tExtended - Knowledge based Framework for Extended Textile Circularity

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tExtended Community webinar

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This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101091575

Specific needs that triggered the tExtended project

Currently textile **production and use** are not sustainable, and linear consumption model produces huge amount of **waste** .

There are multiple **technological** and **non-technological challenges** related to creation of a sustainable circular textile ecosystem.

Separate collection of **textile waste** is starting in EU member states by 2025.

Currently the textile sorting is done mainly by hand, which is not accurate enough for high-value end uses: technologies and know-how are needed for **identification** , **collection** , and automated **sorting** .

Technologies and know-how are also needed in order to **recycle** the collected and sorted waste.

Even though most textile materials are made of **blended fibres** , the current technologies lack the necessary processing options.

The current recycling activities mainly focus on **low value applications** not fibre-to-fibre recycling in secondary raw materials.

And the current textile fibres are **not sustainable** : they are oil-based, and the cultivation of the cotton needed to produce them require lots of water and chemicals.

To support an efficient material flow and circular economy processes and support the Industrial -Urban Symbiosis, also **data sharing** readiness needs to be increased.

The circular textile system also need the contribute of textile users, who need to be **motivated to participate** .

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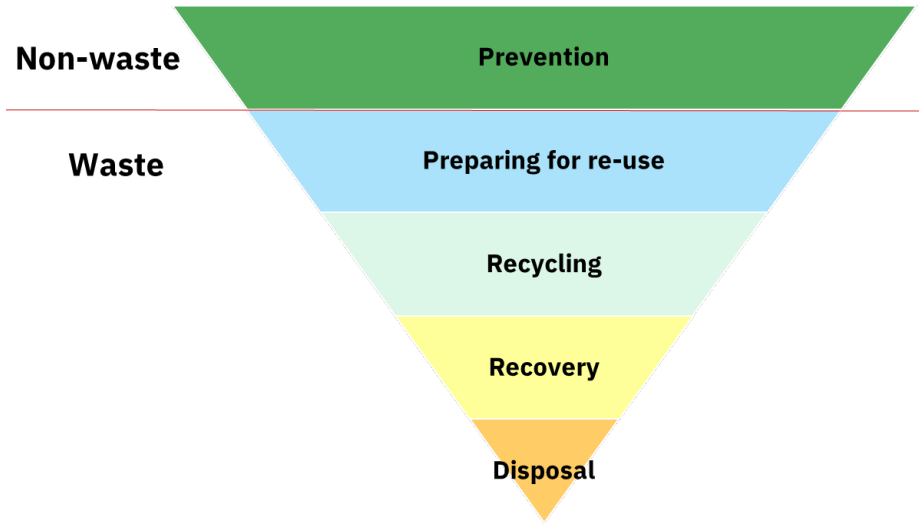
Regulatory Framework

Waste Regulation

+ Separate collection to be started by 2025
+ Waste hierarchy



http://ec.europa.eu/environment/waste/framework/

Vision - EU Strategy for Sustainable and Circular Textiles

+ By 2030 textile products placed on the EU market are long-lived and recyclable, to a great extent made of recycled fibres, free of hazardous substances and produced in respect of social rights and the environment.
+ Consumers benefit longer from high quality affordable textiles, fast fashion is out of fashion, and economically profitable re-use and repair services are widely available.
+ In a competitive, resilient and innovative textiles sector, producers take responsibility for their products along the value chain, including when they become waste.
+ The circular textiles ecosystem is thriving, driven by sufficient capacities for innovative fibre-to-fibre recycling, while the incineration and landfilling of textiles is reduced to the minimum.

https://environment.ec.europa.eu/publications/textiles-strategy_en

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- Funding from Horizon Europe Programme Grant Agreement 101091575
- Call identifier: HORIZON-CL4-2022-TWIN-TRANSITION-01-10
- Call title: Circular flows for solid waste in urban environment (Processes4Planet Partnership) (IA)
- Coordinator: VTT Technical Research Centre of Finland Ltd.
- Number of partners / countries: 20 / 10
- EU contribution / Total budget : 12.3 M€ /15.3 M€
- Duration: 4 years, started 1st Dec 2022
- Linkages to European level activities and initiatives e.g.
  - Processes4Planet Partnership
  - Hubs4Circularity & Industrial-Urban Symbiosis
  - ECOSYSTEX & ECoP - European Community of Practice

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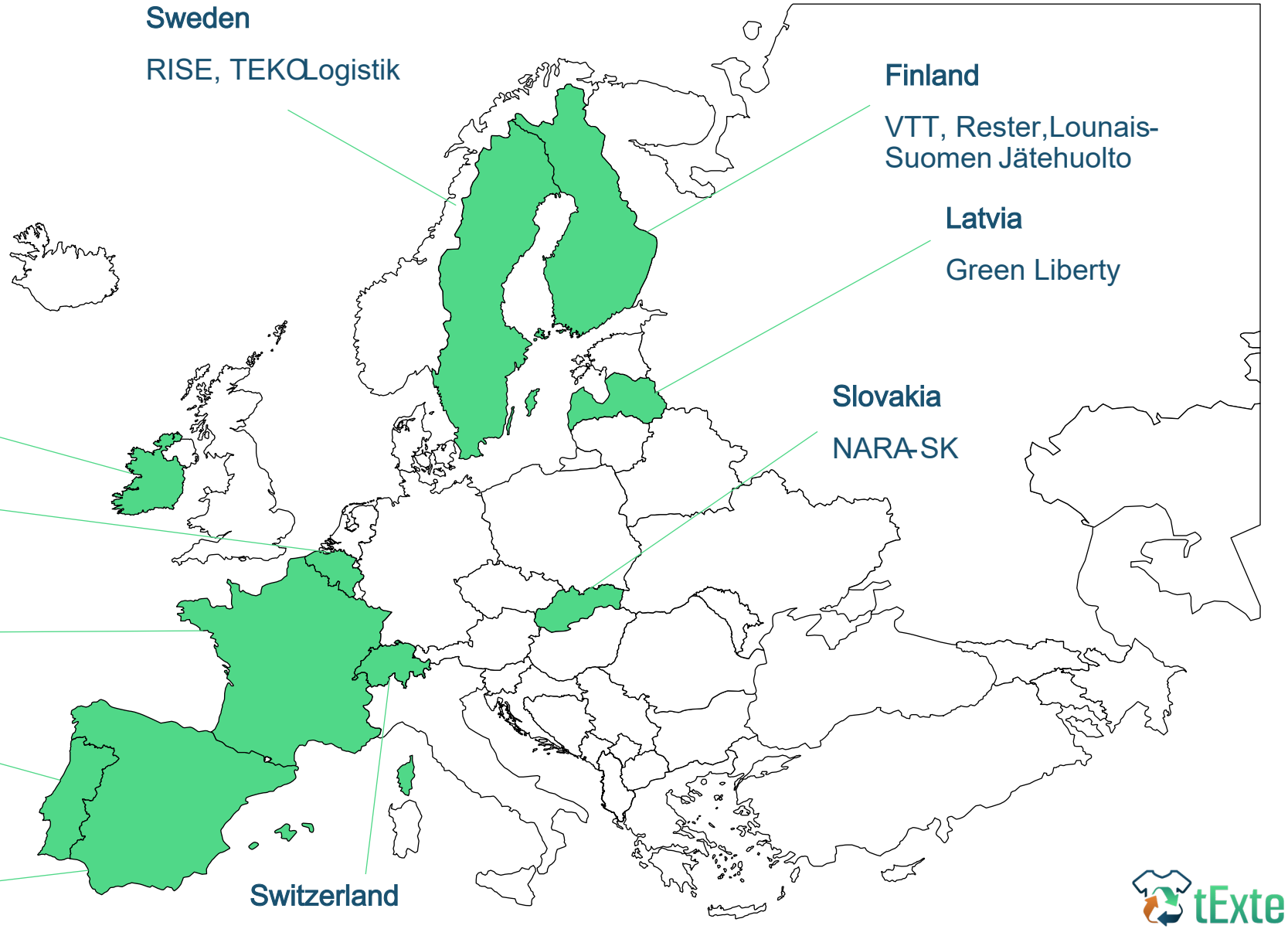
tExtended partners distribution



Sweden

RISE, TEKOLogistik

Finland

VTT, Rester,Lounais-Suomen Jätehuolto

Latvia

Green Liberty

Slovakia

NARA-SK

Ireland

CARR Communications

Belgium

Centexbel, PurFi, Utexbel, Kringloopwinkel

France

Soprema

Portugal

CITEVE,ERTTêxtil, MTEX MS, J.F.Almeida, INESC TEC

Spain

Aimplas

Switzerland

Tally Wejil

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tExtended – Knowledge based Framework for Extended Textile Circularity

The overall objective of the tExtended project is to develop a **Blueprint** , i.e., a masterplan for a **sustainable textile ecosystem** where **product and material cycles** are reducing the use of primary textile raw materials and amount of textile waste.

The basis of the Blueprint is a knowledge-based **Conceptual Framework** determining the **optimized** utilization of textile flows, aiming for **retention of value** of materials in a **safe and sustainable way** .

Based on the Blueprint, we will implement a **Real Scale Demonstrator** , verifying its replicability and potential to reduce textile waste by 80% via **reduction of waste** , increased **product re -use** and **material recycling** .

Development work and impact generation in tExtended project

Systemic, **sustainable and safe** circular ecosystem for textiles

Knowledge based and **digitally enable**d circular textile ecosystem

Efficient textile recovery including **collecting, sorting** and **reuse**

Waste **valorization and recycling** aiming for high value applications

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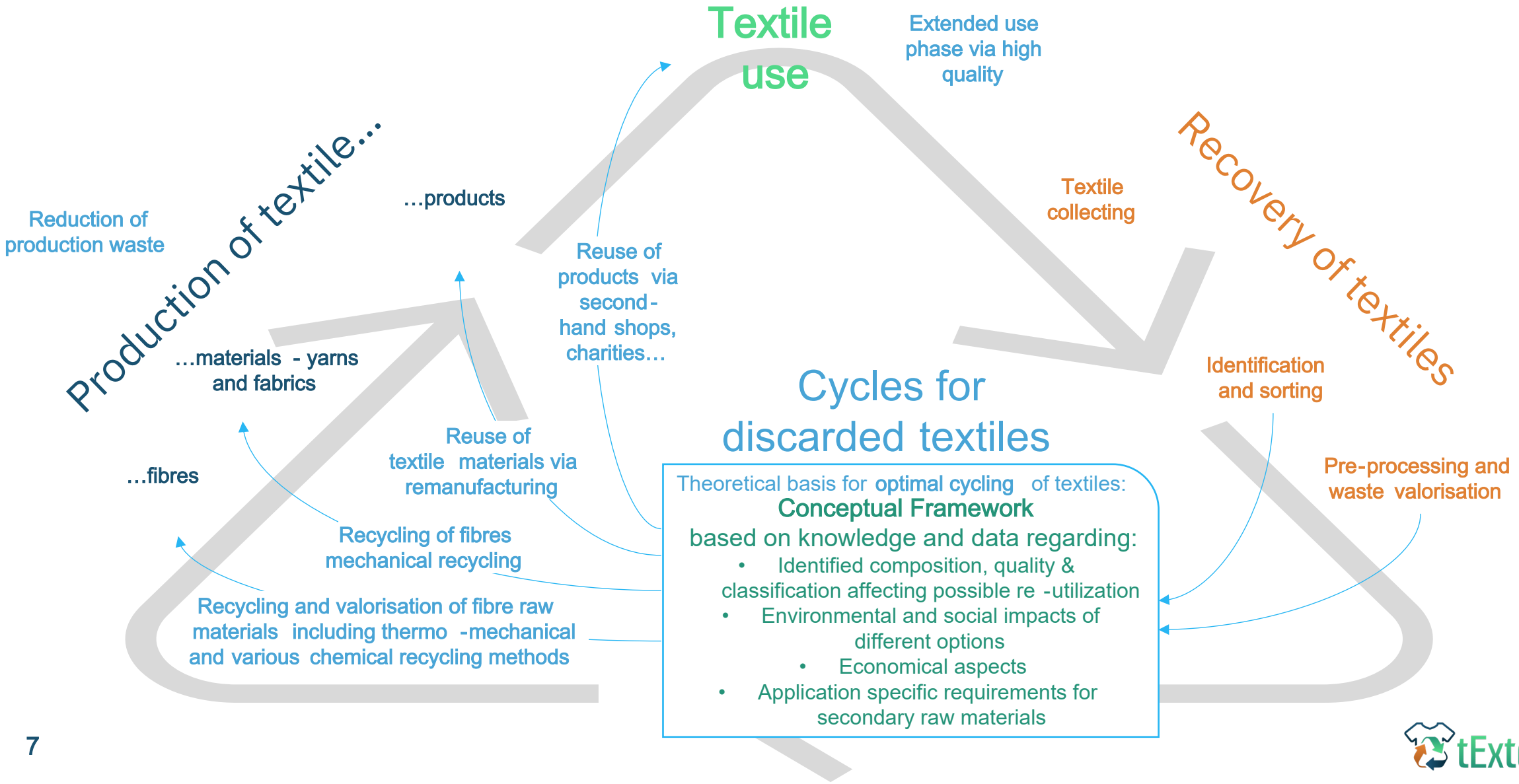
Conceptual Framework and Blueprint for textile circularity



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Research work

Mainly theoretical work
Practical development and experimental work
Focus on engagement

WP1 Circular textile ecosystem
Building an overview on value chains, shared data and symbiotic interactions in future circular textile ecosystem.
Social Innovation Spin-Off

WP2 Digital tools and technologies for textile recovery
Development of data-driven solutions for optimisation of textile recovery including data sharing, identification, sorting, and development of pre-processing aiming for waste valorisation.

WP3 Textile recycling technologies
Development of textile recycling processes including mechanical, thermo-mechanical and chemical processes; and adjusting textile manufacturing to extended use of secondary raw materials.

WP6 Benefits to sustainability and circularity
Evaluation of sustainability, circularity potential and technological and non-technological barriers

WP5 – Demonstrators
The **Blueprint** – implementation plan for the **Conceptual Framework**
A real scale demonstrator by joined resources of the tExtended consortium
Replication potential study in different regions

WP4 Data-driven framework for textile circulation
Builds a textile classification system, collects textile life-time data and develops the **Conceptual Framework** for determination of an optimised – safe and sustainable – utilization route for different types of textile flows

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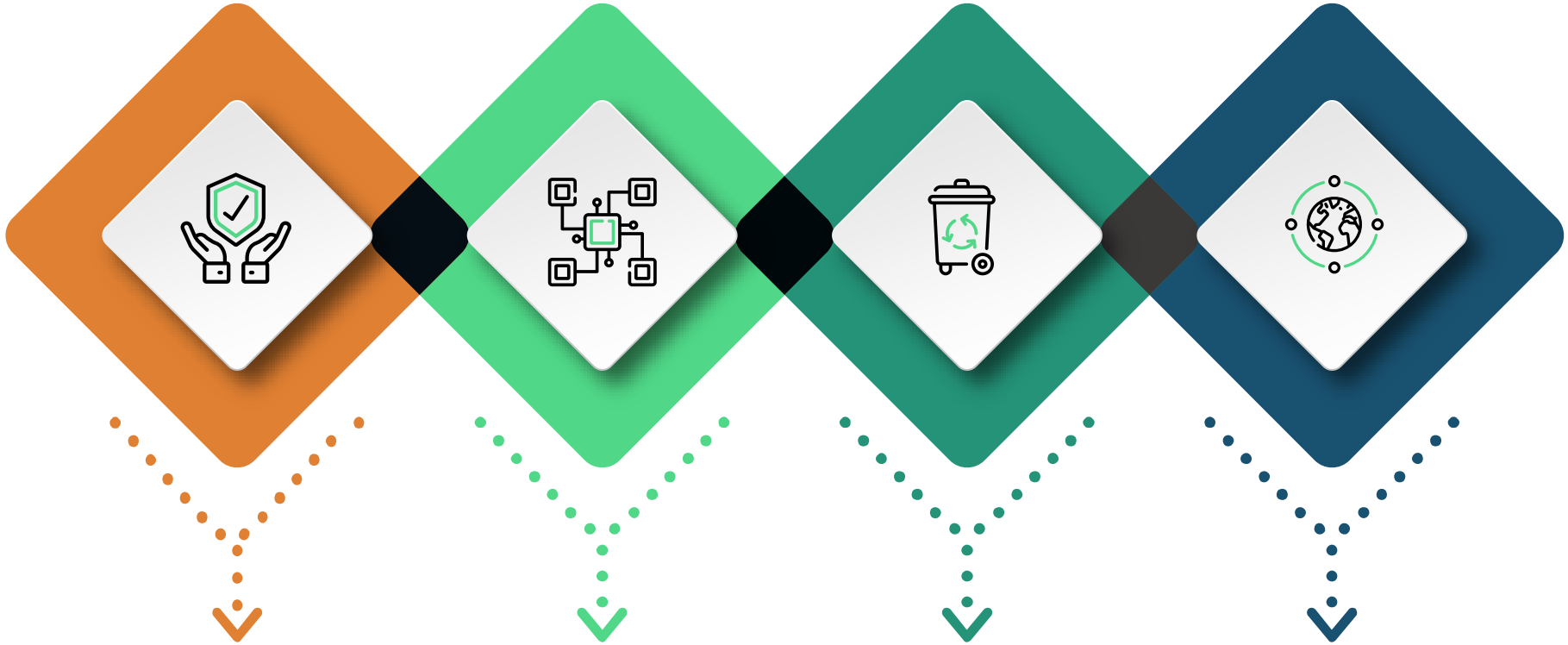
Impact generation pathways in tExtended



PATHWAY 1

Knowledge based & digitally enabled circular textile ecosystem

6 KERS

PATHWAY 2

Efficient textile recovery including collecting and sorting

9 KERS

PATHWAY 3

Waste valorization and recycling aiming for high value applications

12 KERS

PATHWAY 4

Systemic, sustainable and safe circularity for textiles

6 KERS

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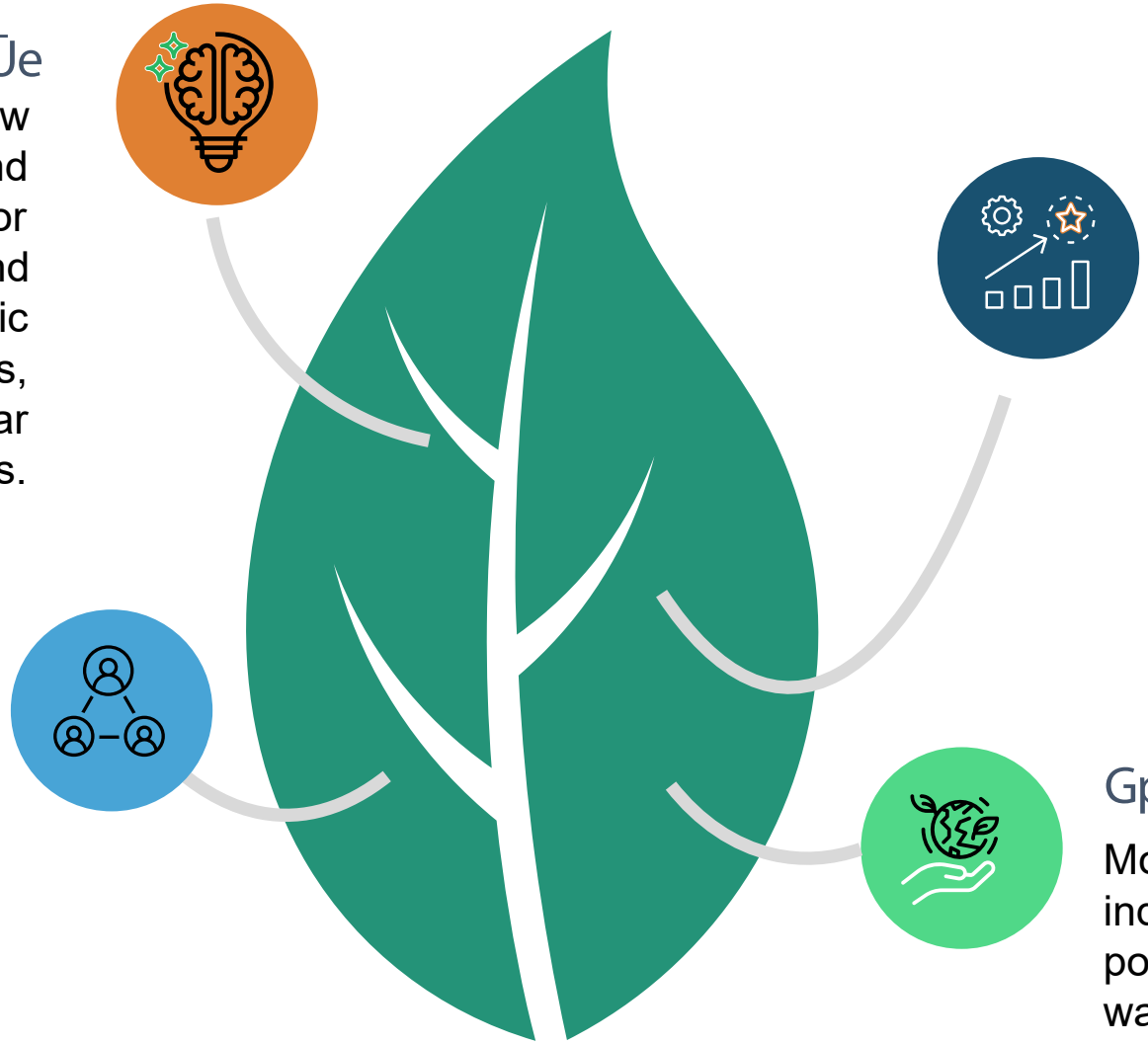
Expected Impact

Uekgpvkūe

Production of new fundamental and applied knowledge for industries and scientific communities, produced on circular economy of textiles.

Uqekgvcn

Prevention of waste, sustainable consumption models via re-use, creation of jobs.



Geqpqo ke1Vgej pqmqi kecn

Accelerate the twin green and digital transition in European textile industry by generating new business, strengthening competitiveness and resilience through sustainability, and digitalization.

Gpxktqpo gpvcn

More sustainable textile industry, less emissions, potential to reduce textile waste by 80 %.

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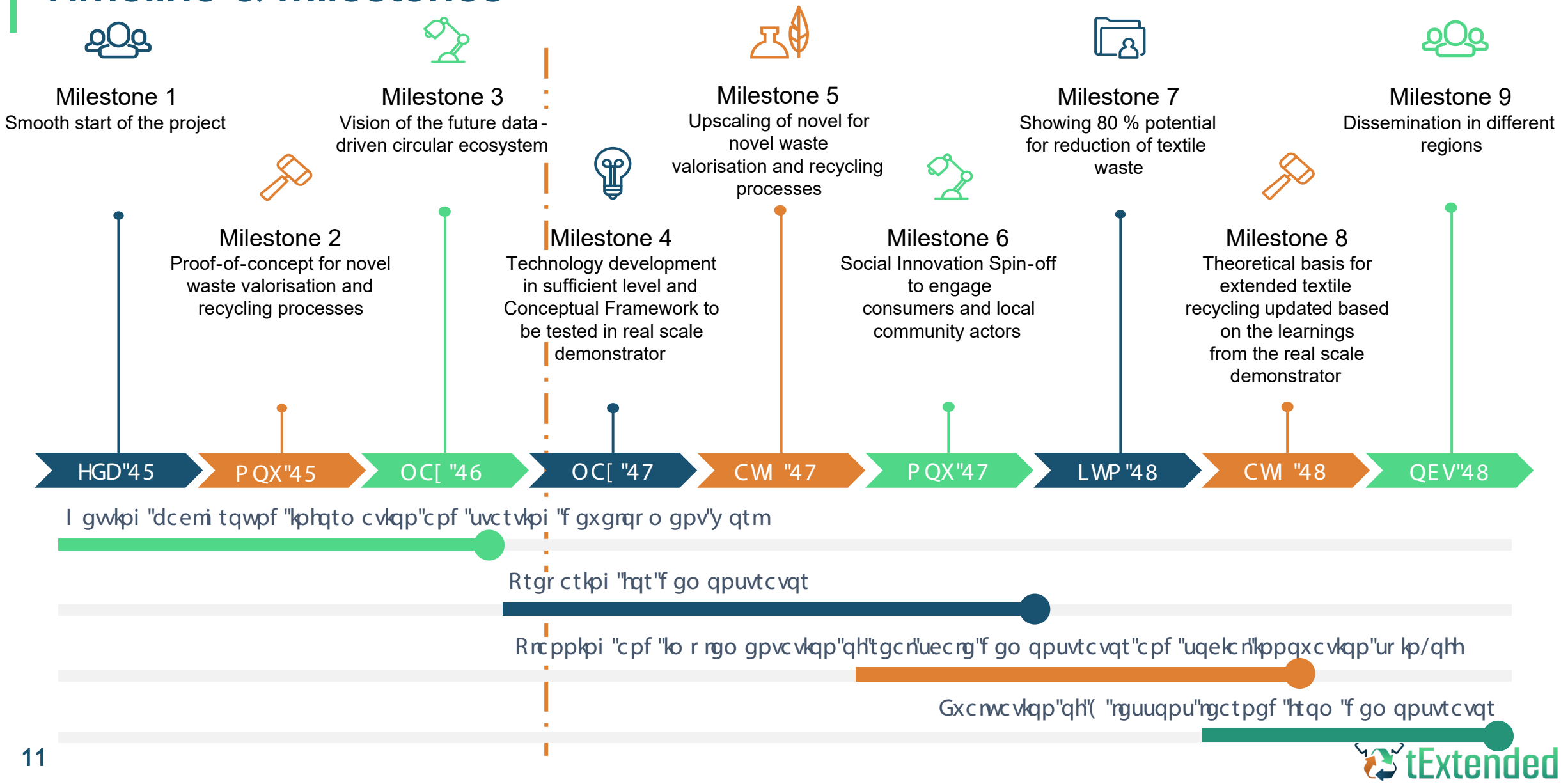
Timeline & Milestones



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MS2 Proof-of-concept for novel waste valorisation and recycling processes

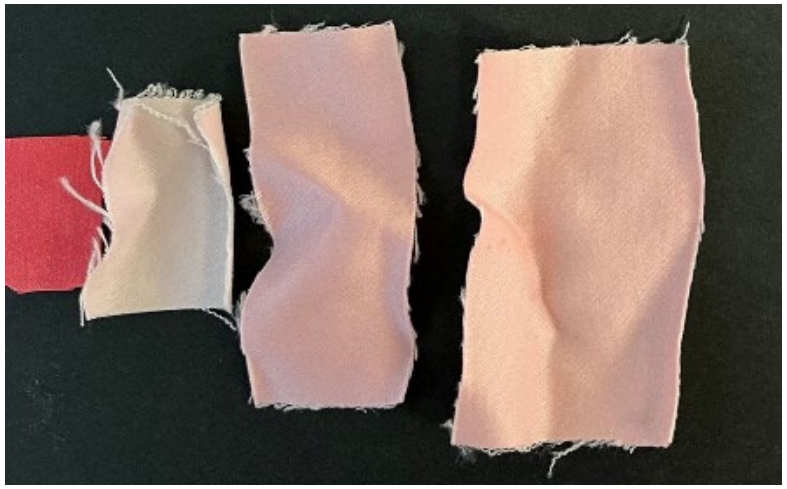
+ We show cased six processes instead of required three
+ Two **waste valorisation** processes
    1. colour removal from cotton (CO)
    2. colour removal from polyester (PES)
+ Two **polymer level recycling** methods
    3. Biocelsol process for separation of cotton and polyester from blends
    4. thermo-mechanical processing of PES
+ Two **methods going to monomer level** into fibre raw materials structure
    5. glycolysis for depolymerization of polyethylene terephthalate (PET), which is most common type of PES in textiles
    6. solvolysis of mixed laminates

Waste valorization processes (MS2)

- CITEVE is developing a sustainable, two-step process for **colour removal from cotton** and its blends combining use of chemical and ozone treatment.
- The process have been applied to 100% cotton and it has shown effectively removal of colours

Cotton fibre samples before and after first and second steps of colour removal process.

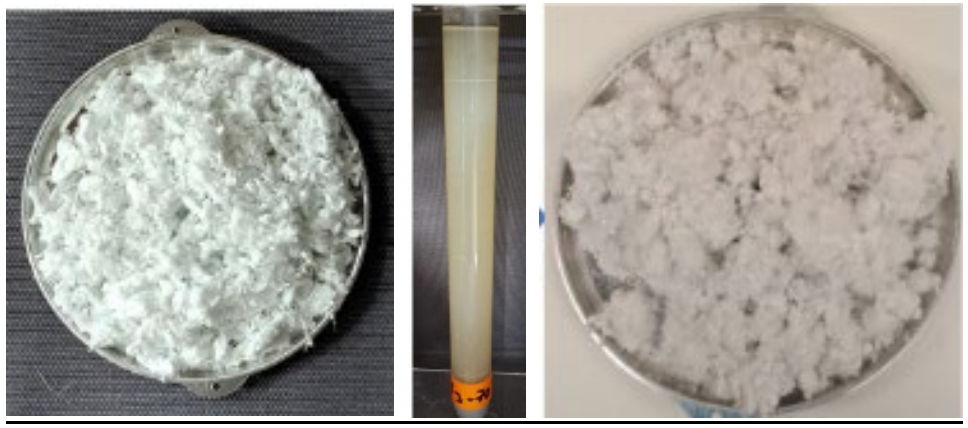
- RISE is developing removal of disperse dyes for **decolourisation of polyester** using solvent treatment in elevated temperature.
- This process, being reverse process for dyeing, has proven effective for extracting dye molecules/ pigments from PES as can be seen from Figure.



Woven PES fabric samples before (red sample) and after dye extraction trials (white-pink samples)

Polymer level recycling (MS2)

- VTT is studying the use of Biocelsol process for **dissolution of cellulose** from cotton-PES blends and thus **separate** the solid polyester.
- The aim is to develop the process enabling the recovery of both of these fractions for further utilization: cellulose to MMCFs and PES to melting or re-polymerization depending on its quality.



Refined cotton-PES blend (L), cellulose solution obtained from cotton after separation of solid PES (M), and washed and dried PES (R).

- VTT has created the MODI X extruder for **open-loop recycling for plastic materials** , including light and fluffy textile materials.
- I t has been successfully used for the melting and compacting of thermoplastic polyester fabric not suitable for fibre-to-fibre recycling.
- Grinded material can be processes e.g. with injection moulding to form plastic samples.

The original technical textile product going into MODIX, and compacted (=melted) polyester lump and the material after grinding

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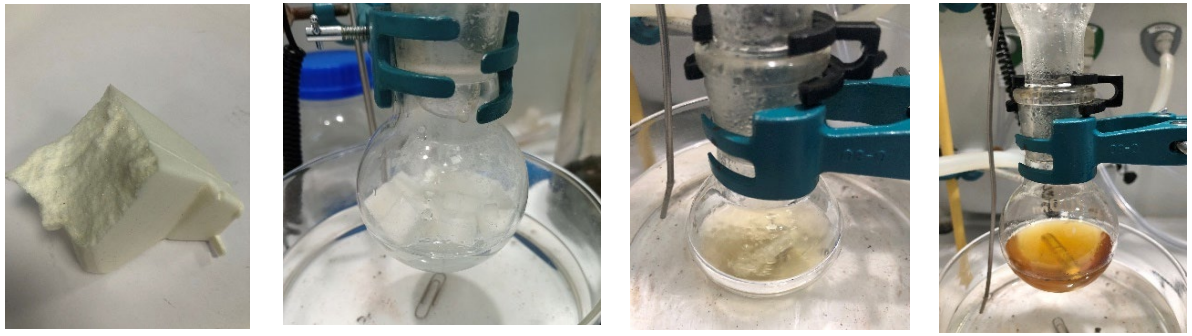
Monomer level recycling (MS2)

- RISE is studying the use of environmentally friendly catalysts for **glycolysis process** , which is a well-known process for **chemical recycling of PET** packages and textiles.
- In this process PES is depolymerised into a monomer BHET i.e., the building block of the polymer, that easily can be re-polymerised to obtain new PET material with virgin properties.

Polyester fibres, as well as lab reactor, catalyst powder, and ceramic balls used for blending (L); Dry BHET monomer (R).

- AIMPLAS is working with ERT Têxtil and Soprema SOPREMA to develop **solvolysis process** for **chemical recycling of polyurethane** foam offcuts from the textile sector.
- In this chemical process solvents are used to cause the depolymerisation of the materials into polyols, which can be used in production of new polyurethane foams.



From left to right: polyurethane foam from textile sector, initial and middle of the reaction, and final polyol.

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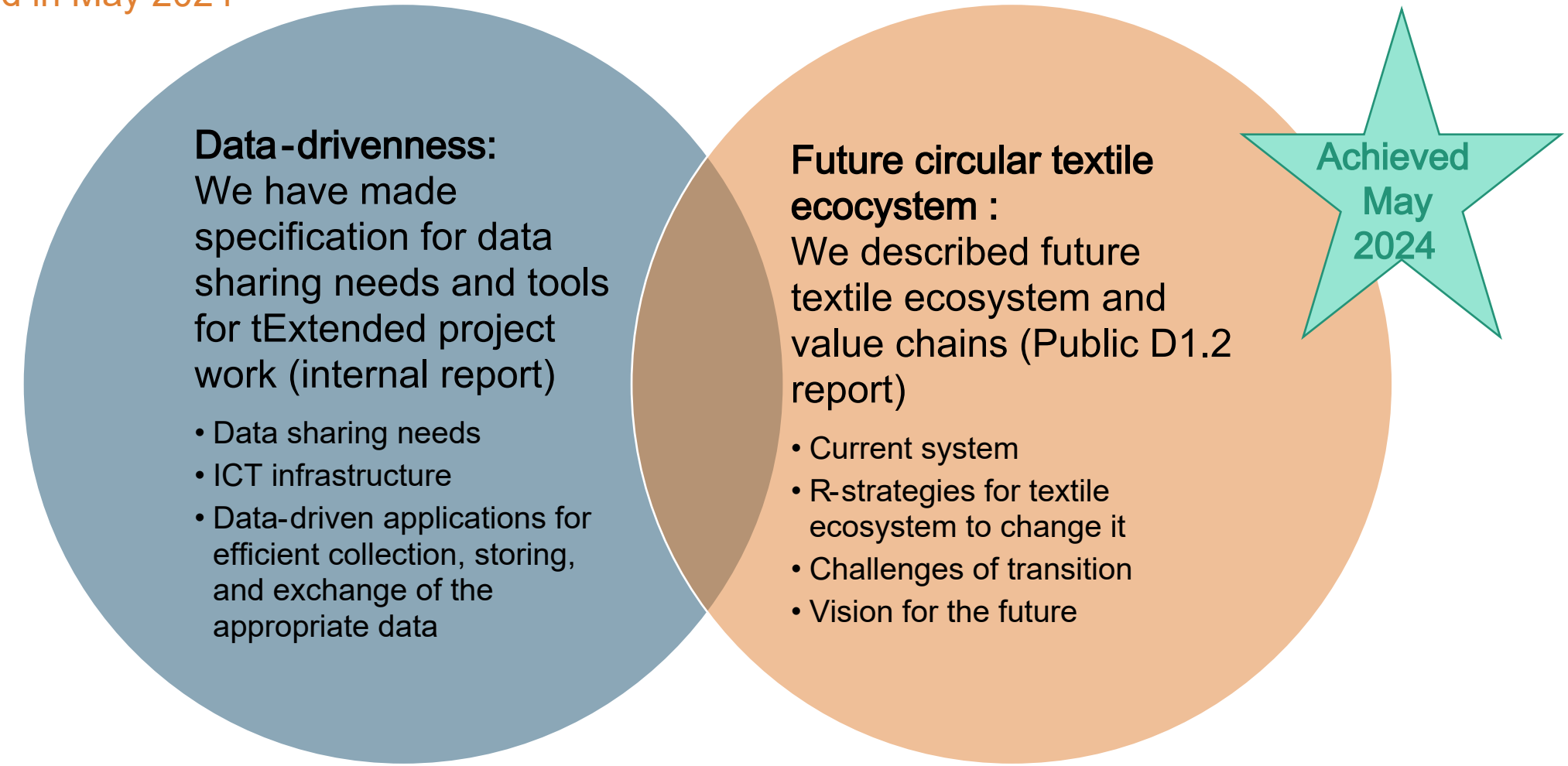
MS3 Vision of the future data -driven circular ecosystem

Achieved in May 2024



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R-strategies for textile ecosystem (D1.2)

Impact	Strategy		Explanation
	Potting *et al.*, 2017	ISO 59004:2024	
Smarter use of resources	R0 Refuse	Refuse	Making product redundant by abandoning its function or using other product instead
	R1 Rethink	Rethink	Make product use more intensive, for example, by sharing or multi-functionality. Reconsider design and manufacturing
	-	Source	Use recycled or renewable resources and that are easily recycled or returned to the biosphere.
	R2 Reduce	Reduce	Increasing efficiency in production, and consuming less through efficient manufacture or use

https://textended.eu/wp-content/uploads/2024/10/tExtended_D1.2-Redesigning_REVISION1-.pdf

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R-strategies for textile ecosystem (D1.2)

Impact	Strategy		Explanation
	Potting *et al.*, 2017	ISO 59004:2024	
Extend lifespan of products	R3 Re-use	Reversed order: repair first repair and then re-use, same definitions.	Re-using functioning discarded products by another user in its original function
	R4 Repair		Repairing and maintenance of defective products thus keeping them in their original function
	R5 Refurbish	Refurbish	Restoring and updating old products and bringing them up-to-date
... parts of products	R6 Remanufacture	Remanufacture	Using parts of discarded products in a new product with same function
	R7 Repurpose	Repurpose	Using products or their parts in a new product with a different function

R-strategies for textile ecosystem (D1.2)

Impact	Strategy		Explanation
	Potting *et al.*, 2017	ISO 59004:2024	
Utilization of materials	-	Cascade	Optimise the use of recovered materials so they are going from one loop to another often decreasing in numbers and quality ending up in another end-of-life solution
	R8 Recycle	Recycle	Processing and recycling materials to obtain the same or lower quality
	R9 Recover	Recover	Incinerating of materials for energy recovery
	-	Remine	Extraction of resources from landfill or waste plants

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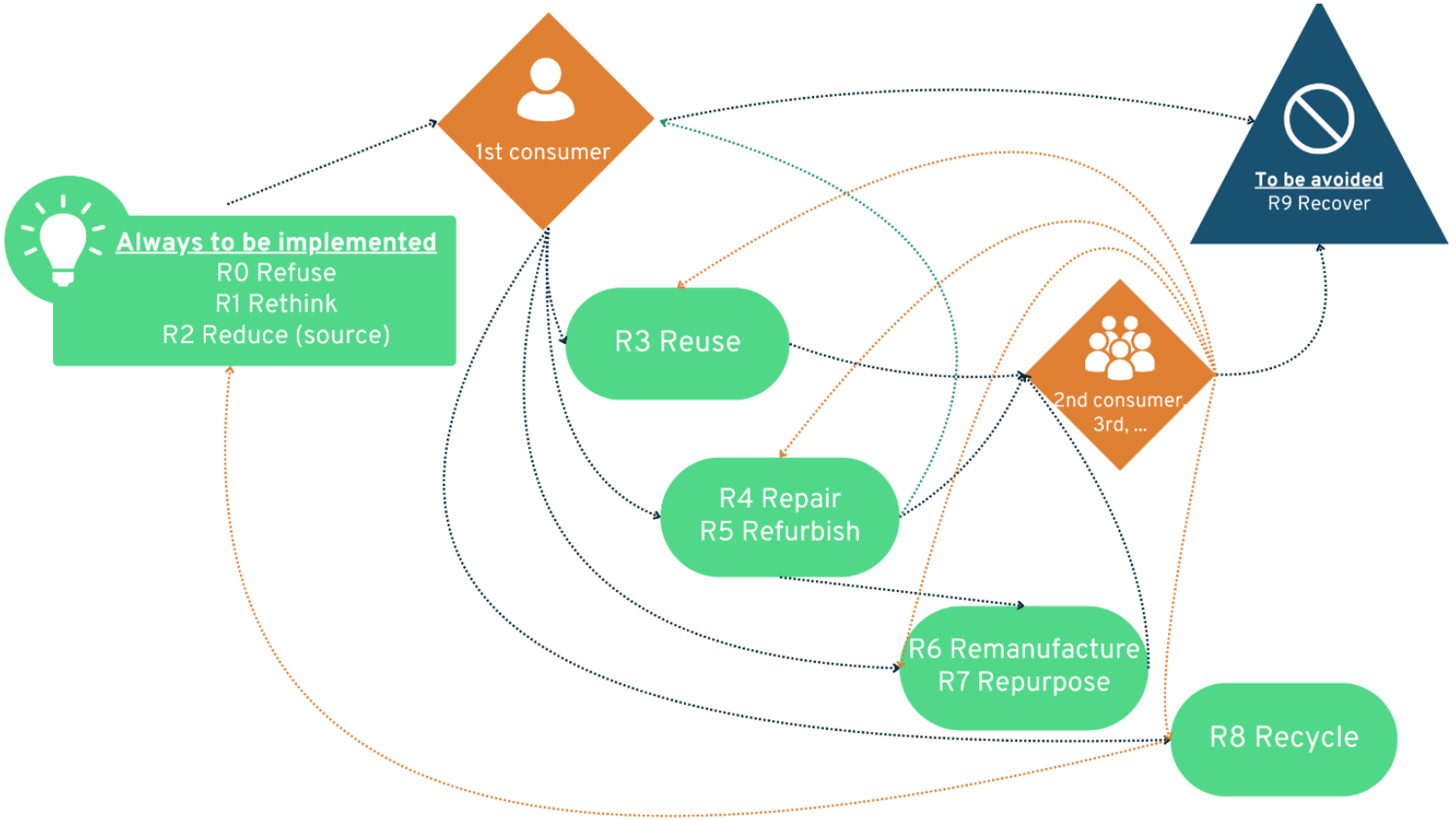
Cascade of R-strategies for textile ecosystem (D1.2)



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MS4 Related to Starting of The Real Scale Demonstrator

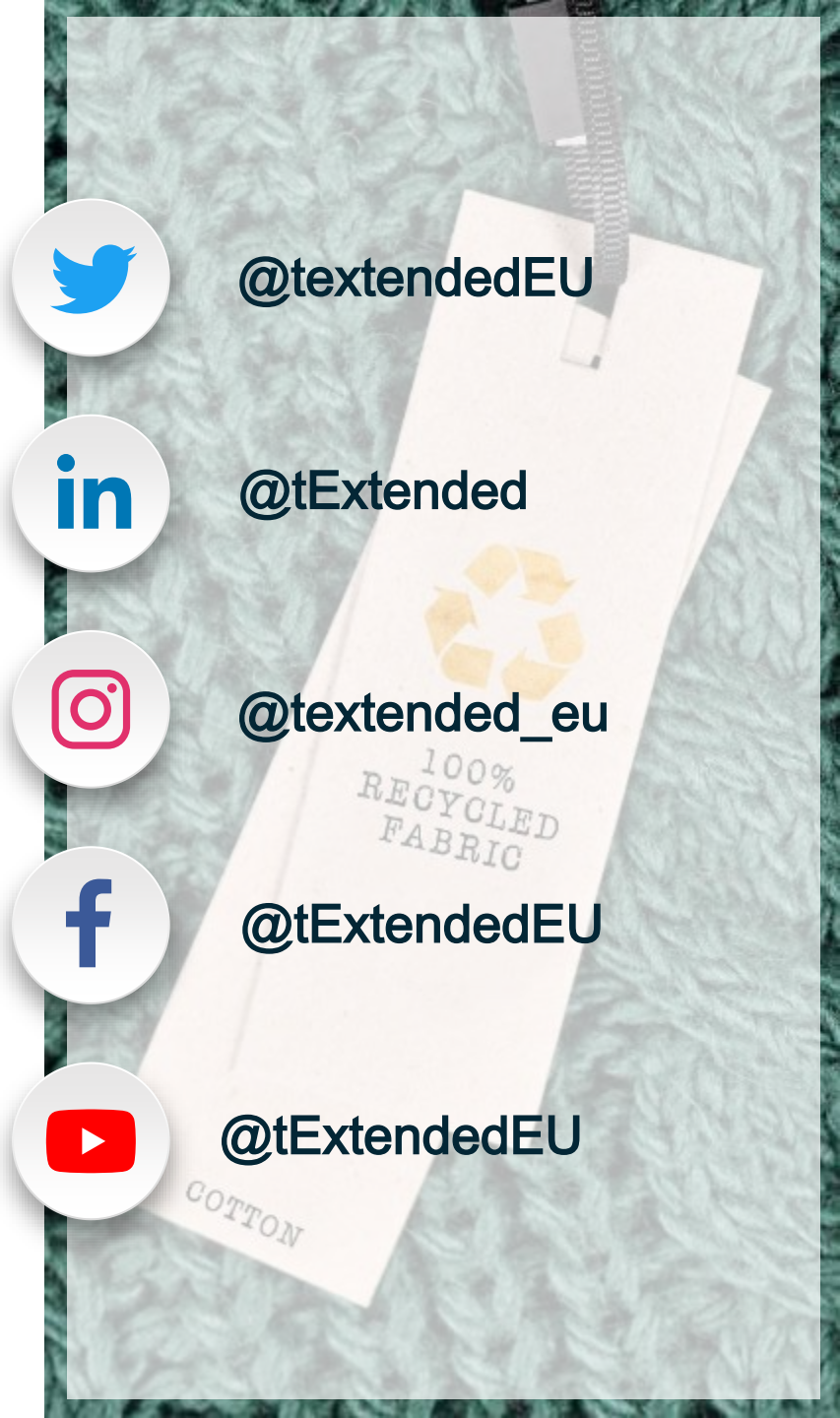
+ Technology development in sufficient level
+ Textile classification tool and Conceptual Framework tools ready to be tested
+ Demonstration planning done

+ More information about the demonstrator in another talk

Communication and collaboration

- The project online channels are: the website, Twitter, LinkedIn, Instagram, Facebook, and YouTube. The project newsletter is going to be published on both LinkedIn and the website.

- Important stakeholders of the projects are:
  - tExtended Community of Practitioners (CoP)
  - ECOSYSTEX, the European Community of Practice for a Sustainable Textile Ecosystem, collaboration with more than 20 EU -funded member projects focusing on textile sustainability
  - Processes4Planet partnership



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Community of practitioners: purpose and role

- The tExtended project welcomes you to join the tExtended Community of Practitioners (CoP).
- The purpose of the CoP is to foster interaction and facilitate knowledge sharing, create synergies between different actors, promote research results and provide feedback on them, identify the most promising tools for end users, and enhance market opportunities.
- To join the tExtended CoP, please fill in the **registration form**
- Scan the QR code or use this link to join: https://forms.office.com/e/ZUER9Q4EUY
- You will receive an email confirmation once your registration has been processed and you have been accepted to the community.

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Thank you!

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