



waste2  
biocomp

# End-of-life alternatives

Colour removal and Reprinting

28<sup>th</sup> November

Author: Joana Gomes

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# Overview

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## 04. Textile reprinting and redyeing

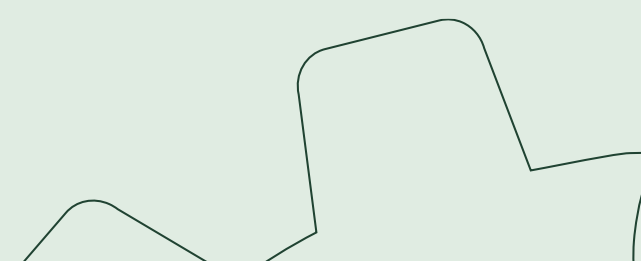
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## 05. Case studies and examples related to W2BC (and other projects)

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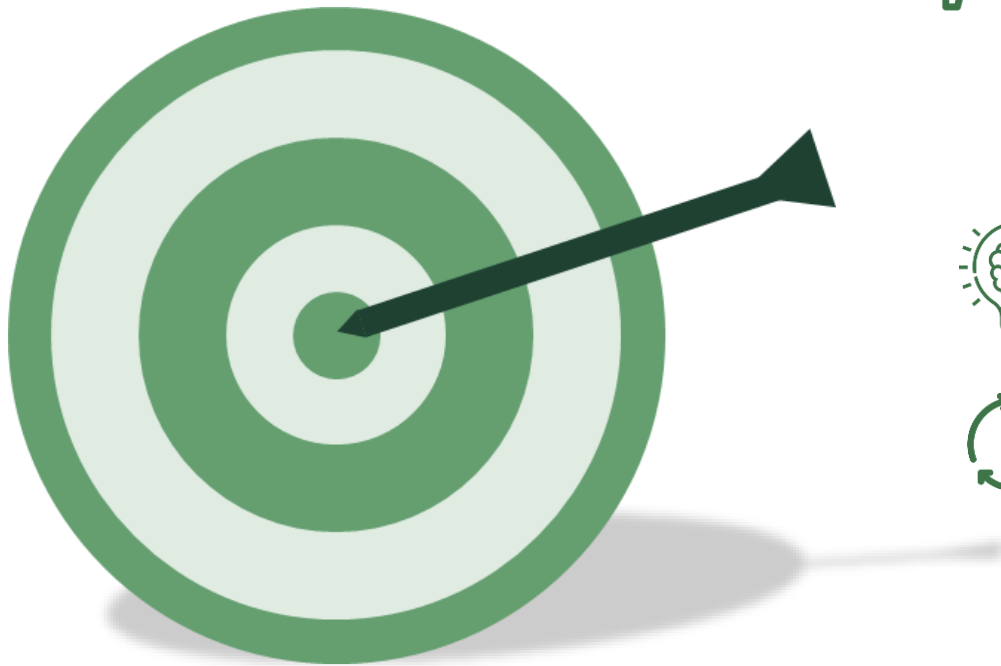
## 06. Conclusions and take-home message

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# 01. Objectives



To provide participants with a clear understanding of the main principles of textiles end-of-life



To increase awareness of the **Environmental Impact of Textile** waste and inform participants about **End-of-Life Solutions for Textile**



To highlight the importance of **Sustainable Practices** with a focus on the importance of colour removal and reprinting



When poll is active respond at [PollEv.com/joanagomes965](https://PollEv.com/joanagomes965)



What words and thoughts come to mind when you hear the phrase "end-of-life of textiles"?

incineration  
end  
lanfill  
death  
landfill  
garbage  
disposal



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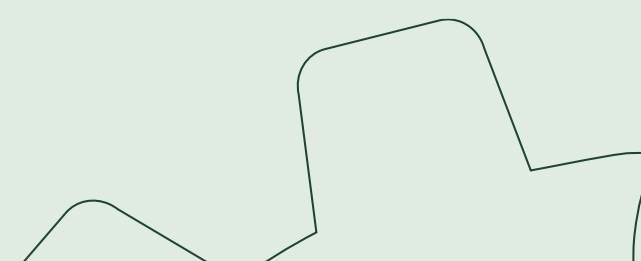
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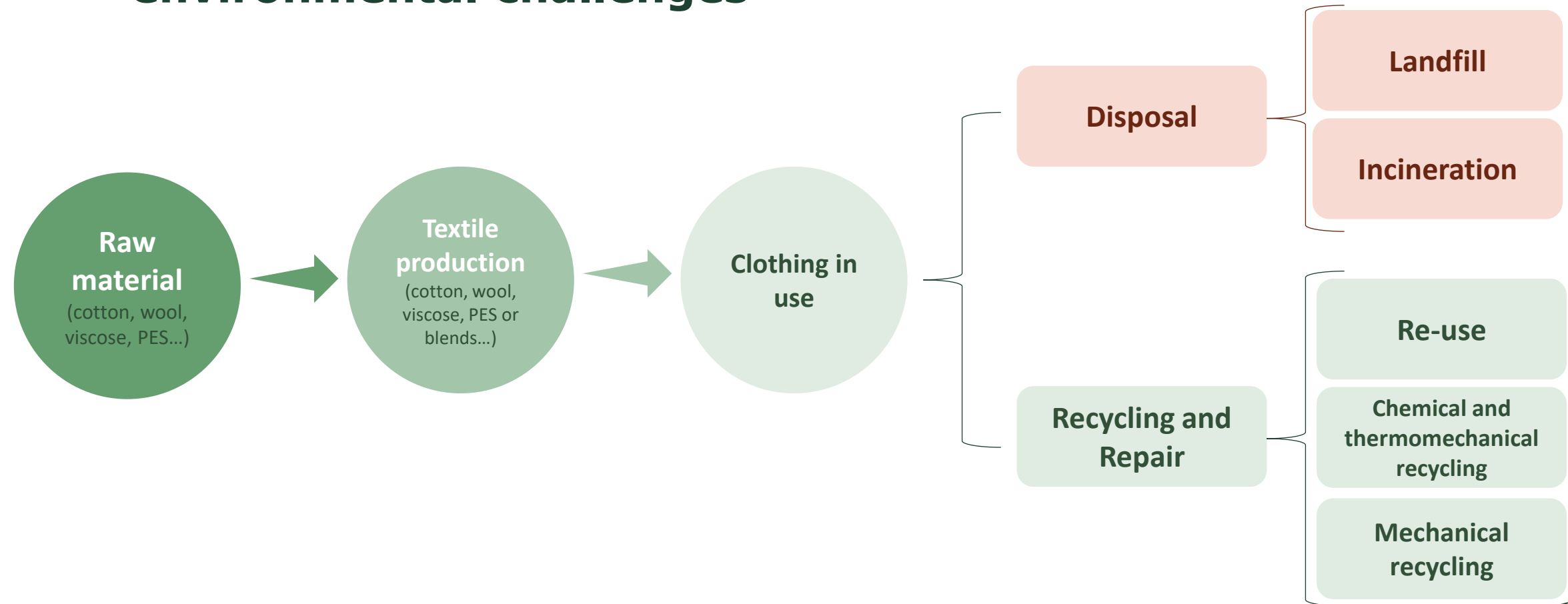
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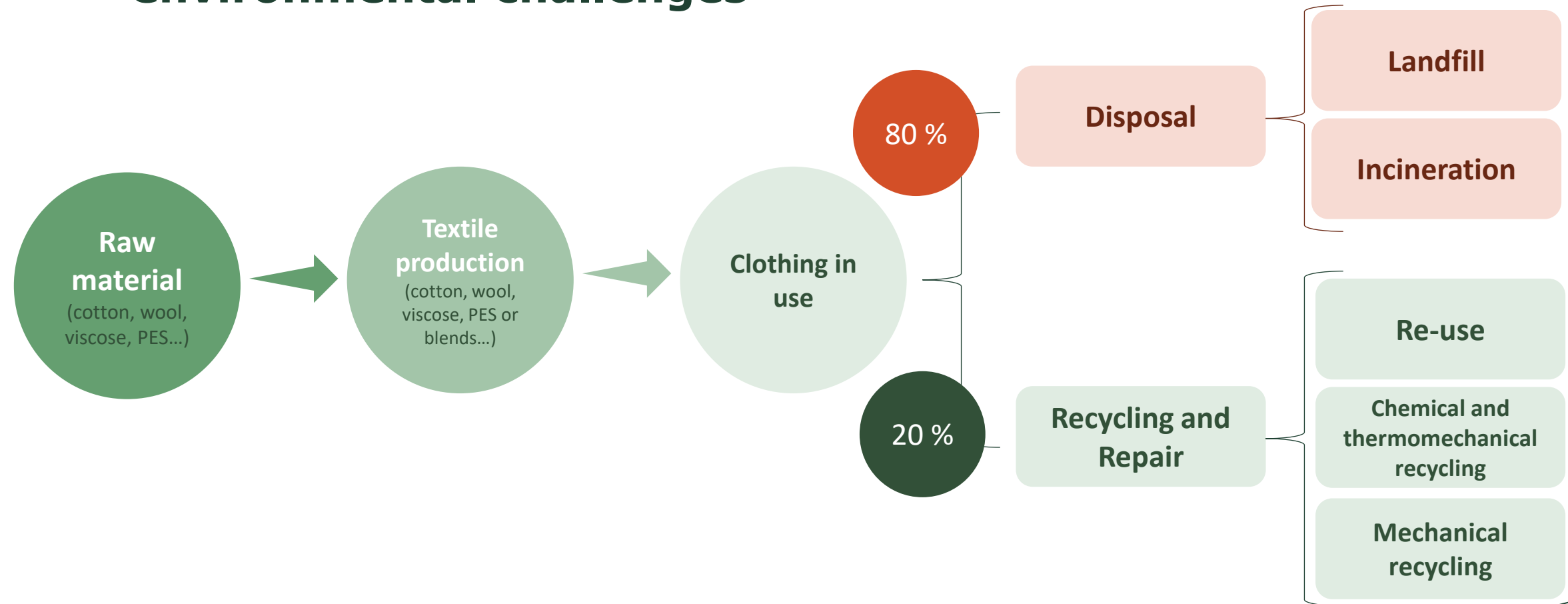


## 02. Introduction to end-of-life alternatives: environmental challenges



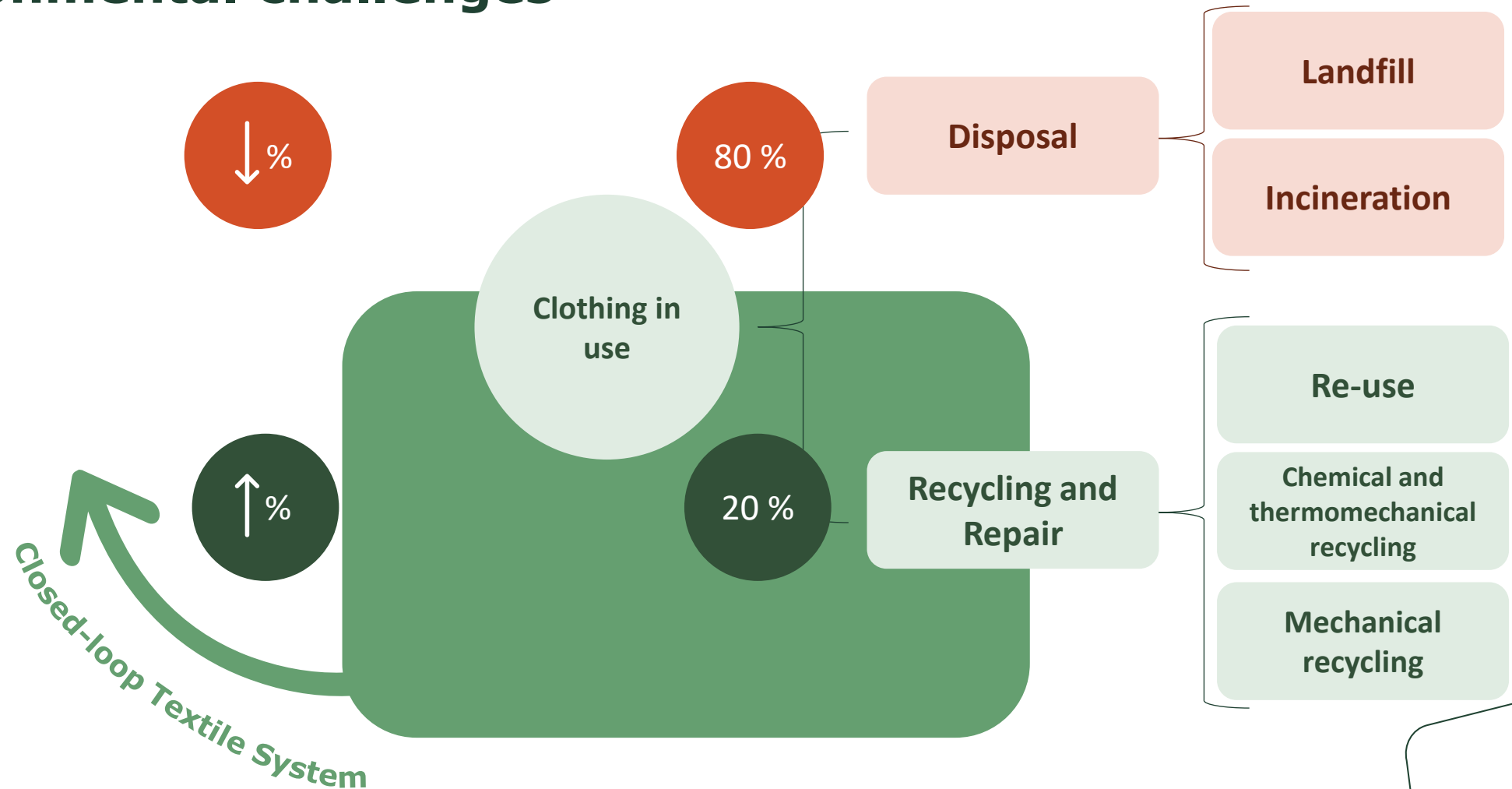


# 02. Introduction to end-of-life alternatives: environmental challenges





## 02. Introduction to end-of-life alternatives: environmental challenges







Join by Web [PollEv.com/joanagomes965](https://PollEv.com/joanagomes965)



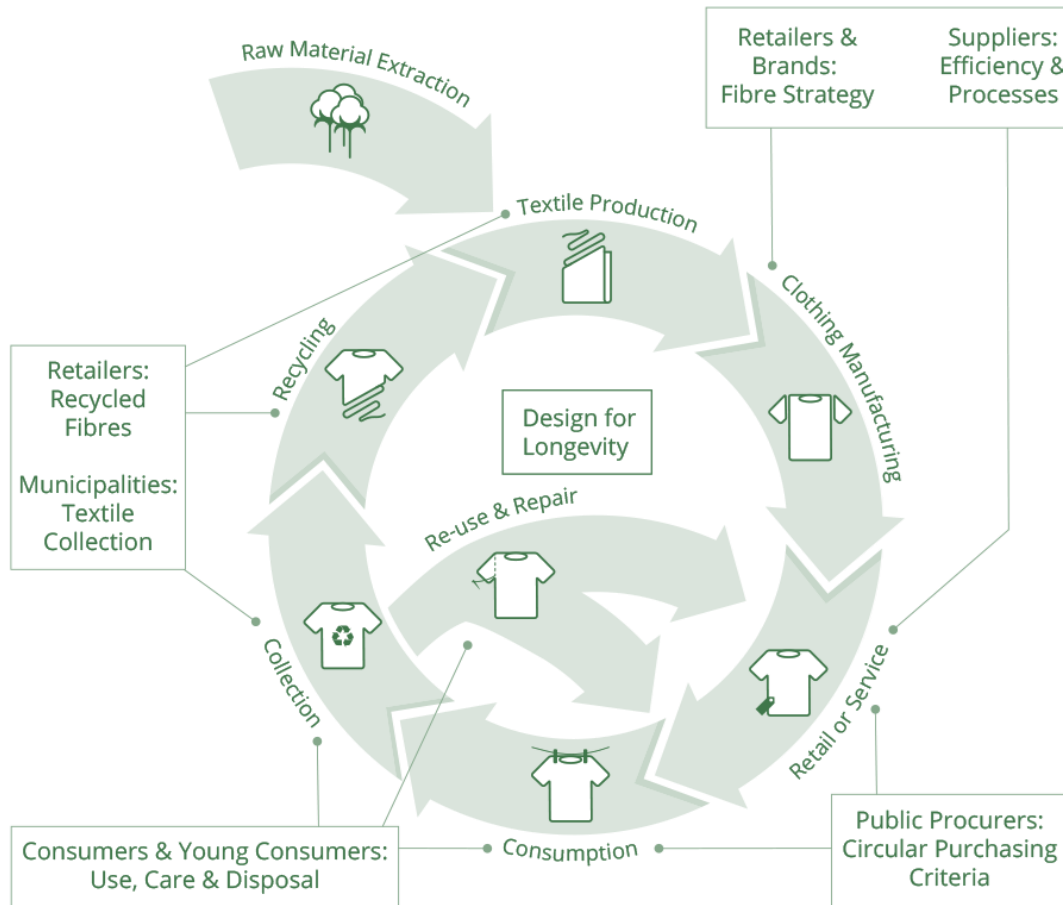
What comes to mind when you think of "circular economy"?





# 02. Introduction to end-of-life alternatives: environmental challenges

## Circular textile sector | Circular Economy Model



Designing, producing, using, and reusing textiles in a way that minimizes waste and maximizes resource efficiency!

R-Strategies are one of the key core principles for circularity <sup>(2)</sup>

3R/4R framework	6R Framework	9R Framework
Reduce <b>Reuse</b> Recycle + Recover	Repurpose Direct reuse <b>Repair</b> Refurbish <b>Remanufacture</b> Resynthesis	Refuse (R0) Rethink Reduce <b>Reuse</b> Repair Refurbish <b>Remanufacture</b> <b>Repurpose</b> Recycle <b>Recover</b>



# 02. Introduction to end-of-life alternatives: environmental challenges

## Circular textile sector | Circular Economy Model

EU strategy for sustainable and circular textiles <sup>(3)</sup> → Until 2030

Objetives
<ul style="list-style-type: none"><li>• All textile products placed on the EU market are durable, repairable and recyclable, to a great extent made of recycled fibres, free of hazardous substances, produced in respect of social rights and the environment</li><li>• <u>"fast fashion is out of fashion"</u> and consumers benefit longer from high quality affordable textiles</li><li>• <b>To make re-use and repair services widely available</b></li><li>• The textiles sector is competitive, resilient and innovative with <b>producers taking responsibility for their products</b> along the value chain with sufficient capacities for recycling and minimal incineration and landfilling</li></ul>

Actions
<ul style="list-style-type: none"><li>• <b>Set design requirements for textiles to make them last longer, easier to repair and recycle, as well as requirements on minimum recycled content</b></li><li>• Introduce clearer information and a Digital Product Passport</li><li>• <b>Reverse overproduction and overconsumption, and discourage the destruction of unsold or returned textiles</b></li><li>• Address the unintentional release of microplastics from synthetic textiles</li><li>• Tackle greenwashing to empower consumers and raise awareness about sustainable fashion</li><li>• Introduce mandatory and harmonised Extender Producer Responsibility rules for textiles in all Member States and incentivise producers to design products that are more sustainable</li><li>• Restrict the export of textile waste and promote sustainable textiles globally</li><li>• <b>Incentivise circular business models, including reuse and repair sectors</b></li><li>• Encourage companies and Member States to support the objectives of the Strategy</li></ul>



# 02. Introduction to end-of-life alternatives: sustainable practices

Recycling and Repair

Collection and Pre-sorting



## 02. Introduction to end-of-life alternatives: sustainable practices

### Recycling and Repair

#### Collection and Pre-sorting

16 kg of textile waste was generated **per person** in the EU in 2020



Only about **one quarter of this amount (4.4 kg)** was collected separately for reuse and recycling

Starting next year, EU Member States must put separate collection systems in place for textiles





# 02. Introduction to end-of-life alternatives: sustainable practices

## Recycling and Repair

### Collection and Pre-sorting



#### Manual

- Preferred method to the reuse market since the facilities need to visually identify and evaluate the clothing suitable for reuse
- Limited in terms of sorting by composition, sizing, colour, contaminants, and disruptors
- Time-consuming



#### Automatic

- Usually performed by Near Infrared Technology (NIR)
- Best suited to enhance fibre-to-fibre recycling in the industry
- The industry needs investment to adapt to new regulations and maximize the textile sorting



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#### Designing for circularity

mono-fibre materials playing a vital role in improving sorting processes



## 02. Introduction to end-of-life alternatives: sustainable practices



### Designing for circularity

mono-fibre materials playing a vital role in improving sorting processes



80% of the **environmental impacts** of the product are determined during the **design stage** <sup>(5)</sup>

The design of products and systems must be re-examined to ensure the integration of these products into the **circular economy models**





# 02. Introduction to end-of-life alternatives: sustainable practices

Recycling and Repair

Collection and Pre-sorting

End-of-life alternatives

Re-use

Chemical recycling

Thermomechanical recycling

Mechanical recycling



# 02. Introduction to end-of-life alternatives: sustainable practices

## Recycling and Repair

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Chemical recycling

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**Resale:** Wearable textiles are sold in second-hand stores or online platforms

**Donation:** Clothes in good condition may be donated

**Upcycling:** Textiles are repurposed for other uses, such as fashion redesign, art projects, or decorative items



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#### Chemical recycling

#### Thermomechanical recycling

#### Mechanical recycling

#### Sorting

Identification of items contaminated with heavy dyes or finishes, and hard parts (zippers and buttons)



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**Depolymerization:**  
Fibers are broken down into their base polymers or monomers

Purification

Polymerization and re-spinning



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Thermomechanical recycling (synthetics)

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**Shredding:** Textiles are mechanically shredded into smaller pieces or fibres

**Thermal processing:** Fibres are melted at controlled temperatures, filtered, and extruded into granules

Melting and filament extrusion



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Melting and filament extrusion

Textiles are teared into fibres

Long fibres

New yarns

Short fibres and dust

Chemical recycling or other applications



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### Collection and Pre-sorting

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Reprinting and redyeing

Colour removal

### Sorting

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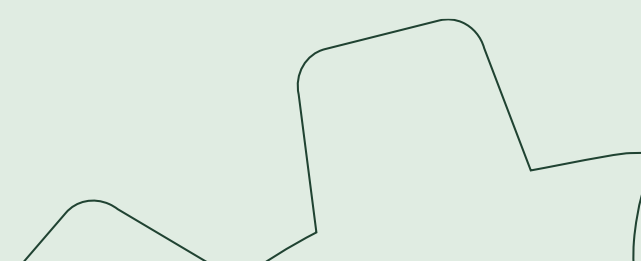
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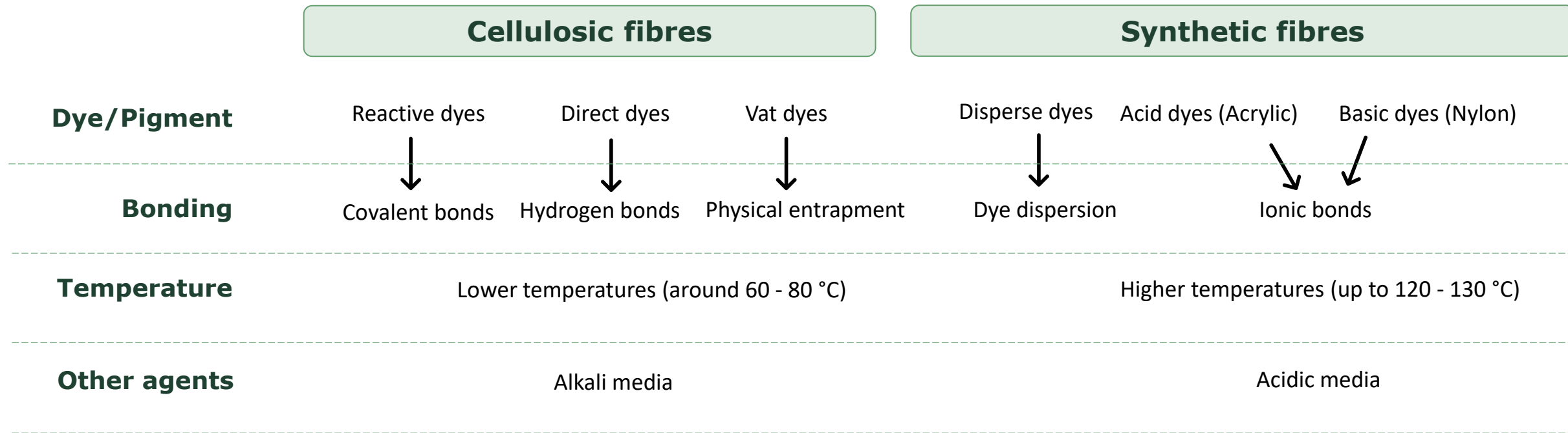






# 03. Colour removal methods



What are the **dyeing processes** for cellulosic and synthetic fibres?





# 03. Colour removal methods

What are the **printing processes** for cellulosic and synthetic fibres ?

Printing methods	Conventional	&	Digital 
	Printing paste		Ink 
	Uses mostly pigments, but can also be done with reactive or dispersive dyes		Uses mostly pigments, but can also be done with reactive, dispersive <b>Vat dyes</b>
	The paste is transferred onto textile substrates through an intermediary (flat screen, rotary screen, or transfer paper)		Direct application



# 03. Colour removal methods

## What are the colour removal processes for cellulosic fibres?



### Chemical methods

- Chlorine
- Hydrogen peroxide
- Hydrosulphite
- 60 – 80 °C

## What are the colour removal processes for synthetic fibres?



### Chemical methods

- Hazard solvents (eg. sodium formaldehyde sulfoxylate)
- High temperatures: 120 - 130 °C

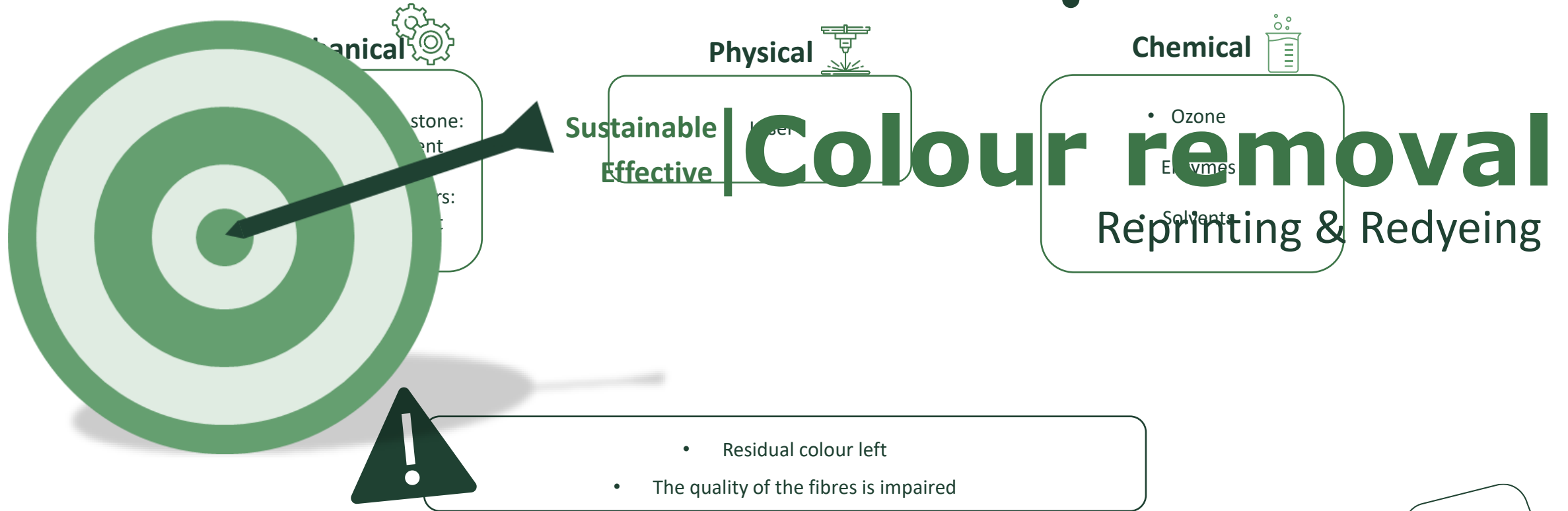


- Use of hazard substances
- Residual colour left
- The quality of the fibres is impaired



# 03. Colour removal methods

What are the printing removal processes ?





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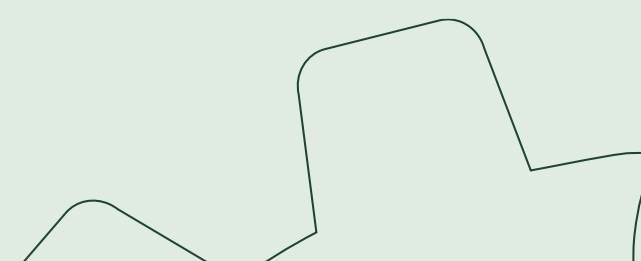
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# 04. Textile Reprinting and Redyeing

Reprinting



Redyeing



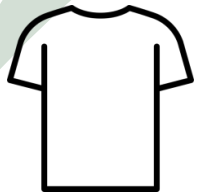
Quality control

Colorimetric analysis  
(colour strength (Ks) and greyscale)

Pilling (Martindale)  
• EN ISSO 12945-2

Mechanical properties after treatment:

- Fabrics: Breaking strength and elongation, according to ISO 13934-1
- Knits: Maximum force (N) (EN ISO13938-2)





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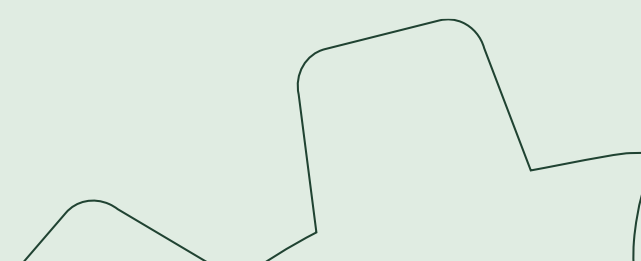
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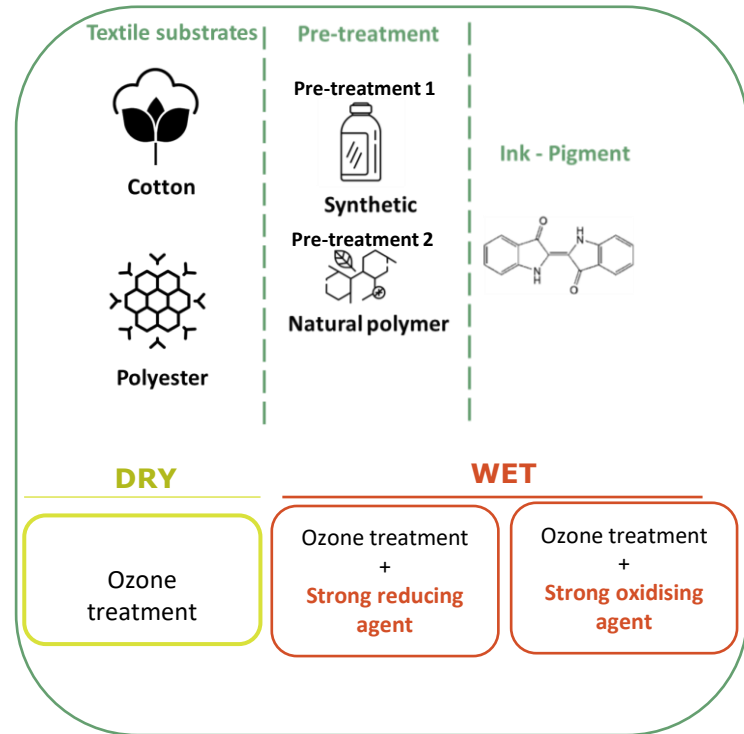




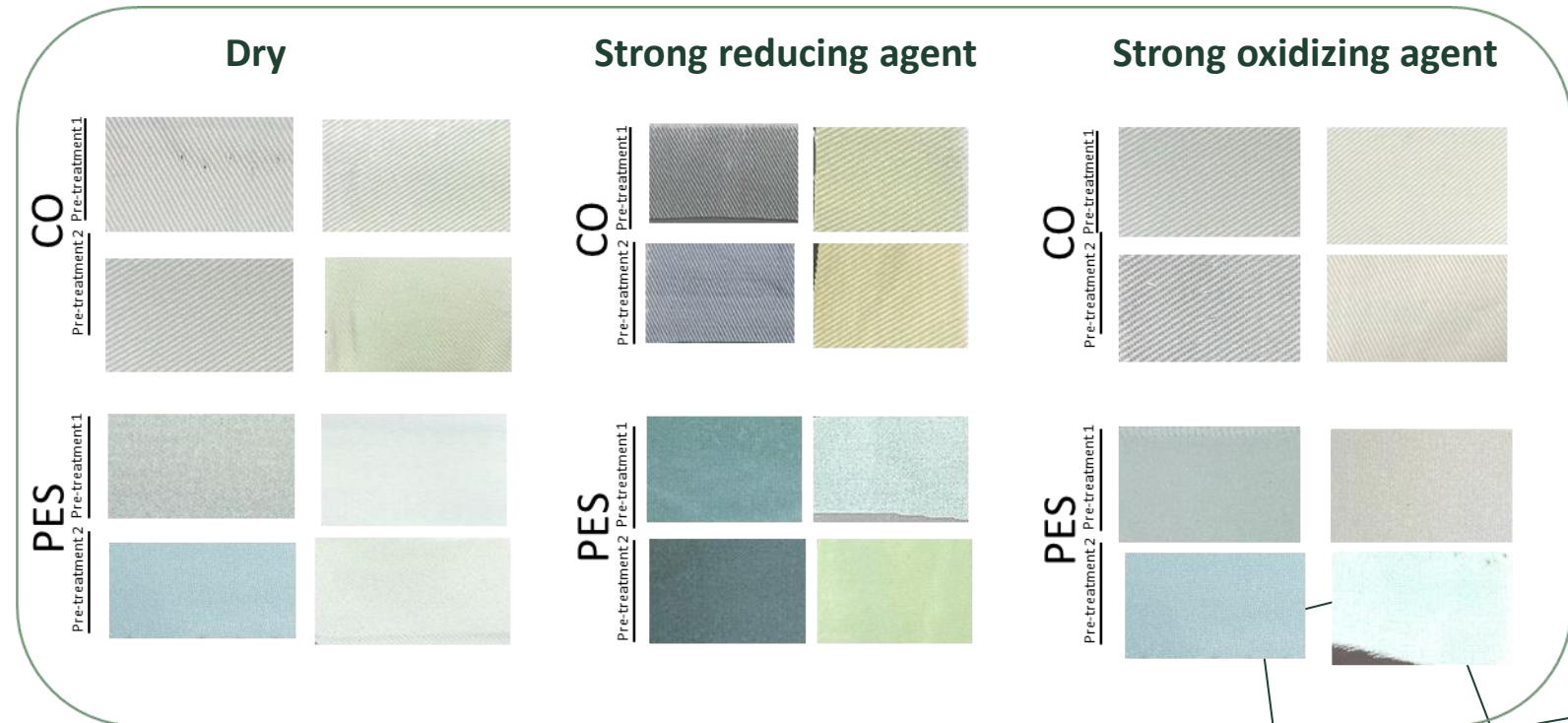
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Printing removal from 100% CO and 100% PES substrates from  waste2biocomp

## Samples and process: Ozone treatment



## Results: CO and PES substrates prepared with Indigo



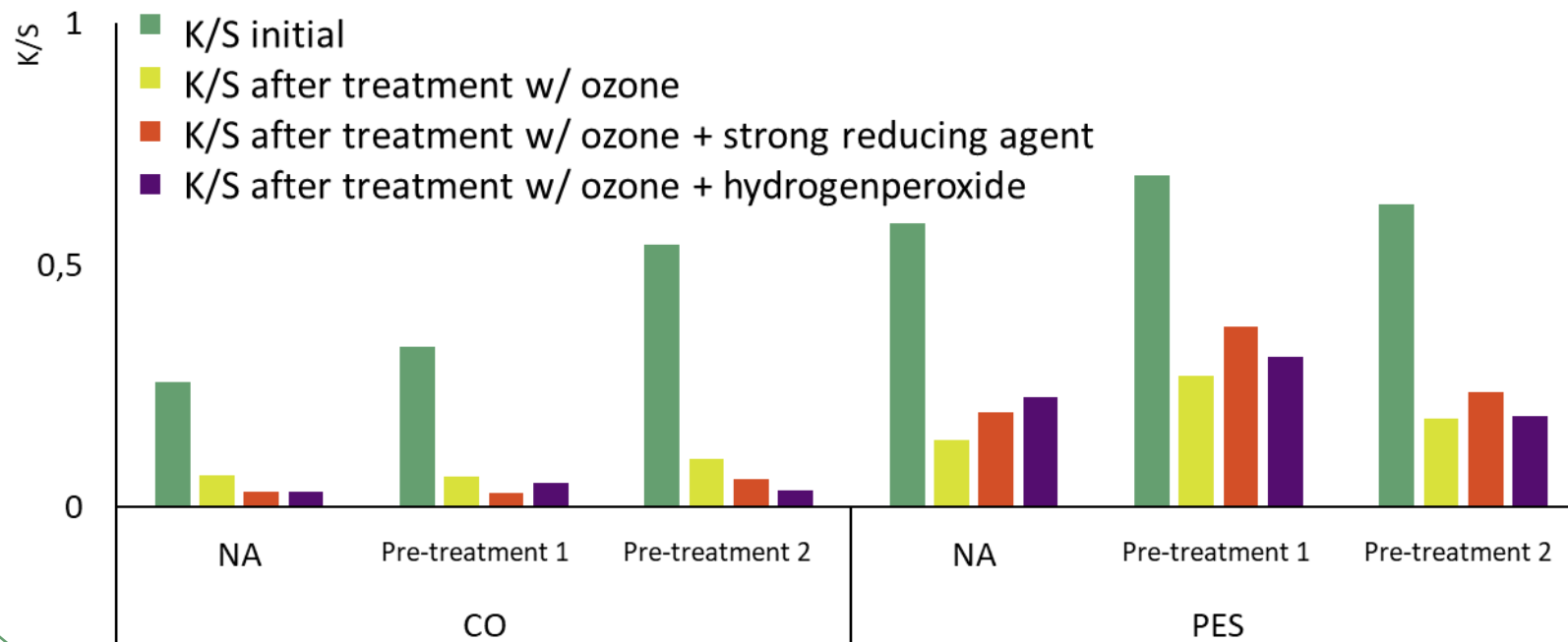




# 05. Case studies and examples related to W2BC (and other projects)

*Printing removal from 100% CO and 100% PES substrates from*

**Results: CO and PES substrates prepared with Indigo**



✓ The **ozone + strong reducing agent/oxidising agent** method were the **most promising for CO samples.**

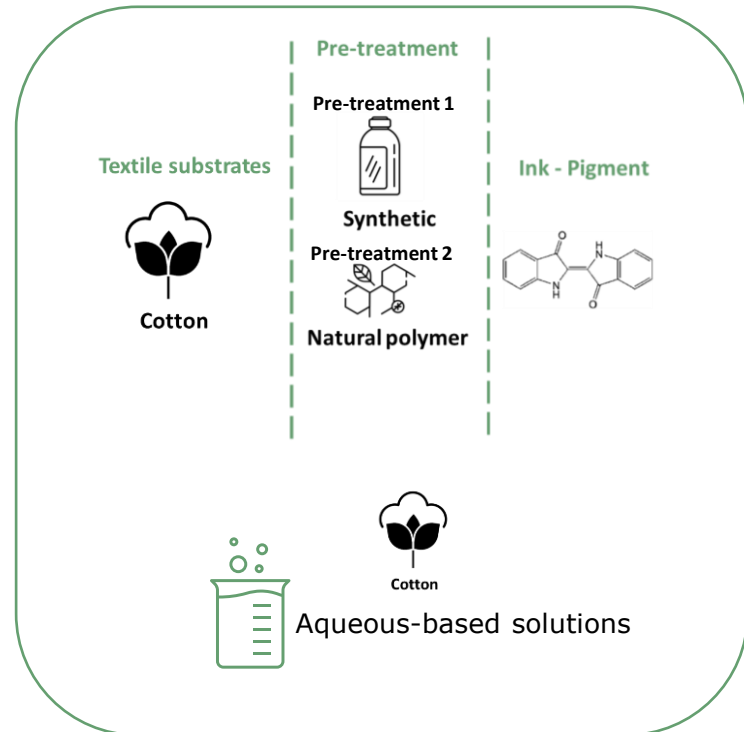
✓ The **ozone method (without solvent impregnation)** was the **most effective** in removing colour from **all the PES samples** under study.



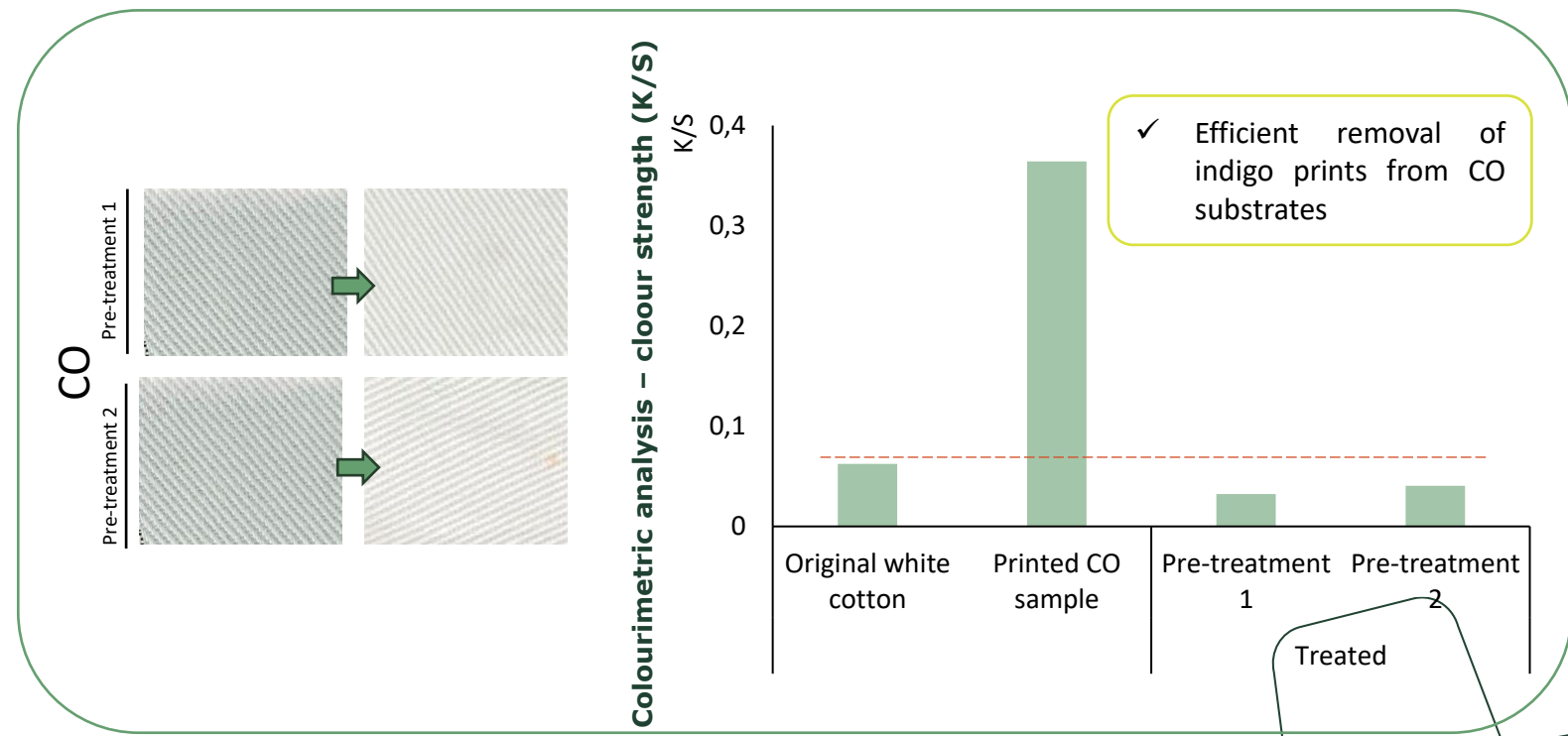
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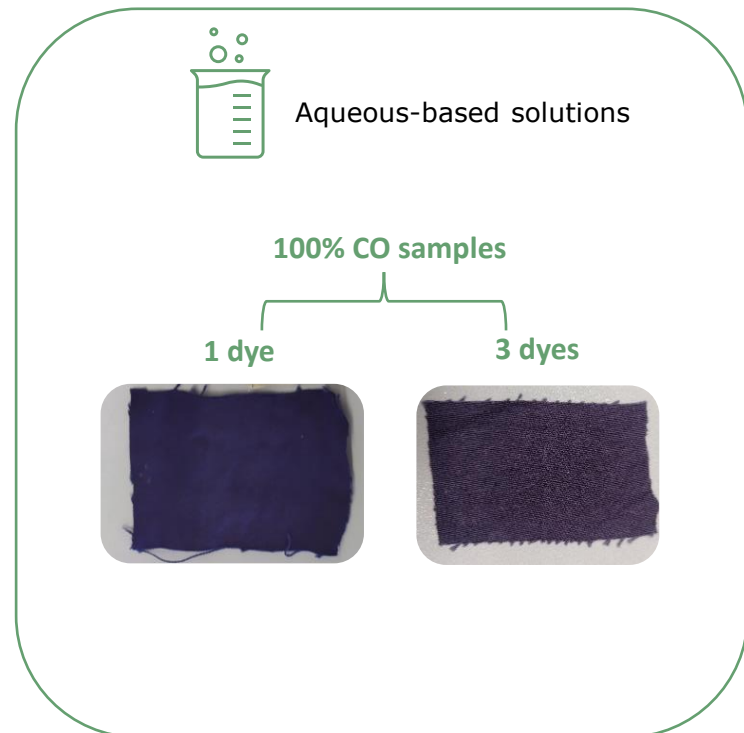




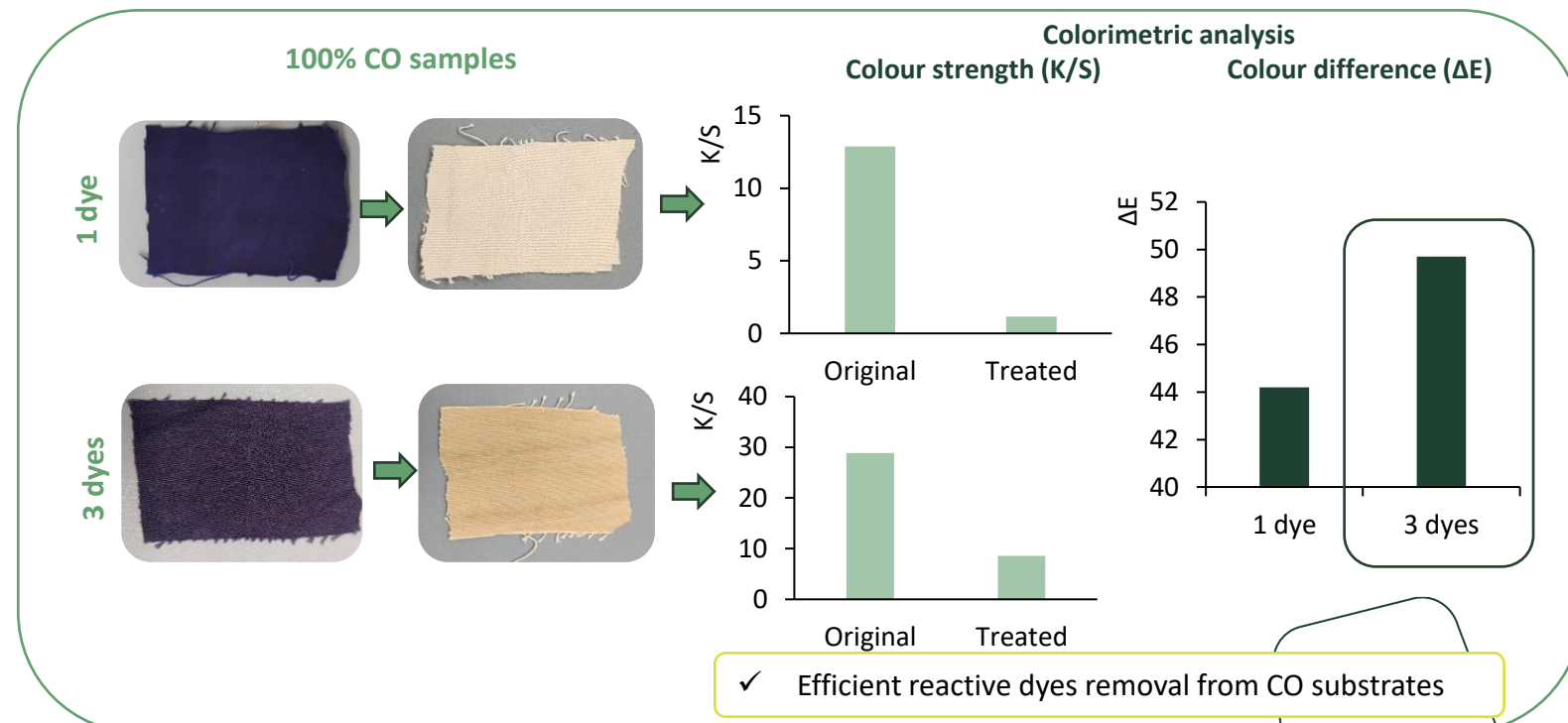
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Colour removal from 100% CO substrates from  tExtended

## Samples and Process: Chemical treatment



## Results: 100% CO fabrics prepared with 1 and 3 dyes

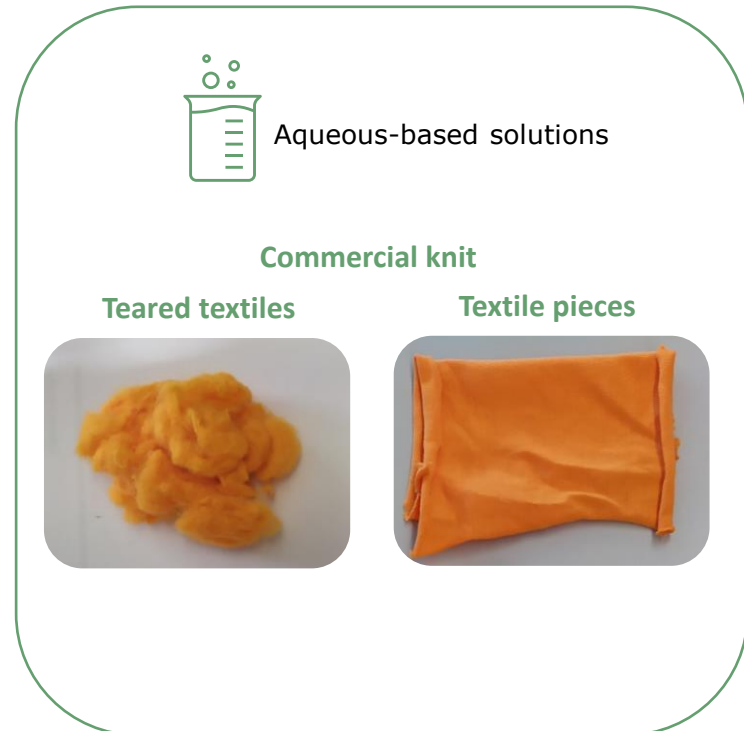




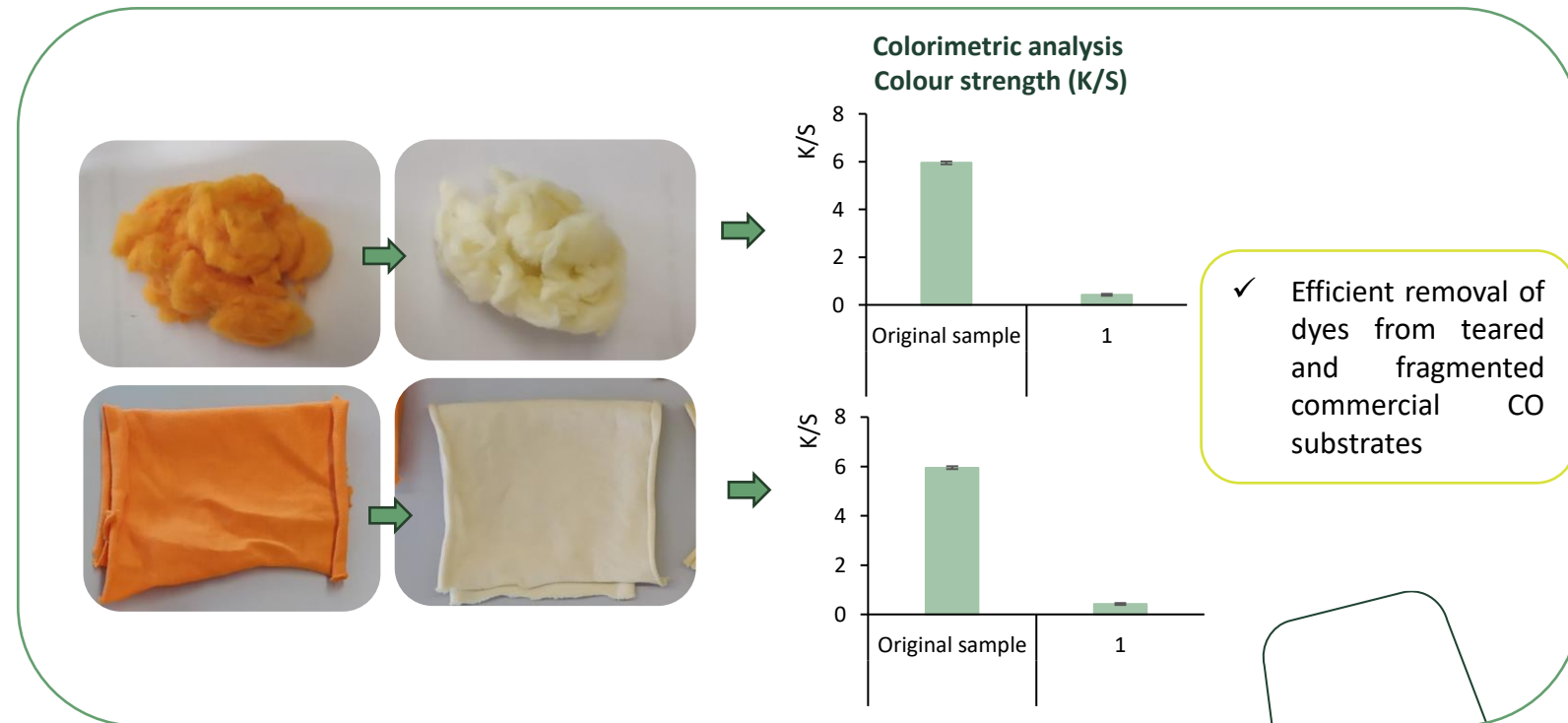
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Colour removal from 100% CO substrates from 

## Samples and Process: Chemical treatment



## Results: 100% CO knits (torn and fragmented)



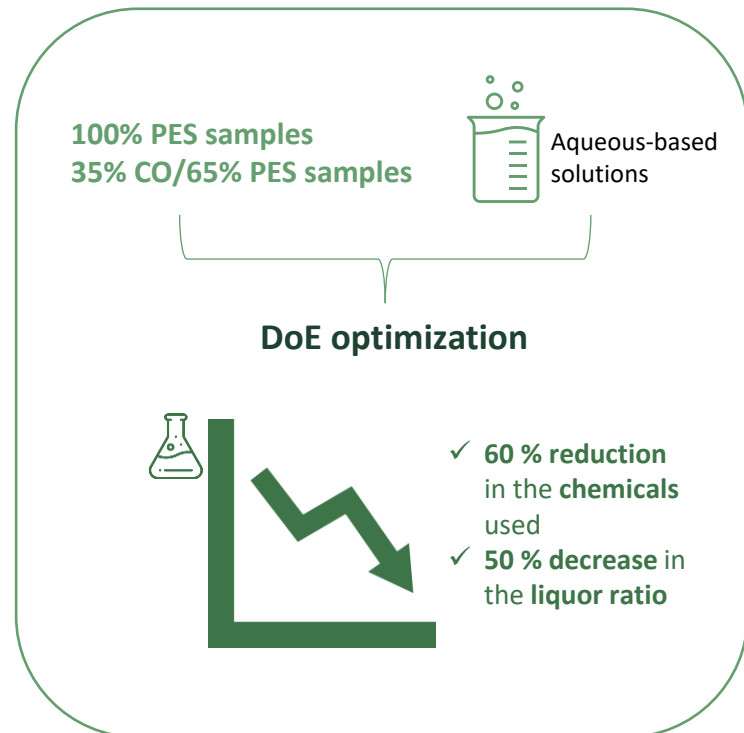


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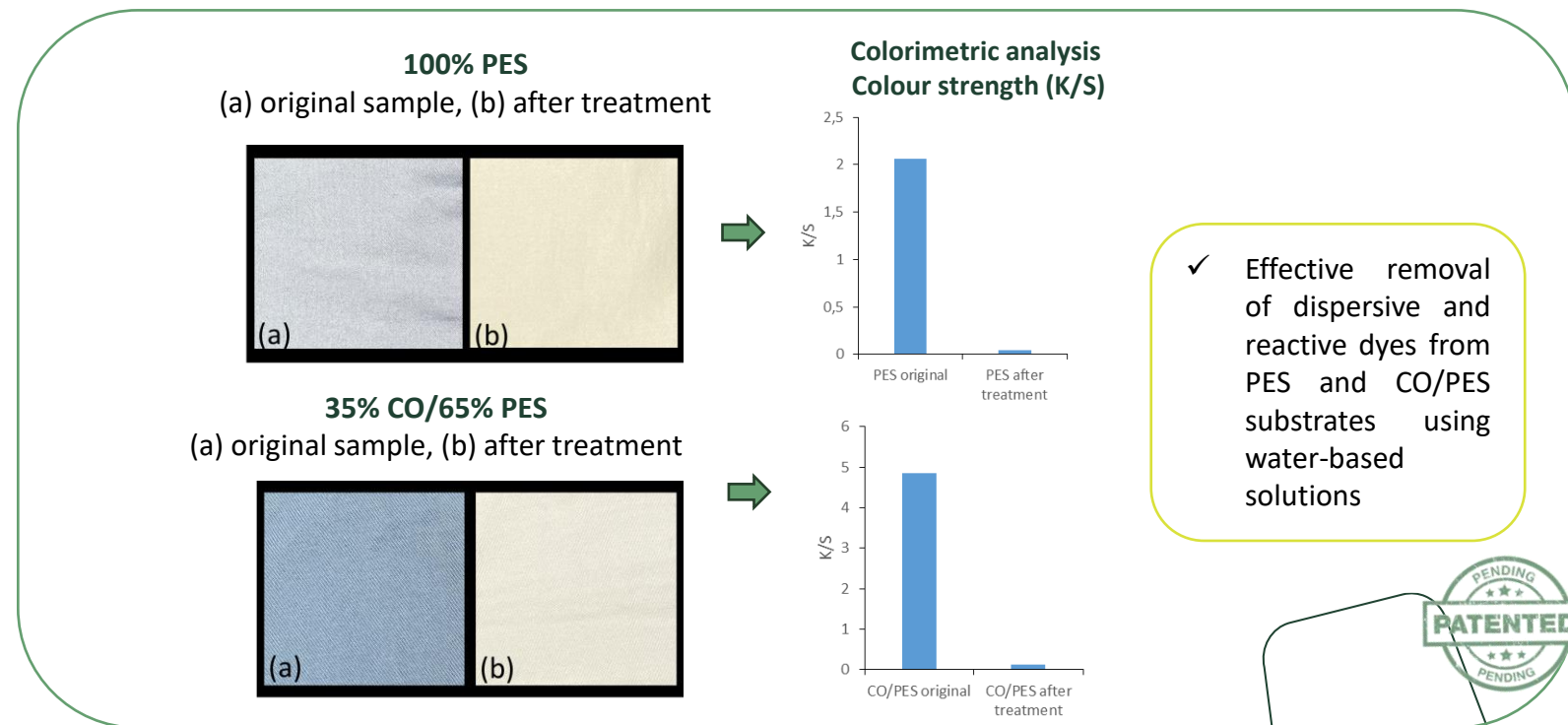
## Colour removal from PES and CO/Blends

Master thesis: Colour removal from polyester textile wastes. *Student: Giorgia Lain; Supervised by: Mauro Carraro, Università Degli Studi Di Padova and Joana M. Gomes, CITEVE (under development)*

### Samples and Process: Chemical treatment



### Results: 100% PES and CO/PES blends



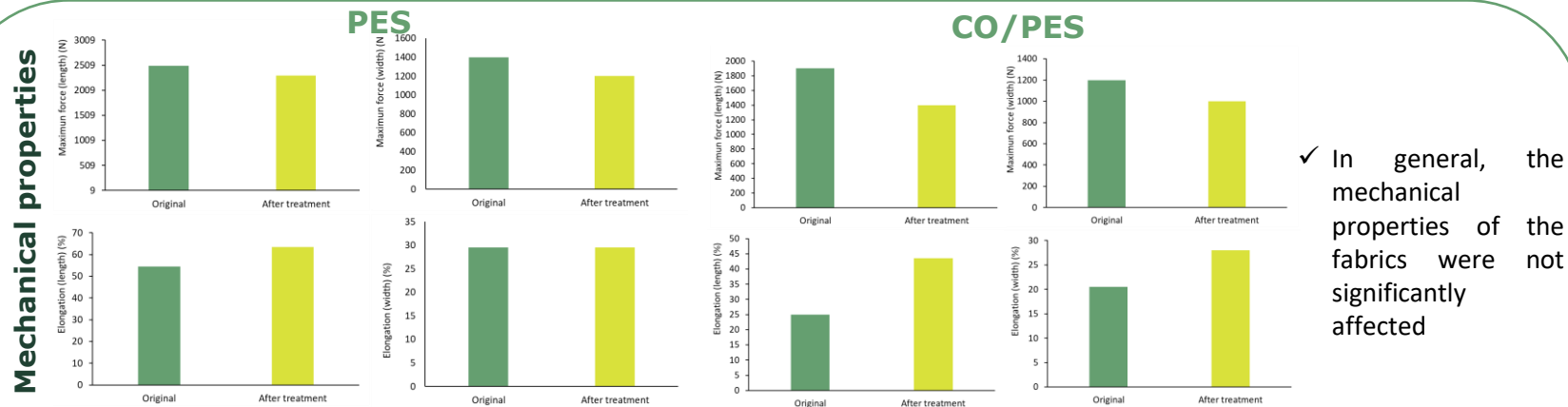


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### Results: 100% PES and CO/PES blends



Pilling	Pilling after 2000 rev	
	Original	After treatment
Original PES	4-5	4-5
PES after colour removal	5	5
Original CO/PES	2-3	2-3
CO/PES after colour removal	3-4	3-4

✓ There was no increase in pilling formation on the treated samples

## Upscale and Redyeing

100 ml upscale 4000 ml

Redyeing





## 05. Case studies and examples related to W2BC (and other projects)

*Brands with campaigns for upcycling*

### SALSA JEANS



#### Results:

5112 used denim items  
3922 repairs | 1190 collections\*

\*Collected items in good condition are donated to charitable organizations, while those no longer usable are sent to textile recycling facilities to be transformed into new products



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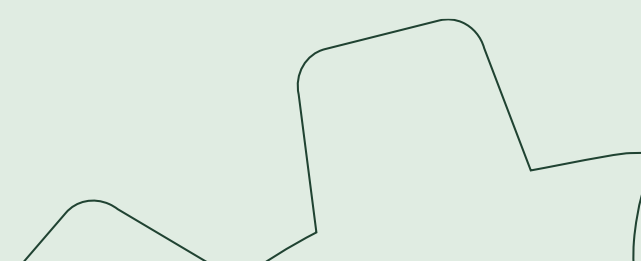
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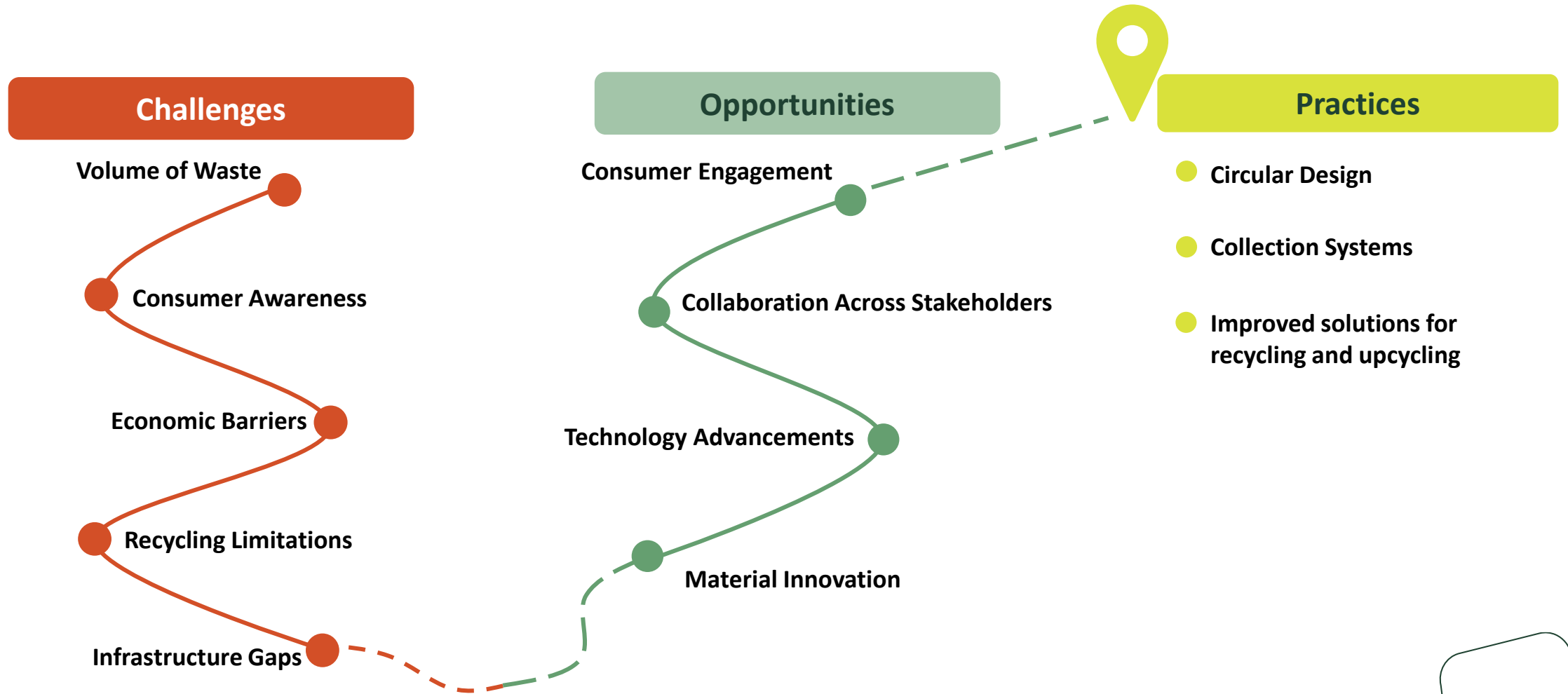
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# 06. Conclusions and take-home message



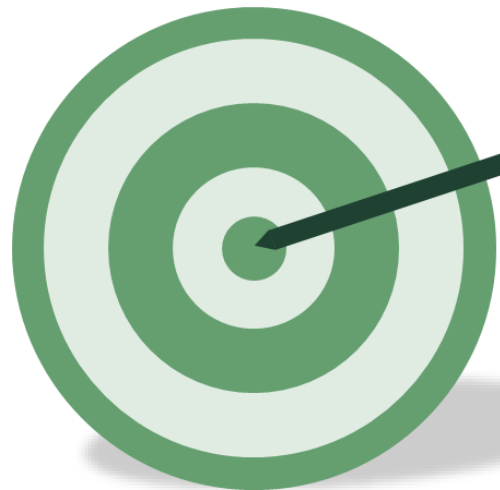


# 06. Conclusions and take-home message



## Practices

- Circular Design
- Collection Systems
- Improved solutions for recycling and **upcycling**



Sustainable  
Effective

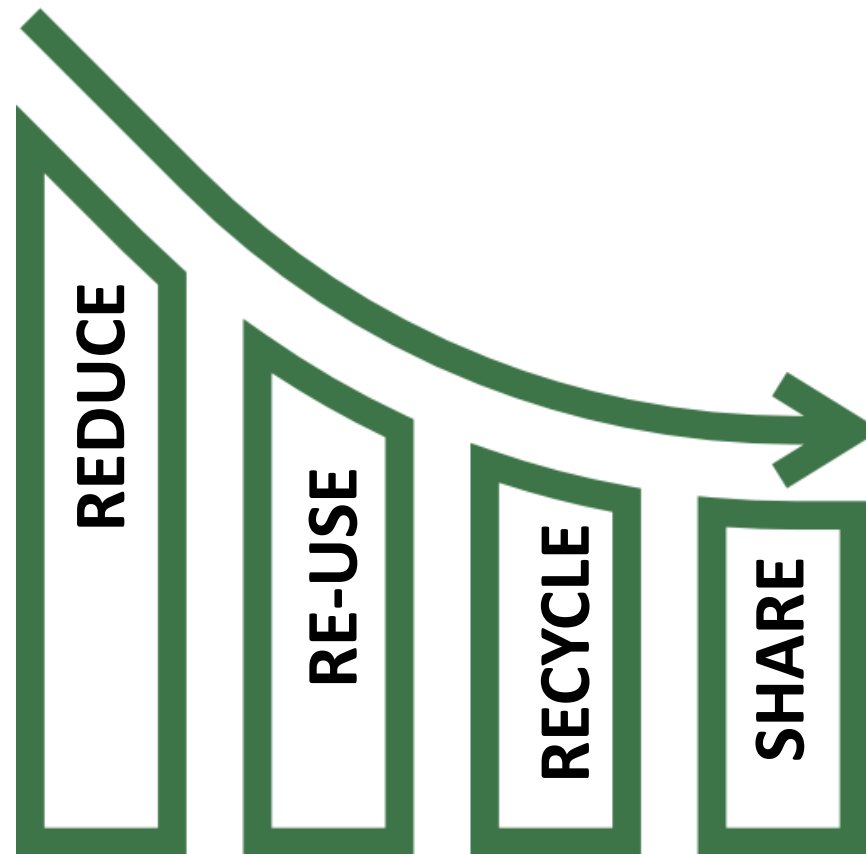
# Colour removal

## Reprinting & Redyeing



# 06. Conclusions and take-home message

Global warming potential of diferente end-of-life scenarios:





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# Thanks for your attention!



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# Discussion

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