EKA DiMa

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Leftover fabric analyses with a description of design input

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Introduction

Textile and garment production is inherently resource-intensive, often resulting in significant waste, including fabric remnants from cutting, defective garments and roll-ends. These materials are frequently discarded or downcycled, yet they hold substantial potential for repurposing in other ways. Upcycling, a design-driven circular fashion strategy, offers a viable approach by transforming pre- or post-consumer textile waste into new garments, enhancing their value and extending their lifecycle. In the textile industry, textile waste can account for 25–40% of the total fabric used in garment production. Upcycling presents an opportunity to reclaim up to 80% of certain waste types, such as spreading loss and excess fabric.

This report builds on the findings from the first report, which mapped the textile waste and leftover materials generated at Rivatex in 2022. This second report will analyze these materials in greater detail, exploring which materials can be used for upcycling and showcasing design examples that demonstrate how textile waste and leftovers can be effectively repurposed into new, circular and marketable products – aligning with the principles of the UPMADE circular design business model.

This report is divided into three sections. Section 1 analyses leftover textile materials at Rivatex, including an assessment of their upcycling potential and evaluates the potential reduction of environmental footprint through upcycling. Section 2 presents examples of upcycled products with design input, showcasing how leftover materials can be creatively repurposed. Section 3 details the life cycle assessment of conventional and upcycled long-sleeved jacket production.

1 Leftover fabric analysis and upcycling potential assessment

This section examines the types of textile waste and leftover materials generated at the Rivatex textile factory, focusing on their potential for upcycling. A detailed mapping process identified several fabric categories as suitable for repurposing into new upcycled products. The findings provide valuable insights into which materials hold the highest potential for integration into upcycling design practices, contributing to a more circular production system at Rivatex.

1.1 Overview of the mapped fabric leftovers

This analysis focuses on the textile waste and leftover materials generated during two key production stages: fabric and garment production. These materials were assessed for their potential to be repurposed into upcycled products, with a particular emphasis on identifying those with the highest upcycling potential (as discussed in Report 1). The materials considered include:

- Non-moving fabric
- Grade A fabric
- Grade B fabric
- Grade C fabric (fents)
- Off-cuts
- Roll-ends and end-bits

The following subsections provide detailed characterizations of these fabric categories, offering insights into their suitability for upcycling.

Non-moving fabric
Non-moving fabric refers to fabric that remains unsold for extended periods, typically due to a lack of market demand or specific quality issues. While some fabrics are repurposed internally or sold at discounted prices, others, especially those with unpopular prints or patterns, can remain in storage for several years. Approximately one-third of the non-moving stock is particularly challenging to sell due to misalignments with current market trends or quality discrepancies. These fabrics are stored in rolls within the processing area, with lengths ranging from as short as 5 meters to as long as several hundred meters for a single type of fabric.

Grade A fabric
Grade A fabric consists of leftovers from production that meet the required quality standards but remain unsold for various reasons, such as being surplus from initial orders. The fabric is generally retained for potential secondary orders, meaning it may be used for client-specific orders or converted into new products for future production. Grade A fabrics typically come in lengths greater than 5 meters.

Grade B fabric

Grade B fabric has minor defects, such as small stains or slight imperfections. Despite these imperfections, grade B fabric is still considered usable for various purposes. It may be suitable for creating products where the defects are not noticeable or for discounted sales. It typically has a length of over 5 meters on average.

Grade C fabric

Grade C fabric, commonly referred to as fents, is fabric waste generated during production that has significant defects, rendering it unsuitable for further use in garment production or sale. This type of fabric is typically discarded due to quality issues such as oil stains, tears, or contamination. The fabric pieces are roughly 0.5 to 1 meter long and can vary in size, with many consisting of smaller fragments or torn sections.

Off-cuts

Off-cuts are one of the most prevalent forms of fabric waste generated during garment production. They are created when pieces of fabric are cut according to the required pattern shapes, leaving behind various smaller fragments and strips. Their amount and size vary from order to order due to the garment’s design elements and order volume. Typically, they are small, ranging from a few centimetres to larger strips, with some reaching up to 30 cm in length.

Roll-ends and end-bits

Roll-ends and end-bits are fabric remnants generated during garment production, particularly during the spreading process. Variations in fabric roll lengths and the allocation of fabric can result in significant amounts of leftover fabric in different lengths. At Rivatex, roll-ends typically range from 3 to 10 meters long, while end-bits are generally from 30 cm up to 3 meters long. Because longer roll-ends are often reused directly in subsequent garment production orders, shorter roll-ends and end-bits have the potential to be repurposed for upcycling purposes.

1.2 Criteria for upcycling potential

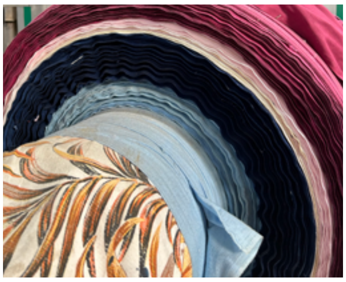
To assess the upcycling potential of textile waste and fabric leftovers, two main criteria were considered:

1. **Suitability of leftover fabric for upcycling**. This criterion evaluates the fabric based on key properties such as quantity, size, shape and quality. For a fabric to be suitable for upcycling, it must meet minimum requirements. Only fabrics that meet these standards can be repurposed into new upcycled products.
2. **Market demand for leftover fabric for textile production**. If a leftover fabric has an established secondary market or demand, it may be directed towards traditional textile product production outside of Rivatex rather than being used for upcycling within the company. Only leftover materials with no market demand and limited external use should be considered for upcycling within the company.

These criteria were assessed using a semi-qualitative approach, where each textile leftover was rated on a scale of High, Medium or Low. Leftover materials were evaluated based on quality, size, shape, and market demand, determining whether the fabric was more suitable for conventional production or upcycling.

The results of the upcycling potential assessment for fabric leftovers generated at Rivatex are presented in Table 1.

Table 1. Textile leftovers with upcycling potential. Photos by SEI Tallinn and EKA.

Type of fabric	Characterisation	Photo	Suitability for upcycling	Existing market or demand as fabric (textile production)
Non-moving fabric	Fabric that remains unsold for long periods due to quality issues or market demand. Length varies, typically 5 meters to 7800 meters.		High	Medium
Grade A fabric	High-quality fabric that meets specifications but remains surplus. Typically, they come in lengths greater than 5 meters.		High	High
Grade B fabric	Fabric with minor defects like stains or imperfections. Typically, it has an average length of over 5 meters.		High	Medium
Grade C fabric	Fabric with significant defects such as oil stains, tears or contamination. Length typically 0.5 to 1 meter.		Medium	Low
Off-cuts	Small pieces of fabric leftovers from the cutting process. Ranges from a few centimetres to tens of centimetres.		Low	Low
Roll-ends and end-bits	Fabric remnants are generated during the garment production spreading process. Roll-end 3 to 10 meters and end-bits <3 meters in length.		Medium	Low

1.3 Upcycling potential by fabric category

Assessing textile waste and fabric leftovers at Rivatex reveals that some materials hold more significant potential for upcycling. In contrast, others are better suited for conventional garment production or resale.

- **Grade B and non-moving fabric** demonstrate the most significant upcycling potential among the fabric categories. These fabrics are either less viable for resale or not incorporated into conventional production, making them ideal candidates for upcycling. Despite its good quality, non-moving fabric remains unsold due to limited market demand or specific quality issues. Approximately one-third of this fabric could be repurposed into upcycled products, either through reprinting or incorporating it into new designs. Grade B fabric, while slightly flawed with minor defects, also offers significant potential for repurposing. These imperfections make it less desirable for conventional production but highly suitable for upcycled products. With 50 tonnes of grade B fabric available according to the stock record in 2022 and moderate market demand, Rivatex has a clear opportunity to integrate this material into its upcycling efforts.
- **Grade A fabric**, however, presents a different case. As a high-quality surplus material that meets production specifications, it is in strong demand for resale or use in new products. Given its high market value and established secondary market, grade A fabric is less suitable for upcycling. It is better directed towards conventional textile production, where its resale value is maximized.
- Other fabric categories exhibit medium to low upcycling potential. **Roll-ends and end-bits**, remnants left over from fabric rolls after the spreading process, generally have medium upcycling potential. Longer roll-ends, typically over 5 meters, are in moderate demand as they can be resold or reused in subsequent orders. However, shorter roll-ends and end-bits have the highest potential for upcycling due to their size. Despite this, shorter end-bits present challenges for large-scale upcycling efforts, as their limited quantity in specific fabric types restricts the ability to use them efficiently in upcycled products.
- **Grade C fabric**, also known as fents, is characterized by significant defects such as oil stains, tears or contamination, making it unsuitable for conventional garment production. With minimal market demand, grade C fabric is generally unused for resale. While it does offer some potential for upcycling, overcoming its defects and the poor storage conditions that exacerbate its deterioration remain significant challenges. Some grade C fabric could be reused in specific applications for upcycled products, but its overall potential is limited.

- **Off-cuts**, the small and irregular fabric pieces leftover from the cutting process, offer the lowest potential for upcycling. Their size and irregular shape make them challenging to repurpose efficiently and are often viewed as waste. While off-cuts may be used in smaller products, their limited size and irregularity reduce their suitability for larger upcycling projects. With low resale value and minimal market demand, off-cuts are generally unsuitable for traditional production or resale. However, with proper design strategies, up to 60% of cutting leftovers could be saved and integrated into smaller-scale upcycling products.

1.4 Estimated fabric leftovers for upcycling

Based on the assessment, Rivatex generates approximately 54.28 tonnes of fabric leftovers annually suitable for upcycling: these materials, particularly grade B and non-moving fabric, present significant potential for material reuse. Table 2 below summarises the estimated annual quantities of fabric leftovers at Rivatex that are considered viable for upcycling purposes.

Table 2. Rivatex's fabric leftovers with the highest upcycling potential (ranked by potential) and their estimated annual generation quantities

Type of fabric leftover	Estimated upcycling potential (t)
Grade B fabric	50
Grade C fabric	2
Non-moving fabric	0.73
Roll-ends and end-bits	0.11
Off-cuts	1.44
Total	**54.28**

Drawing from the experiences of other textile factories that have successfully implemented the UPMADE system, it is projected that, with adequate market demand, Rivatex could upcycle approximately 20% of the total fabric leftovers within the next 3–5 years. This would lead to upcycling approximately 10.86 tonnes of fabric leftovers, effectively reducing waste and contributing to the production of new upcycled products.

1.5 Potential reduction of environmental footprint through upcycling at Rivatex

As part of the textile and garment production waste stream mapping and the analysis of leftover materials, we assessed the potential environmental benefits of upcycling these materials at Rivatex through a Life Cycle Assessment (LCA), as outlined in Section 3. By identifying fabric leftovers suitable for upcycling, we explored how repurposing these materials could reduce the overall environmental impact of textile and garment production. Our analysis revealed that upcycling fabric leftovers from Rivatex's textile and garment production process has the potential to reduce CO_2 emissions significantly.

The assessment found that upcycling, compared to conventional production, has the potential to reduce emissions by 57.3% per ton. Theoretically, if all fabric leftovers identified as suitable for upcycling (54.28 t) were repurposed, greenhouse gas emissions from Rivatex's textile and garment production process could be reduced by up to 375.6 t CO_2 equivalent (CO_2 eq) compared to conventional production. A major driver of this impact reduction is the avoidance of new cotton cultivation and fabric production, as upcycling relies on existing leftover materials instead of newly sourced resources.

Given the projected upcycling capacity of 20% of fabric leftovers over the next 3–5 years, Rivatex can potentially reduce its CO_2 emissions by approximately 75.2 tonnes of CO_2 eq.

This demonstrates that even with limited upcycling capacity, significant environmental benefits can be achieved, with further improvements possible as Rivatex increases its upcycling efforts. Implementing the UPMADE model at Rivatex will play an important role in increasing the amount of upcycled fabric leftovers.

Section 3 provides a comparative analysis of the environmental impacts of two jackets used as a case study (conventional vs. upcycled), produced as part of the project.

2 Examples of upcycled products with design input

This section explores innovative upcycling design solutions developed from some of the leftover materials identified in the analysis. The focus is on upcycling materials with the highest potential, demonstrating how various fabric types, previously considered waste, can be creatively repurposed into functional upcycled products. Different upcycling techniques were tested to assess the feasibility of transforming fabric leftovers into valuable new upcycled items.

The designs, some developed by Reet Aus and others by circular design students from the Estonian Academy of Arts, showcase the potential of using textile waste and fabric leftovers in product development. These efforts emphasize the importance of circular design principles and highlight the role of upcycling in reducing waste, promoting circularity and adding value to leftover materials.

Example 1. Long-sleeved jacket made from grade B fabric.

Reet Aus designed three jacket variations that were all produced at the Rivatex factory.

- The first jacket was conventionally made from newly sourced cotton fabric.
- The second jacket was designed and produced based on upcycling principles. It was crafted from grade B cotton fabric with color defects, giving it a distinctive character. This fabric was neither dyed nor printed before sewing, allowing the fabric's unique flaw to become part of the jacket's aesthetic appeal.
- The third jacket also followed upcycling principles, created from grade B cotton fabric that had been stored for years. This fabric underwent a transformation — a fresh pattern was printed on it to give it new value. Additionally, to further reduce waste, both upcycled designs incorporated leftover buttons and threads.

Designed by Reet Aus, the upcycled jackets showcase the potential of upcycling leftover textile into new, functional garments, contributing to a more circular approach to fashion.

Photos 1–3. Jacket (left) made from newly sourced cotton fabric alongside two different upcycled jackets (middle and right) made from grade B fabric, designed by Reet Aus. Photos by Kristi Laanemäe.

Example 2. Lamp shades and reversible vests made from grade B fabric.

The design process began with identifying cotton fabrics with printing errors from Rivatex's waste materials. These fabrics, typically discarded due to imperfections, inspired a series of upcycled products that celebrated the uniqueness of these "mistakes". The first product was a reversible vest designed to be worn in a solid color or featuring bold Kenyan patterns, allowing the user to choose their style. The design maximized fabric usage, ensuring even the imperfect prints were incorporated meaningfully.

Additionally, the design extended to lampshades, where a minimalist form highlighted the fabric. Using a modular approach, the lampshades could be adjusted to different sizes, ensuring minimal fabric waste. This project demonstrated how fabric with printing errors (grade B) could be repurposed into stylish, functional items, offering both sustainability and creative innovation.

Photos 4–5. Lamp shades and reversible vests made from grade B fabric. Design and photos by Doreen Mägi.

Example 3. Apron and utility belt made from fabric end-bits.

The project began by selecting strong cotton fabric pieces from Rivatex's textile waste pile in the fashion and tailoring division. The chosen leftovers were fabric end-bits, large enough for practical use, which were repurposed into a zero-waste, one-size apron and utility belt for gardeners. The design focused on minimizing waste through clever cutting techniques that required minimal sewing, making the production process efficient.

The resulting aprons and utility belts are functional and durable, offering a sustainable solution for reusing cotton fabric that would otherwise be discarded. These items hold market potential in Estonian and Kenyan markets, where practical, high-quality products are in demand. This case study highlights how end-bits can be creatively repurposed into valuable and marketable products, promoting circularity and reducing industrial textile waste.

Photos 6–8. Utility belts and aprons are made from fabric end-bits. The design and photos are by Kaisa Moora.

Example 4. Quilted jacket made from off-cuts and grade B fabric.

The design for the quilted jacket utilized both off-cuts and grade B fabric. The process began by analyzing leftover fabric from the cutting process and utilising leftover grade B fabric with minor imperfections. The fabric was cut into consistent shapes using a quilting technique and then sewn together to create a quilted fabric. This fabric was incorporated into a simple jacket design, with bias tape added to cover the seams, making the jacket reversible.

This case study illustrates how off-cuts and grade B fabric can be creatively repurposed into stylish, high-value products. The quilted jacket showcases the potential for upcycling materials in fashion, offering an effective solution for reducing textile waste while producing marketable and functional items.

Photos 9–10. Quilted jacket made from off-cuts and grade B fabric. Design and photos by Eva-Liis Lidenburg.

Example 5. Tote bag and hat made from off-cuts and roll-ends.

The upcycled tote bag and hat design incorporated fabric leftovers from the Rivatex factory, including off-cuts and roll-ends. The process began by analyzing the available leftover materials, focusing on their quality and suitability for creating practical products. The fabric was then cut and assembled into unique patterns, ensuring each tote bag and hat had a distinct combination of colors and textures. The simple yet functional design allowed for efficient use of the materials while adding a style touch.

This case study demonstrates how off-cuts and roll-ends, often considered waste, can be creatively repurposed into high-quality, marketable products. The upcycled tote bag and hat illustrate the potential of using textile waste in accessory design, showcasing how upcycling can reduce material waste while creating functional and sustainable products that appeal to local markets.

Photos 11–12. Tote bag and hat made from off-cuts and roll-ends. Tote bag design by Reet Aus. Photos by SEI Tallinn and EKA.

3 Life cycle assessment of conventional and upcycled long-sleeved jacket production

The following section presents the results of the life cycle assessment (LCA) conducted to compare the environmental impacts of conventional and upcycled garment production at Rivatex. This case study aims to evaluate and showcase the potential benefits of incorporating the UPMADE system into the garment production process and assess its contribution to reducing the environmental footprint.

3.1 Background and objective

As part of this project, a jacket was designed by Reet Aus (see Photo 13, depicting both jackets) to use leftover materials from textile and garment production processes and reintegrate them into new garment production. The design focused on repurposing grade B fabric, which would remain unused and discarded over time. To demonstrate the environmental benefits of this upcycling approach, two jackets were created with the same design: one using newly sourced 100% cotton fabric (Jacket A) and the other using leftover grade B fabric (100% cotton) (Jacket B), which was reprinted. This comparison clearly assesses the environmental impact of using leftover materials versus conventional materials in garment production.

This study evaluates the environmental performance of both jackets across 8 impact categories: acidification, climate change, eutrophication (marine, freshwater and terrestrial), land, resource and water use. The findings provide valuable insights into how implementing the UPMADE production model can reduce the environmental footprint of garment production.

Photo 13. The upcycled jacket (Jacket B) on the left and conventional jacket (Jacket A) on the right were designed by Reet Aus and made in the Rivatex factory. Cropped from the original photo by Maria Grunberg.

3.2 Methods

This LCA compares the environmental impacts of two types of jackets produced at Rivatex:

- **Jacket A**: A conventional jacket made from newly sourced 100% cotton fabric.
- **Jacket B**: An upcycled jacket made from leftover 100% cotton fabric, with a new print added through a reprinting process.

The study's functional unit (FU) was defined as one 750g unisex long-sleeved jacket made of 100% cotton fibre. The LCA covers the cradle-to-gate life cycle stages.

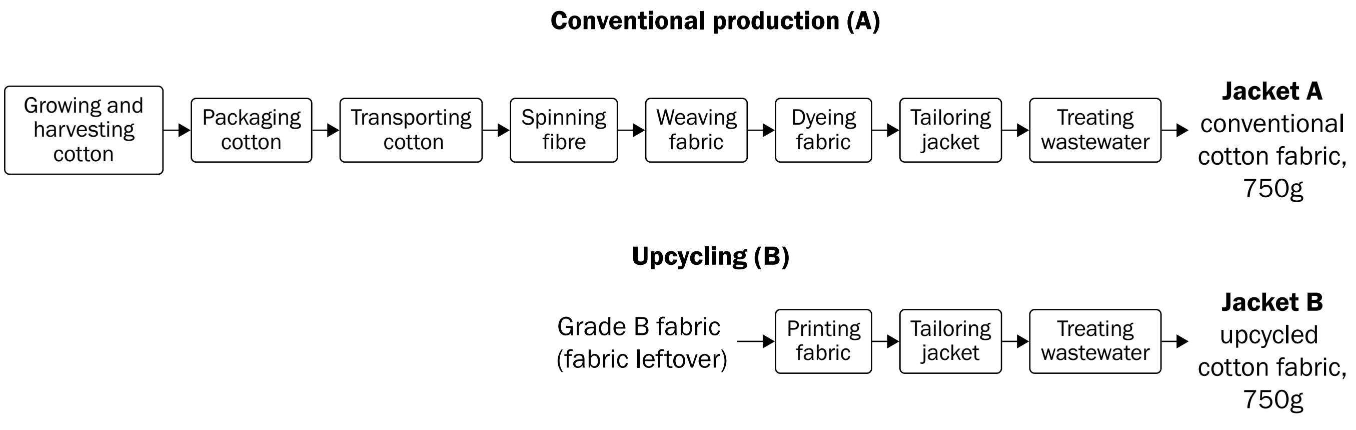
Data collection

Primary data (including information on the transportation of cotton fibre, packaging materials, resource and chemical use in each production step and waste outputs) for this study was collected from Rivatex in collaboration with experts from Moi University and the factory. This data reflects the actual textile and garment production processes at Rivatex. To implement this, secondary data from the Ecoinvent 3.10 database was used to help quantify the impacts of external inputs in the production process.

Life cycle stages and processes

The LCA covers all stages, from cotton cultivation to the final product. Figure 1 illustrates the supply chain stages of the case study, highlighting the processes included in both jacket production methods.

Figure 1. Supply chain stages for conventional (A) and upcycled (B) jacket production.



Both production methods have standard processes, such as tailoring, and wastewater treatment. However, in the upcycled jacket production process, fabric leftovers are repurposed, which eliminates the need for several resource-intensive steps such as cotton cultivation, harvesting, packaging, transportation, spinning and weaving. While leftover fabric may not always be reprinted, the fabric for Jacket B (upcycled) was reprinted, which is why the reprinting process is included in the supply chain stages for this case study.

The modelling of this case study was conducted using SimaPro Craft (Release 9.6.9.1) software.

Environmental impact and resource use categories

This LCA study includes the environmental impact and resource use categories in Table 3. These categories were selected to represent key environmental challenges within the textile industry. They are the areas where interventions, such as upcycling fabric leftovers, have the potential to reduce the environmental impact significantly.

Table 3. This LCA study includes environmental impact and resource use categories, including the characterisation methods used for each category.

Environmental impact and resource use category	Method	Unit
Acidification	Environmental Footprint 3.1	mol H+ eq
Climate change	Environmental Footprint 3.1	kg CO_2 eq
Eutrophication, marine	Environmental Footprint 3.1	kg N eq
Eutrophication, freshwater	Environmental Footprint 3.1	kg P eq
Eutrophication, terrestrial	Environmental Footprint 3.1	mol N eq
Land use	Environmental Footprint 3.1	Pt
Resource use, fossils	Environmental Footprint 3.1	MJ
Water use	Environmental Footprint 3.1	m3 depriv.

3.3 Limitations

While this study provides valuable insights into the environmental impact of conventional and upcycled garment production in Kenya, certain limitations should be acknowledged. These limitations stem from data availability, assumptions made in the modelling process and constraints in tracking specific production parameters. Despite these challenges, the findings offer a strong basis for assessing the benefits of upcycling at Rivatex. The key limitations of this study are as follows:

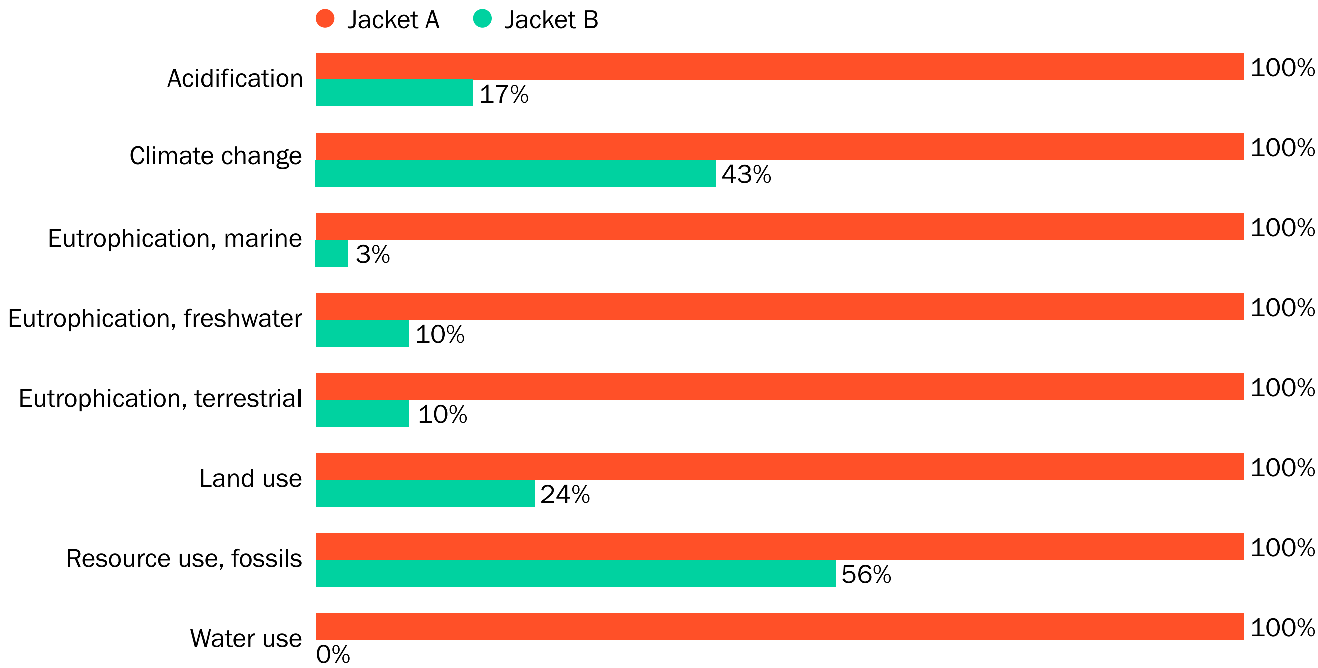
- Jackets A and B were made from cotton fabric sourced from Kenya. Due to the unavailability of cotton growing and harvesting data on Kenya and neighbouring countries in the Ecoinvent database, data on the global market was used for these stages in the life cycle assessment. This assumption may introduce some uncertainty, as the environmental impacts of cotton farming can vary between regions and countries. It is also important to note that Rivatex sources its cotton from a combination of Kenya, Tanzania, and Uganda, with approximately 50% of the cotton coming from Kenya, 30% from Tanzania, and 20% from Uganda.
- Energy consumption data was provided for both the dyeing and weaving processes, with steam supplied by a single boiler at a time. Due to the lack of separate metering units to determine energy use for each division, all energy consumption was allocated entirely to the dyeing process, assuming it requires the most energy. This allocation method introduces some uncertainty, potentially leading to an overestimation of energy use for dyeing and an underestimation for weaving.
- Not all chemicals used in printing the pattern on the upcycled fabric are included in the analysis, as some data is still being verified. However, in general, this should not significantly impact the results of this LCA.
- The environmental impact of wastewater treatment was assessed based on information on the chemicals used in the treatment process provided by Rivatex and energy consumption data obtained from another UPMADE-certified factory, as Rivatex's specific data was unavailable. However, due to the lack of detailed information on the composition of the treated wastewater and the potential pollutants in the effluent released into the environment, the full environmental impact of the wastewater was not considered. This limitation arises because, without knowing the exact substances remaining in the effluent, it was impossible to assess the wastewater treatment process's environmental impact fully.

3.4 Results

This section presents the results for the selected impact categories based on the life cycle assessment for jacket A and jacket B. The analysis focuses on 8 impact categories most relevant to garment manufacturing processes, providing a comprehensive overview of the environmental performance of conventional and upcycled jacket production methods.

The life cycle assessment results indicate that the upcycled jacket exhibits a substantially lower environmental footprint across all impact categories (Figure 2). The reduction in environmental impact is particularly significant (75–100%) in acidification, eutrophication, land use, and water consumption. Additionally, a substantial decrease (43–57%) in impact is observed in climate change and resource use domains.

Figure 2. Impacts of conventional (Jacket A) and upcycled (Jacket B) cotton jacket production.



The following subsections provide a more detailed description of the results from the LCA impact category calculations.

Acidification

Acidification indicates the potential acidification of soils and water due to the release of gases such as nitrogen oxides and sulphur oxides. Jacket B, made from upcycled cotton fabric, exhibits an 83% reduction in acidification compared to Jacket A (Figure 3).

Figure 3. Acidification impact of conventionally produced Jacket A and upcycled Jacket B.

Climate change

The climate change impact category refers to the greenhouse gases (GHGs) emitted during production, contributing to global warming. Jacket B, made from upcycled cotton fabric, demonstrates a 57% reduction in CO_2 emissions compared to Jacket A. This is a direct result of using leftover fabric that does not require the resource-intensive processes involved in sourcing new cotton. The results for climate change are presented in Figure 4.

Unit: kg CO_2 eq

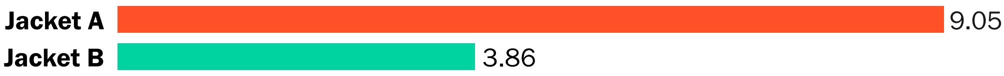


Figure 4. Climate change impact of conventionally produced Jacket A and upcycled Jacket B.

Eutrophication

Eutrophication (also known as nutrification) includes all impacts due to excessive levels of macro-nutrients in the environment caused by emissions of nutrients to air, water and soil. There are three different eutrophication categories: marine, freshwater and terrestrial. Note that the results for the eutrophication impact categories represented below are expressed in different units and, therefore, cannot be compared.

Marine eutrophication occurs when excess nutrients, primarily nitrogen and phosphorus, enter coastal and marine ecosystems, often due to agricultural runoff, wastewater discharge, and industrial pollutants. Jacket B shows a 97% reduction in marine eutrophication, suggesting that upcycling fabric significantly reduces the nitrogen footprint of garment production. The results for marine eutrophication are presented in Figure 5.

Unit: kg N eq

Figure 5. Marine eutrophication impact of conventionally produced Jacket A and upcycled Jacket B.

Eutrophication in freshwater ecosystems results from excess phosphorus or nitrogen, which can degrade water quality and biodiversity. Jacket B shows a 90% reduction in freshwater eutrophication compared to Jacket A, demonstrating that upcycling fabrics reduce marine eutrophication and positively impact the health of freshwater ecosystems. The results for freshwater eutrophication are presented in Figure 6.

Unit: kg P eq

Figure 6. Freshwater eutrophication impact of conventionally produced Jacket A and upcycled Jacket B.

Terrestrial eutrophication involves the deposition of nitrogen compounds into soils, which can alter plant growth and biodiversity. Jacket B shows a 90% reduction in terrestrial eutrophication, suggesting that upcycling fabric significantly reduces the nitrogen footprint of garment production. The results for terrestrial eutrophication are presented in Figure 7.

Figure 7. Terrestrial eutrophication impact of conventionally produced Jacket A and upcycled Jacket B.

Land use

Land use evaluates the impact of land consumption and land management practices throughout a product's life cycle (in this case, from cradle-to-gate). This category focuses on how land use for various purposes, such as agriculture and mining, affects the environment. Jacket B, made from upcycled cotton fabric, exhibits a 76% reduction of the land use impacts compared to Jacket A (Figure 8).

Figure 8. Land use impact of conventionally produced Jacket A and upcycled Jacket B.

Resource use, fossils

Fossil resource use refers to fossil-based resources like coal, oil, and natural gas. These resources are used in garment manufacturing, primarily due to electricity generation. Jacket B demonstrates a 44% reduction in resource use, indicating that upcycling consumes significantly less electricity than conventional garment manufacturing. The results for resource use (fossils) are presented in Figure 9.

Figure 9. Resource use (fossils) impact of conventionally produced Jacket A and upcycled Jacket B.

Water use

The primary considerations of water use (water scarcity) are water quality and water availability in the region. The water use for Jacket B is 0.19 m^3 deprivation-equivalent, which is close to zero. This indicates up to 100% reduction in the water scarcity footprint during the upcycling process compared to a conventionally manufactured jacket. The results for water use are presented in Figure 10.

Figure 10. Water use impact of conventionally produced Jacket A and upcycled Jacket B.

3.5 Conclusion

This life cycle assessment aimed to evaluate the environmental benefits of upcycling by comparing a conventionally produced garment with an upcycled one. The reference product was a jacket made from newly sourced 100% cotton (Jacket A), while the upcycled jacket (Jacket B) was made using leftover grade B fabric (100% cotton), which was reprinted. This analysis was based on the assumption that there was no additional environmental impact from fabric production for Jacket B, as it was made entirely from grade B fabric that had been stored for years. The analysis considered the environmental impacts associated with upcycled fabric processing, starting from printing.

The results indicate that Jacket B has a substantially lower environmental impact than Jacket A across all impact categories. The most notable reductions are in acidification, eutrophication, land use and water consumption. Significant decreases are also observed in climate change impacts and resource use, further demonstrating the advantages of upcycling.

This case study demonstrates that upcycling, mainly when applied at an industrial scale, can significantly reduce the environmental footprint of garment production. It also shows that by adopting the UPMADE model into its existing textile and garment production processes, Rivatex can directly contribute to lowering greenhouse gas emissions and resource consumption. While this study focuses on a single jacket, the environmental benefits of upcycling would be even more pronounced in large-scale industrial production, where substantial volumes of fabric can be repurposed.

Transferring UPMADE Know-How to Kenya, 2025

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