IMPACT

Northumbria University NEWCASTLE

GreenStory

Evaluating Use & End Of Life Impacts

Based on Survey Data in UK

Authors



Akhil Sivanandan

CEO of Green Story, enabling brands worldwide to measure, manage, and communicate environmental impact with confidence.



Dr. Alana James

Director for the IMPACT+ Network and Associate Professor in Fashion in the School of Design at Northumbria University.



Nkumbu Mutambo

Nkumbu is a Post-doctoral Research Fellow at Northumbria University, exploring the role and impact design can have on society.



Dr. Karpagam Subramanian

Technical Manager of LCA Projects at Green Story, translating complex environmental data into actionable sustainability insights.

Executive Summary

Highlighting critical gaps in the measurement of environmental impact during clothing use & end-of-life

Purpose

This report was developed to highlight critical gaps in how the environmental impacts of clothing use and end-of-life are currently understood, measured, and mitigated within the fashion industry. While life cycle assessment (LCA) is widely used to quantify environmental impacts, most existing studies focus predominantly on pre-consumer stages, with system boundaries often ending at the factory gate. As a result, the impacts associated with consumer use, care, and disposal remain underrepresented.

Additionally, incoming and evolving legislation is increasing expectations for more comprehensive, transparent, and standardized environmental impact measurement and disclosure. This creates an urgent need for more rigorous mechanisms that better reflect full life cycle impacts and support industry readiness.

The purpose of this report is to raise awareness among industry and consumers of the environmental significance of garment use and end-of-life behaviors; to provide designers and product developers with actionable insights that can inform eco-design, durability, and longevity strategies; and to contribute evidence that supports more holistic, future-proof assessment approaches aligned with emerging regulatory requirements. By addressing these gaps, this report aims to enable more informed decision-making and support meaningful impact reduction across the fashion value chain.

Contents

01 The Problem

02 Method

03 Findings

04 Recommendations

The Problem

Understanding the environmental impact caused by consumer use and end-of-life behaviors

Life cycle assessment (LCA) is a key method used across industries, including the Fashion and Textiles sector, to quantify environmental impact.



Drawing on a combination of primary and secondary data, the LCA methodology is designed to calculate a range of impact categories across the entire lifecycle of a product from raw material extraction to end-of-life disposal.



LCA studies focus on the pre-consumer stages of the lifecycle with system boundaries defined as cradle to gate or gate-to-gate.

Critical gaps in understanding how consumers acquire, care for and dispose of garments during the use phase is limiting the efforts to create a holistic understanding of environmental impact.



Most Environmental LCAs in both academia and industry are incomplete, focusing primarily on **cradle-to-gate or gate-to-gate stages** that end at the factory or warehouse.

This limited scope excludes critical life cycle phases such as use and end-of-life, which play a major role in a product's true environmental footprint.

As a result, key ecodesign factors like durability, reusability, and actual impact per wear are often ignored, making it difficult to meaningfully compare materials, products, or systems on their real-world sustainability performance.

"This limited scope excludes critical life cycle phases such as use and end-of-life"

Method

Comparing consumer usage across different scenarios and quantifying impact across categories

Phase 1:

Gather primary survey data from consumers about how they care for and dispose of clothing.

Data was gathered via an anonymous online survey from UK consumers to identify usage and disposal patterns of 10 categories of commonly worn items. These representative categories were drawn from those covered by the European Union Product Environmental Footprint (PEF) methodology and LCA based assessment framework.

Product Categories:

- Dresses
- Shirt
- T-shirt
- Pants
- Sweaters
- Jackets
- Underwear
- Jumpsuits
- Leggings
- Swimwear

Survey data gathered was used to quantify impacts in three key categories.

Impact Categories:

1. **Climate Change**
2. **Resource Use**
3. **Water Use**

Phase 2:

The data generated was used to conduct an assessment of the environmental impact of the consumer phase of the lifecycle including use and end-of-life.

Drawing on survey data, an LCA was conducted following ISO 14040/44 methodologies. A cradle-to-gate product footprint was modeled based on secondary data.

Consumer usage scenarios

All scenarios are modelled using secondary data to account for the 'cradle-to-gate' and survey data was used for the use to disposal phase.

Baseline

Business as usual (BAU) with reuse of garments at end of their desirable life.

Product condition is still good when reaching reuse.

Ideal

Garments are used until quality deteriorates and then sent to reuse at the end of its usable life.

Product condition has deteriorated when reaching reuse.

Fast Fashion

Reduced first use with no reuse at end-of-life.

Product condition is still good, but is disposed without reuse.



Interpreting Results

Our research shows that usage patterns have a greater influence on environmental impact than often captured in LCAs, particularly when assessed on a per-wear basis.

Increasing garment use can significantly reduce impact per wear (–39%), highlighting durability and reduced overconsumption as key leverage points.

Why this happens:

Production impacts remain constant, but each additional wear adds washing and care emissions. As a result, total lifetime impacts increase, even while the average impact per wear decreases.

Paradox of usage

Lifetime Impact

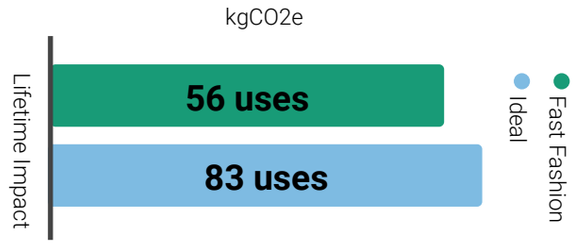
+11%

Lifetime impact (total)= Production + (Washes × impact per wash)

The sum of all emissions across the garment's **entire life**, including **production** and all **washing, drying,** and **care** during use.

Production
(a fixed impact)

Washing & Drying
(adds up over lifetime)



*Assumes proportional increase in washing and care with additional wears.

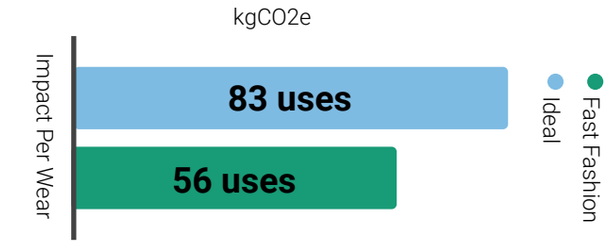
Per Wear Impact

-39%

Per wear impact = Lifetime impact ÷ Number of wears

The average emissions per single wear, calculated by **dividing the total lifetime impact by the number of wears.**

The **manufacturing impact** is now spread over **more wears**



Key insight:

Increasing garment use lowers impact per wear, but does not eliminate, and can increase, total lifetime impacts due to cumulative care emissions.

Findings

Understanding how environmental impacts of consumer usage scenarios varied across product categories

Consumer behavior is the main driver

Jacket 1

Carbon footprint via more sustainable supply chains:

15 kgCO2e

Worn 50 times

Impact per wear:

0.4 kgCO2e/wear



Jacket 2

Carbon footprint via typical supply chains:

24 kgCO2e

Worn 500 times

Impact per wear:

0.05 kgCO2e/wear



How long and often a garment is worn is the single most critical factor determining its ‘per wear’ footprint, often outweighing the impact of materials and manufacturing.

Interpretation - Product level

The most effective ways to reduce per wear impact of garments:

maximizing the number of wears during the first use

opting for reuse at end-of-life

↗ **The ideal:** has significantly lower per wear impacts by avoiding the need for new garment production.

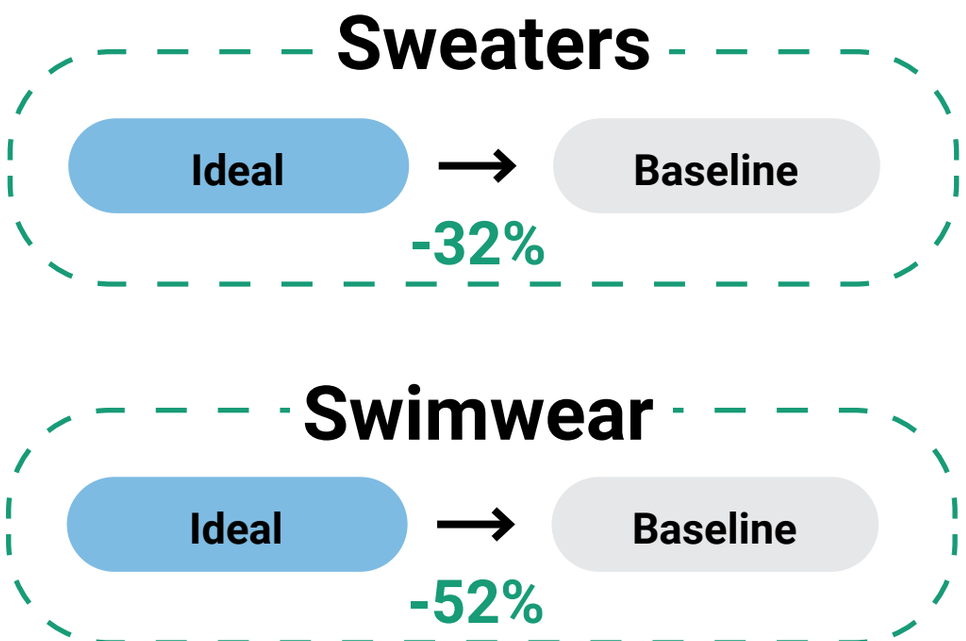
↗ **Fast fashion:** results in the highest per wear impacts due to increased demand for new garments and their resource consumption.

↗ **The baseline:** has lower per wear impacts than fast fashion, but higher than the ideal.

“The use phase is decisive”

– Karpagam Subramanian

Examples of decrease in per-use impact of special items:



Consumer behaviour is the main driver:
How long and often a garment is worn is the single most critical factor determining its ‘per wear’ footprint, often outweighing the impact of materials and manufacturing.

While ideal has the highest total number of washes (leading to higher total life cycle impact), spreading this impact over a greater number of wears drastically reduces the impact per use. With extended lifespan, the gains are more relevant particularly for high production impact items and special items such as, sweaters, jackets, swimwear and dresses.

Extending the initial lifespan of a garment (Ideal) has a greater environmental benefit than the current common practice of buying new and donating lightly used items (Baseline).

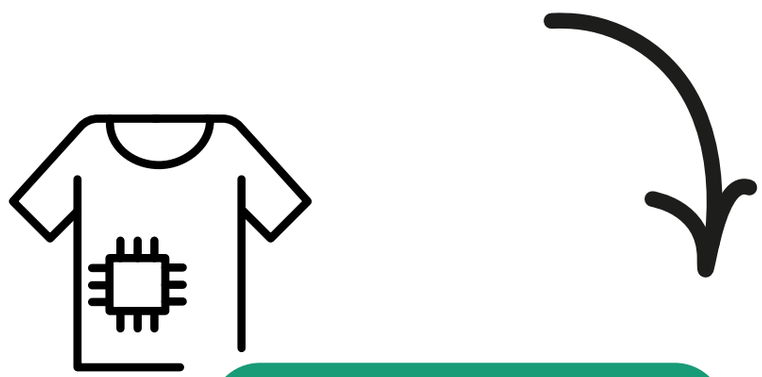
Design for durability and longevity. The environmental payoff of a garment that can withstand 200 wears instead of 50 is immense.

The most significant lever for reducing a garment's footprint is in the hands of the first owner.

Shift consumer messaging from

Recycle Your Clothes





Wear Your Clothes Longer

Consumer Behaviour

High-impact garments

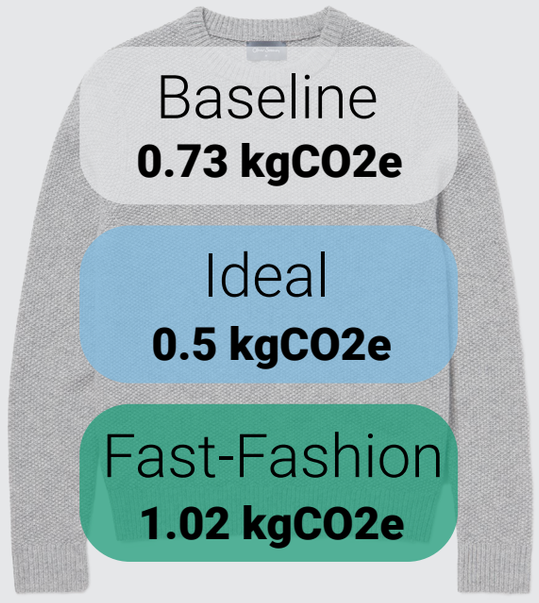
High-impact garments like sweaters (production impact of 56 kg CO_2) and jackets (12 kg CO_2) show significant sensitivity to lifespan. The baseline impact of a sweater can be reduced by 32% with long lifespans or worsened by 40% with short lifespans. The impact soars from 0.5 to 1.02 kg CO_2e/wear, a 104% increase from shortest to longest lifespan, making early disposal one of the most carbon-intensive decisions in a wardrobe.

↗ The impact of a sweater can be reduced by 32% with long life spans.

↗ The impact can be worsened by 40% with short lifespans.

Example: Sweater

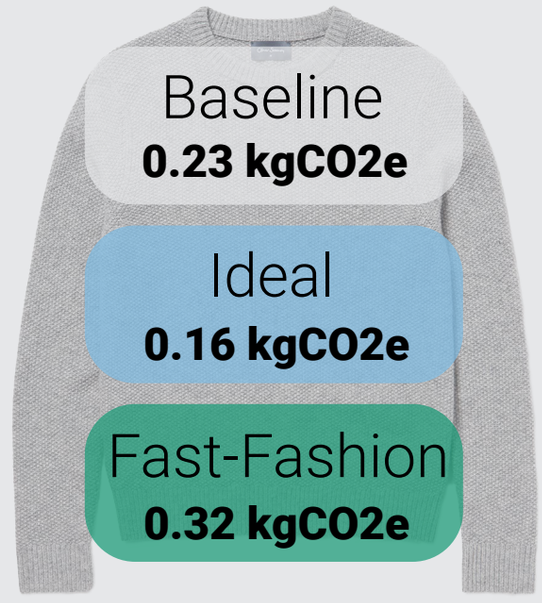
1 Climate Change



2 Resource Use



3 Water Use



Everyday basics

Everyday basics like T-shirts (5 kg CO_2) and underwear (2.33 kg CO_2) have low production impacts. For T-shirts, the baseline per wear can be improved by 25% through extended use, but deteriorates by 38% when discarded early. Unlike heavy and high impact items like sweaters and jackets, for these items, longevity is still important, but improving washing efficiency or product durability that allows these products to withstand extended washing is a critical parallel strategy to reduce their footprint.

The impact of a sweater can be improved by 25% through extended use.

The impact deteriorates by 38% when discarded early.

Example: T-shirt

1 Climate Change



2 Resource Use



3 Water Use



Special products

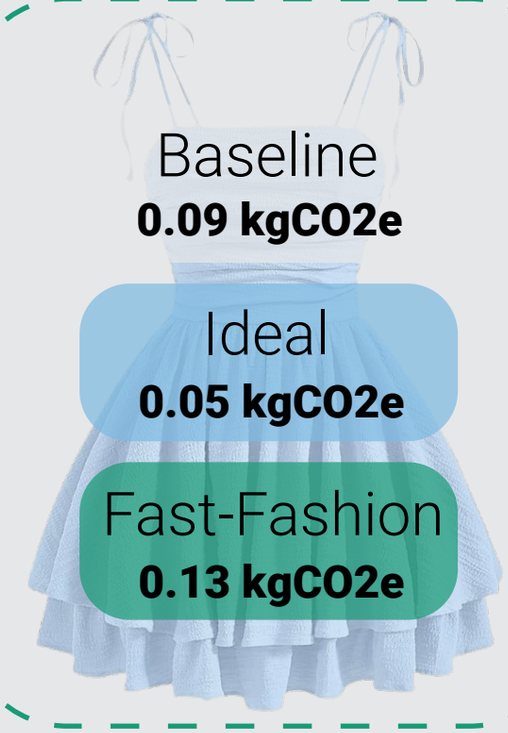
Special products like dresses (4 kg CO_2) and swimwear (8 kg CO_2) have moderate production impacts. Most importantly, these utilization-sensitive items show a baseline of 0.26 kg CO_2e per wear for swimwear that can be cut in half to 0.13 kg CO_2e through high use, but surges by 35% with low utilization, making it the most behavior-dependent item in the wardrobe. The impact soars to a 169% increase from shortest to longest lifespan.

↗ The impact of swimwear can be reduced by 50% through high use.

↗ The impact surges by 35% with low utilization.

Example: Dress

1 Climate Change



2 Resource Use



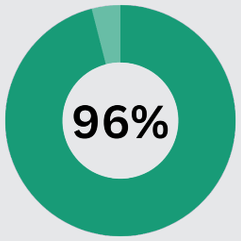
3 Water Use



Key Insights

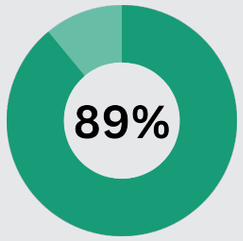
The study highlighted the overall cradle-to-grave impacts of ten representative products aligning with product category rules for PEF.

Up to...



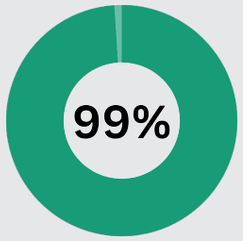
of resource use impacts come from garment production.

Up to...

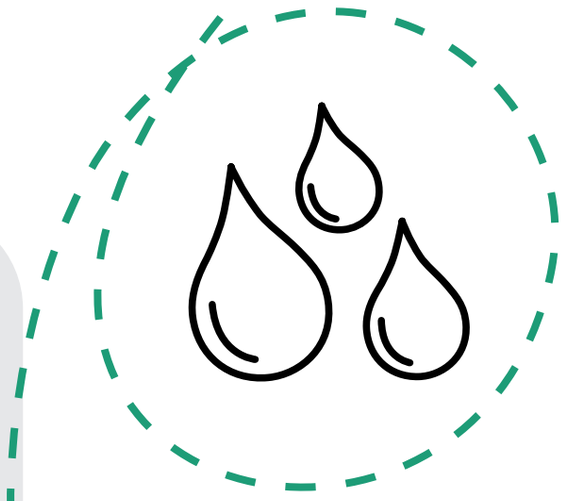


of climate change impacts come from garment production.

Up to...



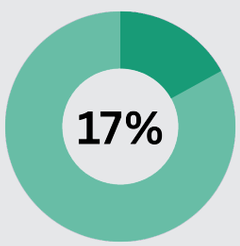
of water use impacts come from the garment production.





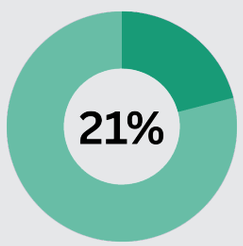
Conventional cotton cultivation is the largest contributor to water use.

Up to...



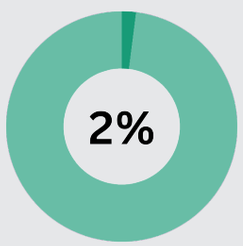
of climate change impacts come from garment use.

Up to...



of resource use impacts come from garment use.

Only...



of the water use impacts come from garment use. Driven by water used in residential washing.

Recommendations

Strategic interventions to reduce environmental impact

Recommendations

Based on the study findings, several strategic interventions can be recommended to reduce the ‘per wear’ environmental footprint of garments throughout their life cycle:

1 Consumer Awareness and Behavioral Shifts

Educate consumers on the advantages of extending the product’s life and share disposal options that incentivize garment returns for reuse/recycling.

2 Increase Adoption of Circular Fashion Models

Promote alternative end-of-life options like charity, donation, resale, rental, rather than landfilling. Motivate consumer participation in cicrcular fashion initiatives.

3 Enhance Sustainable Garment Care Practices

Educate consumers on washing at lower temperatures, reducing washing frequency, and air drying instead of machine drying. Encourage the use of eco-friendly detergents and microfiber filters to minimize water pollution.

4 Optimize Production Processes

Invest in more sustainable fiber sourcing, such as organic cotton and recycled materials. Improve energy efficiency and reduce wastage across garment manufacturing and production processes.

5 Policy and Industry Collaboration

Implement Extended Producer Responsibility (EPR) regulations, making manufacturers accountable for the end-of-life management of their products.
Strengthen apparel sustainability certification systems to encourage transparency and accountability.

Contact Us

Join us in empowering clothing companies to create a sustainable future with data-driven transparency.



GreenStory

Akhil Sivanandan

akhil@greenstory.io

www.greenstory.io



IMPACT+

Dr. Alana James

alana.james@northumbria.ac.uk

https://hosting.northumbria.ac.uk/impactplusnetwork/

The IMPACT+ Network is supported by:

UKRI Arts and Humanities Research Council

UKRI Natural Environment Research Council

UKRI Innovate UK