

Additionally, the textiles value chain relies on highly globalised supply chains, meaning that final consumption in a given location has impacts that bridge multiple countries and continents. Approximately 4–6% of the EU's environmental footprint is attributed to textile consumption, with the majority of those impacts occurring elsewhere in the world.[9]

The global textile industry is also largely linear: of the 3.25 billion tonnes of textile materials consumed each year, over 99% come from virgin sources, making it only 0.3% circular.[10] The impacts of textiles are exacerbated by rapid consumption cycles, a symptom of the rise of fast fashion, which is, in addition to a range of negative social and environmental impacts, associated with clothing of lower quality and shorter useful lifetimes.[11]

In this chapter, we provide a brief description of the environmental impacts of textiles across the value chain and present the estimated impacts of different textile fibres.

[8] Manufactured goods includes a diverse group of household products such as appliances, clothing, furniture, personal care products, and electronics.

[9] Köhler, A., Watson, D., Trzepacz, S., Löw, C., Liu, R., Danneck, J., Konstantas, A., Donatello, S. & Faraca, G.(2021). *Circular Economy Perspectives in the EU Textile sector* (pp. 1-143, Rep.). European Union: Luxemburg. Retrieved from: European Commission Website

[10] Saliba, M., Keys, A., & Murdie, M. (2024). *The Circularity Gap Report Textiles* (pp. 1-54, Rep.). Circle Economy: Amsterdam. Retrieved from: Circle Economy Website

[11] Olivar Aponte, N., Hernández Gómez, J., Torres Argüelles V., & Smith, E.D. (2024). Fast fashion consumption and its environmental impact: a literature review. *Sustainability: Science, Practice and Policy, 20*(1). doi: 10.1080/15487733.2024.2381871

3.1 Impact of clothing textiles at different stages of the value chain

The textile life cycle stages associated with the highest environmental footprint are typically **material extraction, processing, product manufacturing, and the use phase.**[12] Most of these impacts occur outside of Europe, particularly in dominant textile manufacturing countries such as China, Vietnam, Bangladesh, and India.[13] The environmental footprint of the use phase depends largely on consumer behaviour, including the number of washes, the electricity mix, and whether drying is used.[14] The end-of-life stage can also generate significant impacts, as post-consumer textile waste is still predominantly treated through incineration and landfilling rather than reuse, repair, or recycling pathways. Moreover, the majority of textiles that are separately collected in the EU and sorted for recycling are exported to Africa and Asia, where their final destination and treatment pathways remain highly uncertain.[15] A similar pattern is observed in the four project territories, as reflected in the MFA results presented in the territory profiles.[16]

Each stage of the textile value chain contributes differently across environmental impact categories (climate change, non-renewable energy consumption, water consumption, land use change, and energy use), and these contributions also vary by fibre type. Climate impacts are largely driven by energy-intensive production processes and post-fibre processing, while the relative contribution of distribution and retail is comparatively small. This is partly because clothing is lightweight and typically shipped in bulk. Water use is concentrated in the fibre production stage, particularly due to the high irrigation needs of cotton cultivation. Land use impacts similarly arise mainly from cotton farming, whereas downstream stages contribute indirectly through the land required to produce the energy used in manufacturing and laundering.

[12] Saliba, M., Keys, A., & Murdie, M. (2024). *The Circularity Gap Report Textiles* (pp. 1-54, Rep.). Circle Economy: Amsterdam. Retrieved from: Circle Economy Website

[13] World Trade Organization (2024). Global Value Chains: Sectoral Profiles. Textile and Clothing Industry. Retrieved from https://www.wto.org/

[14] Wiedemann, S.G., Biggs, l., Nguyen, Q., Clarke, S.J., Laitala, K., & Klepp, I.G. (2021). Reducing environmental impacts from garments through best practice garment use and care, using the example of a Merino wool Sweater. *The International Journal of Life Cycle Assessment (2021)26*, 1188–1197. doi: 10.1007?s11367-021-01909-x

[15] European Environment Agency (EEA). (2024). Management of used and waste textiles in Europe's circular economy. Retrieved from: EEA Website

[16] The territory profiles are accessible through https://www.solstice-project.eu/deliverables

Value chain stage	Substages included	Climate change(kg CO_2e)[17][18][19][20][21]	Water use[2][4][5]	Land use (PDFs)[4]	Non-renewable energy consumption (MJ)[5]
Material production	This stage encompasses the cultivation or extraction of raw fibres from natural or synthetic sources, followed by their conversion into yarn through spinning processes, including carding, drafting, twisting, and winding.	24-46%	54-90%	62%	27%
Post-fibre preparation & processing	This stage includes fabric construction through weaving, knitting, or non-woven bonding methods to convert yarns into textile structures, followed by wet processing operations such as dyeing and finishing that treat fabrics to achieve desired aesthetic properties, functionality, and colour.	21-48%	4-26%	14%	29%
Garment manufacturing	This stage involves the systematic transformation of finished fabrics into wearable garments through pattern cutting, stitching, seaming, and finishing operations including washing, pressing, and quality control.	4-17%	2%	12%	13%
Distribution and retail	This stage encompasses logistics, warehousing, transportation, and the wholesale or retail sale of finished garments to consumers through physical stores or e-commerce channels.	1-14%	0%	0%	5%
Use	This phase covers the consumer interaction with the textile product over its useful lifespan, including wearing, washing, drying, ironing, and general maintenance.	0-24%	4-18%	13%	25%
End of life	This stage encompasses all pathways for discarded or no longer usable textiles, including reuse of whole garments, mechanical recycling (shredding fibres for new products), chemical recycling (dissolving fibres to recover raw materials), thermal recycling of synthetics, and disposal through landfill or incineration	0-3%	0%	0%	1%

Table 3: Estimated percentual impact contribution of clothing textiles' different stages of the value chain.

[17] Sharpe, Samantha; Dominish, Elsa; Martinez-Fernandez, M. Cristina (2022) : Taking climate action: Measuring carbon emissions in the garment sector in Asia, ILO Working Paper, No. 53, ISBN 978-92-2-035324-0, International Labour Organization (ILO), Geneva, https://doi.org/10.54394/WAWN5871

[18] Östlund,Åsa; Ross, Sandra; Sweet Susanne; Sjöström, Emma (2020) Investor Brief: Sustainability in Textiles and Fashion. Available at : Mistra website

[19] McKinsey & Company and Global Fashion Agenda (2020) Fashion on Climate : How the fashion industry can urgently act to reduce its greenhouse gas emissions. Available at Global Fashion Agenda website

[20] United Nations Environment Programme (2020). Sustainability and Circularity in the Textile Value Chain - Global Stocktaking. Available at UNEP website

[21] Sandin, Gustav & Roos, Sandra & Spak, Björn & Zamani, Bahareh & Peters, Greg. (2019). Environmental assessment of Swedish clothing consumption – six garments, sustainable futures. 10.13140/RG.2.2.30502.27205.

3.2 The impact of different textiles

Textiles are a highly heterogeneous group of materials. Clothing and household textile items are composed of a variety of materials, each with distinct origins and manufacturing processes, and therefore different environmental impacts. The origin of textile fibres can be **natural** (cotton, wool, linen, silk), **synthetic** (polyester, nylon), or **semi-synthetic** (viscose). The textile industry is increasingly using fossil-fuel-derived synthetic fibres, such as polyester, which currently account for 63% of the raw materials used in global textile production.[22]

Many textiles are composed of blends of different natural and synthetic fibres. Modern jeans, for example, often contain 1–5% of elastane in addition to their cotton fibres.[23] Additives to the fabric, such as softeners, water-repellent fixing agents, and colouring agents, increase the material's complexity. Such additives are, for example, used in performance clothing, making the garments more durable but also significantly increasing the number of components and chemicals used and inhibiting recyclability. Repairability is possible but highly specialised.

The impact factors per kilogram of each textile type, across the impact categories mentioned above, were calculated using the LCA software SimaPro and the ecoinvent v3.12 database. The system boundaries include the following simplified stages to produce a finished textile product:

1. Raw material production
2. Fabric dyeing
3. Finishing (mechanical and chemical treatments to obtain a final textile product)

Garment manufacturing processes (cutting, stitching, and seaming) were excluded because relevant data were not available in the database, and these steps are expected to contribute relatively little to the overall environmental impact.

For all impact indicators, the ReCiPe 2016 midpoint (H) method was used. Energy use was assessed separately using the Cumulative Energy Demand (V1.11) method. Fibre types were categorised based on research by the European Joint Research Centre (JRC), which also provided data on the average composition of textiles.[24] The impact factors are summarised in Table four below.

It is important to note that results may vary depending on the LCA database, impact assessment method, and accounting approaches used—particularly regarding the treatment of organic carbon uptake. Other influential factors include the region of production and the specific production processes applied (such as cultivation or extraction methods and the electricity mix). The numbers presented below are based primarily on global averages and should therefore be interpreted as a first indication. For more detailed

[22] Saliba, M., Keys, A., & Murdie, M. (2024). *The Circularity Gap Report Textiles* (pp. 1-54, Rep.). Circle Economy: Amsterdam. Retrieved from: Circle Economy Website

[23] Fumao Fabric. (n.d.). What is Stretch Denim and How Much Elastane Should You Use?. Retrieved from: Fumao Fabric Website

[24] Huygens. D., Foschi, J., Caro, D.,, Patinha Caldeira, C., Faraca G., Foster, G., Solis, M. Marschinski, R., Napolano, L., Fruegaard Astrup, T. and Tonini, D.,. (2023). *Techno-scientific assessment of the management options for used and waste textiles in the European Union* (pp. 1-204, Rep.). European Union: Luxembourg. Retrieved from: European Commission Website

information on the environmental impact of textiles, see the extensive LCA studies by Cotton Incorporated[25] and MISTRA.[26]

Impact categories per kilogram of textile type	Climate change (kg CO2e/kg)	Non-renewable energy use (MJ/kg)	Water use (m3/kg)	Land use (m2a crop eq/kg)
Cotton	16.2	160.4	5.5	7.4
Polyester	10.6	160	0.03	0.31
Polyamide	14.7	171	0.06	0.12
Wool	59.1	206.6	6.2	55.4
Polypropylene	7.9	143	0.002	0.15
Viscose	19.3	192.8	5.6	8.4
Acrylic	8.5	137.1	0.04	0.15
Other fibres	N/A	N/A	N/A	N/A
Non-textile material	N/A	N/A	N/A	N/A

Table 4: Summary of environmental impact factors per kilogram of textile per type.

4. Textile composition

To ensure methodological consistency across territories, this study uses the EU-average post-consumer textile (PCT) composition reported in the JRC's report on management options for used and waste textiles in the EU.[27] The choice for this approach followed a review of the available literature, which consistently showed that country-level data on textile composition is largely unavailable, but that textile fibre composition is expected to vary only minimally across European regions. The available data shows little variation between new versus post-consumer textile material composition.

Since there is limited traceability of both imported textiles and post-consumer waste, country-specific composition data for textiles is unavailable.[28] In general, territorial composition values are rarely published for individual countries: most textile composition studies report material composition at the EU-wide rather than national level. For example, a JRC study on the fate and composition of textile waste in Italy, Romania, and Czechia reports a single aggregated composition profile rather than separate datasets for each country to protect strategic know-how of the facilities. The report provides a breakdown of

[25] Cotton Incorporated. (2017). *LCA update fiber and fabric life cycle inventory* (pp. 1-162, Rep.). Retrieved from: Cotton Today Website

[26] Sandin, G., Björn, Spak, S.R., Zamani, B. & Peters, G. (2019). *Environmental assessment of Swedish clothing consumption* (pp. 1-167, Rep.). Retrieved from: RISE Website

[27] Huygens. D., Foschi, J., Caro, D.,, Patinha Caldeira, C., Faraca G., Foster, G., Solis, M. Marschinski, R., Napolano, L., Fruegaard Astrup, T. and Tonini, D.,. (2023). *Techno-scientific assessment of the management options for used and waste textiles in the European Union* (pp. 1-204, Rep.). European Union: Luxembourg. Retrieved from: European Commission Website

[28] Niinimäki, K., Hemberg, H., Bhatnagar, A., & Ghoreishi, M. (2024). *Identifying data gaps in the textile industry and assessing current initiatives to address them* (pp. 1-80, Rep.). European Union: Brussels. Retrieved from: European Parliament Website

the data showing the datasets as country one, two, and three, from which it can be seen that the results were closely aligned.[29] Similarly, a report by the project 'Sorting for Circularity Europe' presents a pooled material composition for Belgium, Germany, the Netherlands, Poland, Spain, and the UK, with no country-specific data included.[30] Spain and Germany are therefore present only as part of this European average, not as standalone datasets.[31]

Composition data are unavailable for both textiles placed on the market and PCT. However, the two streams are expected to be similar. Annexe nine of the JRC report shows a difference of less than 1% between new textiles and PCT. This pattern is also consistent across apparel subcategories: trousers, T-shirts, shirts, knitwear, and dresses all exhibit differences below 1%. Only jackets and coats show a slightly larger deviation, with a -1.98% difference in post-consumer waste.[32] Nevertheless, this variation remains marginal and does not alter the dominance of the primary fibre categories. Given that material composition remains effectively stable from the new product stage to the waste stage, PCT data can be considered a reliable and representative basis for the LCA study.

Given the lack of information on territory-specific material composition for the four territories included, this study uses the regional averages from the JRC technical report as a reference, considering it is the most complete and recent EU-level study. Additionally, there is little variation across the reviewed studies compared to the JRC technical assessment results. The only country with a separate national dataset available is France, for which a ReFashion report provides a composition that aligns closely with the EU-average JRC baseline.[33] Moreover, across all multi-country studies, the composition pattern remains consistent: cotton and polyester, including poly-cotton blends, dominate the textile stream, while fibres such as wool, viscose, and acrylic appear only in low percentages. The distribution of the material in these studies also largely aligns with the JRC techno-scientific study.

The table below presents the fibre-composition values used in this assessment.

Material	Percentage
Cotton	33.7%
Polyester	29%

[29] Bakowska, O., Mora, I., Walsh, S., van Duijn, H., Novak, M., Cherubini, G., Joshi, R., Morbiato, A., Visileanu, E., Veselá, A., Ryšavá, E., & Holicky, M. (2025). *Fate and composition of textile waste from Italy, the Czech Republic and Romania* (pp. 1-106, Rep.). European Union: Luxembourg. Retrieved from: Publications Office of the European Union Website

[30] Van Duijn, H., Papú Carrone, N., Bakowska, O., & Huang, Q. (2022). *Sorting for Circularity Europe* (pp. 1-60, Rep.). Retrieved from: Fashion For Good Website

[31] Van Duijn, H., Papú Carrone, N., Bakowska, O., & Huang, Q. (2022). *Sorting for Circularity Europe* (pp. 1-60, Rep.). Retrieved from: Fashion For Good Website

[32] Huygens. D., Foschi, J., Caro, D.,, Patinha Caldeira, C., Faraca G., Foster, G., Solis, M. Marschinski, R., Napolano, L., Fruegaard Astrup, T. and Tonini, D.,. (2023). *Techno-scientific assessment of the management options for used and waste textiles in the European Union* (pp. 1-204, Rep.). European Union: Luxembourg. Retrieved from: European Commission Website

[33] Re_fashion. (2023). *Characterisation study of the incoming and outgoing streams from sorting facilities* (pp. 1-34, Rep.). Retrieved from: Re_fashion website

Material	Percentage
Polyamide	7.1%
Wool	3.9%
Polypropylene	3.2%
Viscose	3.1%
Acrylic	2.7%
Other fibres:	5.9%
Non-textile material	11.5%

Table 5: Post-consumer textile composition in the EU.[34]

5. Displacement rates

5.1 Estimating the environmental benefits of circular solutions

In light of the textile sector's significant environmental impact, circular business models such as resale, repair, rental and upcycling have gained prominence as strategies to reduce waste, extend product lifespans, and reduce overconsumption.[35] These models are expected to generate environmental benefits on the assumption that second-hand or repaired items substitute, at least to some extent, for the purchase of new products.[36]

However, their sustainability potential ultimately depends on the extent to which they actually **displace the purchase of new garments**. This substitution is not guaranteed. Circular options can also stimulate additional consumption, giving rise to so-called rebound effects. In this context, rebound effects occur when circular activities fail to meaningfully replace new purchases, thereby diminishing the expected environmental gains.[37] A well-described psychological phenomenon at play is *moral licensing*: the tendency for individuals who perceive their consumption as ethical to justify additional purchases or feel less guilt about consuming more overall.[38]

To assess the effectiveness of circular economy activities, research increasingly incorporates estimates of displacement rates—that is, the share of circular transactions that replace new

[34] Huygens. D., Foschi, J., Caro, D.,, Patinha Caldeira, C., Faraca G., Foster, G., Solis, M. Marschinski, R., Napolano, L., Fruegaard Astrup, T. and Tonini, D.,. (2023). *Techno-scientific assessment of the management options for used and waste textiles in the European Union* (pp. 1-204, Rep.). European Union: Luxembourg. Retrieved from: European Commission Website

[35] Meital Peleg, M., & Ori, S. (2025). Secondhand fashion consumers exhibit fast fashion behaviors despite sustainability narratives. Retrieved from: Scientific Reports Website

[36] WRAP. (2025). Displacement Rates Untangled: A Standardised Methodology (pp. 1-46, Rep). Retrieved from: WRAP Website

[37] Metic, J. and Pigosso, D.C.A. (2022). Research avenues for uncovering the rebound effects of the circular economy: A systematic literature review. Journal of Cleaner Production, 368, 133133. https://doi.org/10.1016/J.JCLEPRO.2022.133133

[38] Meital Peleg, M., & Ori, S. (2025). Secondhand fashion consumers exhibit fast fashion behaviors despite sustainability narratives. Retrieved from: Scientific Reports Website

purchases.[39] For example, a scientific study modelled a range of displacement rates to estimate greenhouse gas emission reductions from redistributing product flows to the least impactful second-hand recovery routes.[40] Similarly, the peer-to-peer resale platform Vinted applied replacement assumptions in its product-level climate impact calculations,[41] while EuRIC modelled impacts at displacement levels of 10%, 40% and 80%.[42]

The remainder of this chapter zooms in on some of the methodological challenges of calculating displacement rates, provides a brief overview of displacement rates reported in the literature, and outlines the range used in this study.

5.2 Factors influencing displacement rates

Across reports and academic studies assessing the environmental benefits of circular solutions, displacement rates are not treated as fixed values. Instead, they are understood to rely on a complex interplay of factors.

One key determinant is the **type of circular strategy** being evaluated. For instance, resale and repair models tend to achieve higher levels of substitution for new purchases, whereas redistribution and rental models may more often supplement rather than replace consumption. The Waste and Resources Action Programme (WRAP) report on displacement rates, which is among the most cited studies on this topic, explicitly highlights that the contribution of each R-strategy differs because individuals engage with these models in different ways and for different reasons.[43]

Another variable that strongly influences the estimated replacement rate is the **methodological approach** used to assess substitution. Several methods are available, each with its pros and cons. Common approaches include national or consumer surveys, wardrobe studies, and more macro-level approaches such as volume comparisons (for example, comparing sales data for new versus second-hand clothing). Macro-level approaches can provide broad system insights, but they obscure differences in displacement rates across consumer groups. Wardrobe studies produce a rich set of real-world data but are expensive and time-consuming. Consumer survey-based approaches are widely used, but interpreting their results is complicated by the intention-behaviour gap: consumers struggle to accurately predict how they would behave in a hypothetical scenario.[44] As noted in the Vinted climate impact study, second-hand purchases cannot be assumed to automatically replace new consumption, as motivations differ and self-reported data do not reliably capture counterfactual behaviour.[45]

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[39] WRAP. (2025). *Displacement Rates Untangled: A Standardised Methodology* (pp. 1-46, Rep). Retrieved from: WRAP Website

[40] Fortuna, L.M., & Siyamandoglu, V. (2017). Optimization of greenhouse gas emissions in second-hand consumer product recovery through reuse platforms. *Waste Management, 66, 178-189*. Doi: 10.1016/j.wasman.2017.04.032

[41] Vinted. (2023). Climate Impact Report Summary (pp. 1-15, Rep.). Retrieved from: Vinted Website

[42] Trzepacz, S., Bekkevold Lingas, D., Asscherickx, L., Peeters, K., van Duijn, H., & Akerboom, M. (2023). LCA-based assessment of the management of European used textiles (pp. 1-70, Rep.). Retrieved from: Circular Economy Website

[43] WRAP. (2025). *Displacement Rates Untangled: A Standardised Methodology* (pp. 1-46, Rep). Retrieved from: WRAP Website

[44] WRAP. (2025). *Displacement Rates Untangled: A Standardised Methodology* (pp. 1-46, Rep). Retrieved from: WRAP Website

[45] Vinted. (2023). *Climate Change Impact Reoprt* (pp. 1-31, Rep.). Retrieved from: Vinted Website

In addition, **survey design** introduces additional sources of uncertainty. Factors such as timing (point-of-purchase versus Retrospective questioning), sample representativeness, demographic composition, product mix, and seasonality (such as lower off-season purchases of jackets) can all distort results.[46] Seasonal bias, for example, was recognised by Depop, whose survey was conducted in winter in the US and UK and summer in Australia.[47] Similarly, QSA notes that recall-based questioning can lead to memory gaps, and that winter-season sampling likely explains why 68% of reported items were classified as 'recent' purchases.[48] To improve methodological robustness, WRAP applied cognitive testing to verify both respondent comprehension and the behavioural accuracy of its survey questions.[49]

Displacement also varies across **product types and consumer segments**. Depop reports higher substitution for clothing than for accessories or footwear, and more substantial displacement among younger users.[50] This aligns with research recommending the use of product-specific avoided-purchase rates. Items such as coats, jackets, bottoms, and shorts tend to reflect more utility-driven demand and have comparatively high manufacturing footprints. As a result, they are more likely to displace a new purchase and deliver greater avoided environmental impacts.[51] [52] Scientific research also suggests a strong influence of consumer characteristics on displacement rates, with high user heterogeneity significantly influencing environmental outcomes.[53] The varying responses of different consumer segments to specific circular offerings may be explained by consumers' predispositions and acceptance of circular solutions, which, in turn, may be influenced by a complex mix of socio-demographic characteristics such as age, gender, income, nationality, political orientation, and education.[54]

Lastly, a further challenge in estimating displacement is that consumers may purchase second-hand items **in addition to new ones**, rather than instead of them, resulting in imperfect substitution and lower actual displacement.[55] For example, it has been found that consumers who use second-hand items, in addition to new fashion products, make seven

[46] WRAP. (2025). *Displacement Rates Untangled: A Standardised Methodology* (pp. 1-46, Rep). Retrieved from: WRAP Website

[47] Deepop. (2022). *The power of secondhand: how resale slows consumption* (pp. 1-40, Rep.). Retrieved from: Depop Website

[48] Callewaert, P., & Bekkevol Lingas, D. (2024). *Does increased clothing reuse lead to reduced consumption of new clothes?* (pp. 1-23, Rep). Norsus. Retrieved from: Norsus Website

[49] WRAP. (2025). *Displacement Rates Untangled: A Standardised Methodology* (pp. 1-46, Rep). Retrieved from: WRAP Website

[50] Deepop. (2022). *The power of secondhand: how resale slows consumption* (pp. 1-40, Rep.). Retrieved from: Depop Website

[51] Stevenson, A. and Gmitrowicz, E., 2012. Study into consumer second-hand shopping behaviour to identify the re-use displacement effect. Waste Res. Act. Prog.(WRAP);

[52] Nørup, N., Pihl, K., Damgaard, A. and Scheutz, C., 2019. Replacement rates for second-hand clothing and household textiles–A survey study from Malawi, Mozambique and Angola. Journal of Cleaner Production, 235, pp.1026-1036.

[53] Bączyk, M., Tunn, V., Worrell, E., & Corona, B. (2024). Consumer behavior in circular business models: Unveiling conservation and rebound effects. *Sustainable Production and Consumption*, *52*, 283-298.

[54] Mizrachi, M. P., & Sharon, O. (2025). Secondhand fashion consumers exhibit fast fashion behaviors despite sustainability narratives. *Scientific Reports*, *15*(1), 34968.

[55] Bubinek, R., Knaack, U., & Cimpan, C. (2025). Reuse of consumer products: Climate account and rebound effects potential. *Sustainable Production and Consumption, 54,* 190–201. doi:10.1016/j.spc.2024.12.019

supplementary purchases a year, compared to individuals who use new items only.[56] Similarly, a positive correlation was indicated between second-hand and fast-fashion purchasing, especially among younger consumers, signalling that second-hand fashion can complement rather than replace primary market demand.[57] In parallel, income effects can trigger higher overall consumption: money saved on cheaper second-hand items is often re-spent on additional purchases, illustrating a so-called **rebound effect.**[58] Income-driven rebound has been estimated to increase second-hand clothing consumption by 23%, and revenue earned from resale is, in some cases, used to finance the purchase of new garments.[59]

As noted earlier, these behavioural responses may be exacerbated by moral licensing, whereby purchasing 'ethical' second-hand products serves to justify continued or even increased consumption of new items.[60] Although rebound and moral licensing effects introduce significant uncertainty into displacement calculations, research on their quantitative environmental impacts remains limited. For these reasons, such effects are acknowledged but excluded from the modelling in this study.

5.3 Displacement rates: Overview and range

Based on our literature review, this study considers a **displacement rate of 40–80%** for the circular economy strategies under examination. This range is drawn from both scientific literature and relevant reports, with the key findings presented in Table six below. The wide range reflects current uncertainty and ensures that the results do not artificially inflate the environmental impact reductions of the pilots.

Source	Year	R-strategy	Displacement rate	Location
NORION[61]	2023	Reuse (resale)	10-40%	Global
NORSUS[62]	2024	Reuse (resale)	27%	Norway
Vinted[63]	2021	Reuse (resale)	33% - 42%	Belgium, Germany, Spain, France, Italy, Netherlands, Poland, UK

[56] Dekhili, S., Achabou, M. A., & Nguyen, T.-P. (2025). When the pro-ecological intentions of second-hand platforms backfire: An application in the case of Vinted. *Journal of Cleaner Production, 486,* 144399. doi:10.1016/j.jclepro.2024.144399

[57] Mizrachi, M. P., & Sharon, O. (2025). Secondhand fashion consumers exhibit fast fashion behaviors despite sustainability narratives. *Scientific Reports*. doi:10.1038/s41598-025-19089-

[58] Farrant, L., Olsen, S. I., & Wangel, A. (2010). Environmental benefits from reusing clothes. *The International Journal of Life Cycle Assessment*, *15*(7), 726-736.

[59] Bączyk, M., Tunn, V., Worrell, E., & Corona, B. (2024). Consumer behavior in circular business models: Unveiling conservation and rebound effects. Sustainable Production and Consumption, 52, 283–298. doi:10.1016/j.spc.2024.10.022

[60] Mizrachi, M. P., & Sharon, O. (2025). Secondhand fashion consumers exhibit fast fashion behaviors despite sustainability narratives. *Scientific Reports*. doi:10.1038/s41598-025-19089-

[61] Trzepacz, S., Bekkevold Lingas, D., Asscherickx, L., Peeters, K., van Duijn, H., & Akerboom, M. (2023). LCA-based assessment of the management of European used textiles (pp. 1-70, Rep.). Retrieved from: Circular Economy Website

[62] Callewaert, P., & Bekkevol Lingas, D. (2024). *Does increased clothing reuse lead to reduced consumption of new clothes?* (pp. 1-23, Rep). Norsus. Retrieved from: Norsus Website

[63] Vinted. (2021). *Vinted Climate Change Impact Report* (pp. 1-164, Rep). Retrieved from: Vinted Website

Vinted[64]	2023	Reuse (resale)	40%	EU
Fartetch[65]	2019	Reuse (resale)	41-65%	China, US and UK
WRAP[66]	2022	Reuse (rental)	42%	UK
		Reuse (resale)	54%	
		Reuse (upcycled)	57%	
Catellani et al.[67]	2014	Reuse (resale)	47%	Italy
Schibsted[68]	2024	Reuse (resale)	47% - 55%	Denmark, Norway, Sweden, Finland
QSA partners[69]	2020	Reused (resale locally)	52%	UK
WRAP[70]	2025	Reuse (resale)	64.6%	UK
	2025	Repair	82.2%	
Farrant, et al.[71]	2010	Reuse (overseas)	70%	Sweden, Estonia
Humana[72]	2023	Reuse (resale)	70%	Spain
Verstaire Collective	2024	Reuse (resale)	79%	US, UK, France, Italy, Germany
Verstaire Collective	2023	Reuse (resale)	82%	EU
Depop & QSA partners[73]	2022	Reuse (resale)	88% - 92%	US, UK, Australia

Table 6: Key takeaways from studies on displacement rates.

[64] Vinted. (2021). *Vinted Climate Change Impact Report* (pp. 1-31, Rep). Retrieved from: Vinted Website
[65] FARFETCH. (2019). *Understanding The Environmental Savings Of Buying Pre-Owned Fashion*(pp. 1-111, Rep.). Retrieved from: FARFETCH Website
[66] Gray, R. Sabaiduc, C., Salvidge, C., Doriza, A., & Downing, P. (2022). *Citizen Insights: Clothing Longevity and Circular Business Models receptivity in the UK* (pp. 1-34, Rep). Retrieved from: WRAP Website
[67] *Integrated Environmental Assessment and Management*, Volume 11, Issue 3, 1 July 2015, Pages 373–382, https://doi.org/10.1002/ieam.1614
[68] Schibsted. (2024). *The Second Hand Effect Report* (pp. 1-43, Rep.). Retrieved from: Schibsted Website
[69] QSA Partners. (2020). *Does buying pre-loved clothing mean buying less new?: A new consumer research report.* Retrieved from: QSA Partners Website
[70] WRAP. (2025). *Displacement Rates Untangled: A Standardised Methodology* (pp. 1-46, Rep). Retrieved from: WRAP Website
[71] Farrant, L., Olsen, S.I., & Wangel, A. Environmental benefits from reusing clothes. *The International Journal of Life Cycle Assessment, 15(7)*, 726-736. doi: 10.1007/s11367-010-0197-y
[72] Humana. (2023, June 05). For every kilo of used clothing that is managed correctly, the emission of 6.1 kg of CO2 is avoided. Retrieved from: Humana Website
[73] Deepop. (2022). *The power of secondhand: how resale slows consumption* (pp. 1-40, Rep.). Retrieved from: Depop Website

6. Pilot goals

6.1 Berlin

Pilot plans

Berlin's pilot revolves around the 'Repair Deal',[74] a repair bonus initiative led by the NGO Circular Berlin[75] in partnership with FixFirst[76] as a technology partner. The programme offers residents a 50% discount on jeans repairs for 14 months, making textile repairs accessible to Berliners. Interested participants can complete an online form on the dedicated Repair Deal website to receive a discount voucher, which can be redeemed at participating repair shops. The SOLSTICE project finances this discount until the end of 2026, with the goal of establishing a permanent repair bonus for clothing in Berlin after the project ends. At the time of writing, eight repair shops have been onboarded successfully, and 65 users have been registered.

The Repair Deal is complemented by Repair Days: three pop-up weeks taking place across Berlin from November 2025 to November 2026. Berliners are invited to bring their jeans to the initiative's Repair Stations for free repairs and take part in hands-on workshops, panels, roundtables, and evening events, all while discovering the Repair Bonus Programme.

The pilot is designed to help customers save money on repairs, assist repair shops in securing income, and simultaneously reduce textile waste and avoid the purchase of new jeans. These goals align with Berlin's goal to become a zero-waste city by 2030. Additional objectives are to (1) establish an infrastructure connecting repair services, consumers, and fashion brands, (2) create a digital use case for a clothing repair bonus, and (3) promote education and behavioural change by building a community around repair actors.

Impact goals

The pilot sets clear quantitative goals:

- **1,000 repaired denim pants** (July 2025–November 2026), equivalent to 568 kilograms[77] of textiles and 3.97 tonnes of CO_2e saved
- Engaging at least 15 repair shops and 500 Berlin consumers.

Composition of jeans: 94% cotton, 6% polyester

6.2 Catalonia

Pilot plans

At the time of writing, the Catalonia pilot has not yet been finalised. The *Generalitat de Catalunya* (GENCAT), the key territorial partner in SOLSTICE, analysed three previous

[74] See: https://repairdeal.circular.berlin/en/
[75] See: https://circular.berlin/de/
[76] See: https://www.fixfirst.io/
[77] Using an average weight of 568 grams per denim pants, from: Beton, Adrien., Cordella, Mauro., Dodd, Nicholas., Boufateh, Ines., Wolf, Oliver., Kougoulis, Jiannis., Dias, Debora., Desaxce, Marie., Perwueltz, Anne., Farrant, Laura., Gibon, Thomas., & le Guern, Yannick. (2014). *Environmental improvement potential of textiles (IMPRO Textiles)*. Publications Office.

initiatives to inform the pilot design: Ressò[78] (a pop-up market for reusable products, including textiles), Didaltruck[79] (a repair van offering free self-repair services to promote the prevention of textile waste through upcycling and raising public awareness), and *Renueva tu ropa*[80] (a clothing exchange network for used clothes that are still in good condition). From this analysis, GENCAT has identified several success elements. The pilot will build on collaborations with existing initiatives to test textile prevention and reuse strategies in an urban environment, fostering strong links with the community.

GENCAT is currently seeking new partners to support these collaborations. The pilot intends to hold four repair and upcycling workshops in April, July, and October 2026 and in January 2027, in collaboration with local community actors and Dídaltruck. A final event inspired by Ressò and Renova is planned for April 2027.

Impact goals

Due to the early stage of development, the Catalonia pilot has not yet established specific impact goals.

6.3 Grenoble

Pilot plans

The Grenoble pilot is currently still under development. At this stage, the territory has outlined two main components. First, the pilot will establish a 'third place' dedicated to circular textiles, creating a hub that offers an alternative to fast fashion in collaboration with local Reduce, Reuse, Repair, and Recycle (4R) stakeholders. Over the course of one year, this third place will host innovative, practical, centralised 4R sales and service offerings.

Second, the pilot includes a service design approach focused on behavioural change. This involves experimenting with an innovative textile collection system, including the introduction of three newly designed collection containers and an accompanying communication campaign. The containers have been designed to be more visually attractive than conventional textile collection bins. The aim is to enhance visibility, support upcyclers with communication and marketing innovations, increase consumer engagement, and boost collection rates. Collected garments may subsequently be sorted by partner organisations. Based on a defined quality criteria grid, items will be directed either to local resale channels or to recycling.

Impact goals

The SOLSTICE partner, *Grenoble-Alpes Métropole*, has provided their initial impact estimates, while noting that these figures remain highly uncertain due to the early stage of the pilot's development.

The expected volumes are as follows:

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[78] Mes Osona. (2025, December 15). Torna el Ressò, el mercat social de segona mà a Vic que dona segones oportunitats a objectes i persones. Retrieved from: Revista Més Osona Website

[79] Acte. (2023, April 18). Spain: Supporting upcycling where people are. Retrieved from: Acte Website

[80] Ayuntamiento de Barcelona. (n.d.). Renueva tu ropa. Retrieved from: El portal oficial del Ayuntamiento de Barcelona

- Repair/upcycling was indicated to be **200 units** (estimated at 76 kilograms)[81]
- Swapping and reuse was indicated to be **300 units** (estimated at 114 kilograms)
- Collection through innovative containers is 350 kilograms,[82] based on the estimated number of times a 200-litre collection point is filled to full capacity

6.4 Prato

Pilot plans

Prato's pilot centres on a customised version of the GreenApes app,[83] supported by a dedicated communication campaign. The app encourages citizens to repair and reuse clothing by rewarding circular and sustainable behaviours with discounts and benefits at participating businesses in the local circular textile sector.

The app's design and objectives emerged from a series of co-design workshops. Participants expressed the need for an incentive scheme that rewards circular and sustainable behaviour, as well as for an informative, educational, and action-oriented digital tool. Proposed features included educational content, a space for sharing best practices, a social space, a system for validating sustainable actions, and a function for proposing or signalling local events and rewards.

The app was launched on 7 November 2025[84] and is available for both iOS and Android devices. Users can explore a digital environment dedicated to textile sustainability and identify local businesses (such as shops, artisan workshops, and associations) offering circular services. Videos, quizzes, and interactive articles provide guidance on caring for, repairing, and recycling clothing. The app also includes a map of local points of interest, indicating where to donate, exchange, or dispose of clothing responsibly. To incentivise engagement, users earn points by completing actions such as interacting with content, participating in app activities, or checking in at participating shops and workshops. Points can be donated to local social and environmental projects, unlocking rewards such as store discounts, reduced admission to theatres and museums, and cultural experiences within the city.

Shortly after its launch, the app included 50 mapped shops, more than 60 textile donation bins, 20 active partners, and over 130 active users.

Impact goals

Prato aims to achieve 2,000 downloads of the GreenApes app. Based on early pilot data and extrapolated over the full project duration; this target corresponds to an estimated 5,052 registered actions. For the purposes of this analysis, each action is assumed to correspond to one garment, resulting in an estimated total of 1,920 kilograms of textiles.[85]

[81] Using an average weight of 380 grams per garment. Data shared by Alia Servizi Ambientali Spa (Solstice partner), resulting from analysing a 350 kg compacted bale of clothing.
[82] For the analysis it is assumed that from the collected textiles, only 54% is gonna be reused, following the pattern as current textiles collected separately in Grenoble.
[83] See: https://www.solstice-project.eu/press-releases/1wzkjs3psnsxqbaa4zqwo51xyfn1my
[84] GreenApes. (n.d.). GreenApes a Prato: La rivoluzione dall'armadio. Retrieved from: GreenApes Website
[85] Using an average weight of 380 grams per garment. Data shared by Alia Servizi Ambientali Spa (Solstice partner), resulting from analysing a 350 kg compacted bale of clothing.

7. Estimated environmental impact reductions

7.1 Berlin

The impact results for Berlin are presented in Table 7. The results are expressed as low-high value ranges, reflecting assumed displacement rates of 40-80%. This means that between 40 and 80% of repairs are considered to avoid the purchase of a new pair of jeans. The analysis assumes a material composition of 94% cotton and 6% polyester.[86]

Impact categories	Total estimated environmental impact reduction	Contextualisation
Global Warming Potential (tonnes CO_2e)	5.7–11.4	Equivalent to ~ 67,059 kilometers driven by car (equivalent to 12 round trips by car Berlin-Lisbon).[87]
Energy Use (non-renewable, fossil, MWh)	19.0–38.0	Annual electricity consumption of 6 to 11 households in Germany. [88]
Water Consumption (m^3)	1,182.7–2,365.4	Annual water consumption of 26 to 52 persons in Germany.[89]
Land Use (m^2 crop eq)	1,651.1–3,302.1	Approximately one-third to two-thirds of a football field of agricultural land.

Table 7: Estimated environmental impact reductions Berlin (results reported in their respective units).

In Europe, consumers own on average nine pairs of jeans per person.[90] For Berlin's approximately 3.7 million residents, this corresponds to around 33 million pairs of jeans in use. Given that the pilot covers 1,000 jeans out of an estimated 33 million in use, the results presented here represent only a small fraction of the potential environmental benefits that could be achieved through large-scale adoption of repair services.

7.2 Grenoble

The impact results for Grenoble are presented in Table 8. The results are expressed as ranges reflecting displacement rates of 40-80%, meaning that 40-80% of the textiles to be repaired,

[86] Beton, Adrien., Cordella, Mauro., Dodd, Nicholas., Boufateh, Ines., Wolf, Oliver., Kougoulis, Jiannis., Dias, Debora., Desaxce, Marie., Perwueltz, Anne., Farrant, Laura., Gibon, Thomas., & le Guern, Yannick. (2014). *Environmental improvement potential of textiles (IMPRO Textiles)*. Publications Office.

[87] Considering an average petrol car emitting 170 grams per kilometer. https://ourworldindata.org/travel-carbon-footprint#:~:text=An%20average%20petrol%20car%20emits,123%2C000%20grams%20(123%20kilograms).

[88] Considering an average consumption of 3,383 kWh per household. https://www.destatis.de/EN/Themes/Society-Environment/Environment/Environmental-Economic-Accounting/private-households/Tables/electricity-consumption-private-households.html

[89] Considering a daily consumption of 123 liters per person. https://www.bundesumweltministerium.de/en/topics/water-management/overview-water-management/drinking-water#:~:text=The%20%22consumption%22%20of%20water%2C,is%20particularly%20high%20in%20conurbations.

[90] Cotton Inc survey (2025). Supply Chain Insights – Denim Jeans (Europe). Available at The Cotton Incorporated Lifestyle Monitor™ website

swapped and collected for reuse are considered to prevent the purchase of a new clothing item. The textile composition presented in Table 5 was used for this analysis.

Impact categories	Total estimated environmental impact reduction	Contextualisation
Global Warming Potential (tonnes CO_2e)	2.0–3.9	Equivalent to ~22,941 kilometers driven by car (equivalent to five round-trips from Grenoble to Athens by car).[91]
Energy Use (non-renewable, fossil, MWh)	5.7–11.4	Annual electricity consumption of one to three households in Isère.[92]
Water Consumption (m^3)	346.6–693.2	Annual water consumption of six to 12 people in France.[93]
Land Use (m^2 crop eq)	762.8–1,525.7	Approximately one-third of a football field of agricultural land.

Table 8: Estimated environmental impact reductions in Grenoble (results reported in their respective units).

In Grenoble, textiles placed on the market are estimated at 17.7 kilograms per capita,[94] corresponding to a total of 7,900 tonnes. Given that the pilot covers only 540 kilograms, this represents less than 0.01% of the textiles put on the market. As such, the results presented here reflect only a very small fraction of the potential environmental benefits that could be achieved through large-scale adoption of textile repair and reuse practices.

While the Grenoble pilot focuses on repair, upcycling, swapping, reuse, and increasing collection, the collection component will generate tangible environmental benefits only if the collected textiles are effectively reused rather than incinerated.

7.3 Prato

The impact results for Prato are presented in Table 9. The results are expressed as ranges reflecting displacement rates of 40-80%. This means that 40-80% of the textiles to be repaired, swapped and collected for reuse are considered to avoid the purchase of a new clothing item. The textile composition presented in Table 5 was used for this analysis.

Impact categories	Total estimated environmental impact reduction	Contextualisation
Global Warming Potential (tonnes CO_2e)	9.9–19.8	Equivalent to ~116,470 kilometers driven by car (equivalent to 19 round trips Prato-Moscow by car).[95]

[91] Considering an average petrol car emitting 170 grams per kilometer. See https://ourworldindata.org/

[92] Considering an average consumption of 4.2 MWh per household. https://observatoire.enedis.fr/consommation

[93] Considering a daily consumption of 150 liters per person. https://www.notre-environnement.gouv.fr/themes/societe/le-mode-de-vie-des-menages-ressources/article/quelle-est-la-consommation-des-menages-en-eau-potable

[94] Territory Profile Grenoble (2025). Retrieved from Solstice website

[95] Considering an average petrol car emitting 170 grams per kilometer. See https://ourworldindata.org/

Energy Use (non-renewable, fossil, MWh)	28.8–57.6	Annual electricity consumption of 9 to 17 households in Italy. [96]
Water Consumption (m^3)	1,755.8–3,511.5	Annual water consumption of 40 to 80 people in Prato.[97]
Land Use (m^2 crop eq)	3,864.0–7,728.0	Approximately two-thirds to one football field of agricultural land.

Table 9: Estimated environmental impact reductions Prato (results reported in their respective units).

In Prato, textiles placed on the market are estimated at 16.5 kilograms per capita,[98] corresponding to a total of 4,200 tonnes. Given that the pilot only covers 1,920 kilograms, this represents less than 0.5% of the textiles put on the market. As such, the results presented here reflect only a small fraction of the potential environmental benefits that could be achieved through large-scale adoption of textile repair and reuse practices.

8. Discussion

In this report, we presented a preliminary estimation of the environmental impact reductions associated with the SOLSTICE pilot projects, identifying the variables that influence the magnitude of these reductions. The research methodology consisted of: (1) estimating the environmental impacts of different textile fibres, (2) establishing the composition of the textiles affected by the pilots, (3) determining the quantitative goals of each pilot,[99] and (4) estimating the displacement effects associated with the pilots. The results are presented as ranges and represent a first-order estimate of the environmental impact reductions across four environmental impact categories: Global Warming Potential, Energy Use, Water Consumption, and Land Use.

As with any LCA, the analysis entails several uncertainties. Firstly, the environmental impact data for the different categories was retrieved from the ecoinvent database. These data often represent global averages and therefore do not account for regional variations or differences in specific production processes (such as cultivation or extraction methods, and electricity mixes in the production process). The reported impacts should therefore be interpreted as indicative estimates. More detailed LCA studies incorporating specific cultivation practices, production techniques, and distribution and use phases can be retrieved in dedicated reports from Cotton Incorporated[100] and MISTRA.[101].

Second, the selected displacement rate, which describes the extent to which a circular intervention substitutes for the purchase of a new product, remains uncertain. It is based

[96] Considering an average consumption of 3.3 MWh per household. https://www.facile.it/energia-luce-gas/guida/consumo-medio-luce-di-una-famiglia-tipo.html

[97] Considering a daily consumption of 119 liters per person. https://esploradati.istat.it/databrowser/#/en/dw/categories/IT1,Z0920ENV,1.0/ENV_CITIES/DCCV_URBANENV_WATER/IT1,609_1_DF_DCCV_URBANENV_1,1.0

[98] Territory Profile Grenoble (2025). Retrieved from Solstice website

[99] At the time of writing, three out of four pilots were able to deliver this data.

[100] Cotton Incorporated. (2017). *LCA update fiber and fabric life cycle inventory* (pp. 1-162, Rep.). Retrieved from: Cotton Today Website

[101] Sandin, G., Björn, Spak, S.R., Zamani, B. & Peters, G. (2019). *Environmental assessment of Swedish clothing consumption* (pp. 1-167, Rep.). Retrieved from: RISE Website

on a high-level review of the available literature on this relatively new topic. The review indicated a range of 40-80%, influenced by multiple contextual and behavioural variables (as discussed in Chapter 5.2). In the next phase of the project, primary data from citizens engaging with the pilots may be collected to refine and strengthen this estimate.

Third, the current approach captures only the impacts associated with avoided clothing production. The direct environmental impacts generated by the pilots themselves—such as transport movements, electricity use of digital infrastructure, heating of buildings, or material losses—were not included in this assessment. These contributions are expected to be relatively small but will be examined in more detail in WP6. Social and economic impacts, which fall outside the scope of an environmental LCA, may also be addressed at a later stage.

A recurring challenge in LCA and environmental impact analyses more generally is the contextualisation of the results. Interpretation depends strongly on the objective of the study: whether the LCA is intended to compare alternatives, identify hotspots, or provide a broad-strokes overview of a new intervention. As this study is not designed for comparative purposes, carbon emissions results were contextualised by referencing total garment consumption within each city. Additional tangible equivalents (such as kilometers driven by car) were also provided to enhance interpretability. While the quantified impacts may appear modest at first glance, further research may show substantially greater benefits if the pilots are successfully scaled beyond the SOLSTICE project duration.

9. Conclusion

This study provided a high-level estimation of the environmental impacts associated with the circular textile pilots of the SOLSTICE project. The methodology also identified the variables that influence the magnitude of these impacts, with particular attention to displacement rate linked to the pilot interventions. The results offer an initial contribution to evidencing the environmental benefits of circular economy solutions—benefits that are often assumed but remain difficult to quantify. Although the methodology will be further refined in the next stage of the SOLSTICE project, the preliminary estimates presented here indicate a measurable reduction in environmental impacts resulting from the pilots.

These findings highlight the potential contribution of circular economy measures to reducing environmental pressures, particularly if the pilot initiatives are successfully scaled up in the future.

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