LCA of the multivalorization biorefinery of botanical ingredients in the project SustaiNext.

LCA discussion Forum 94: Turning Waste into Value, Life Cycle Assessment of Side Stream Valorisation and Food Waste Reduction (06.11.2026).

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SustaiNext

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Circular Bio-based Europe Joint Undertaking

Bio-based Industries Consortium

Co-funded by the European Union

SustaiNext Project

The plant for botanical extracts in Extremadura (Spain) was inaugurated in 2021 with a capacity of 3,000 tons/year. In 2024 it reached 9,000 tons/year.

SustaiNext is scaling-up and validating an industrial facility, aiming at 20,000 tons/year and showcasing a new way of manufacturing extracts:

- → Vertical integration from feedstocks providers to end-users.
- → Complete valorization of feedstocks, with a zero-waste and zero-emissions ambition.
- → Smart Dynamic Analytical Biorefinery with a circular and multi-product model.



Photo: SustaiNext project, 2026

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Complete valorization

Multi-product cascade

7 Feedstocks, of which **4** are agri-food waste streams



12 Valorisation routes

46 Plant-based extracts



21 well known ingredients



12 newly produced in Europe



13 totally new in the market

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Smart Dynamic Analytical Biorefinery

SustaiNext

BIOREFINERY

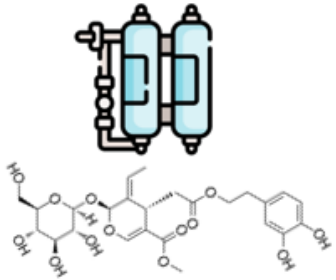
Micronized plant extractions, purification of polyphenols, triterpenes isolation plant



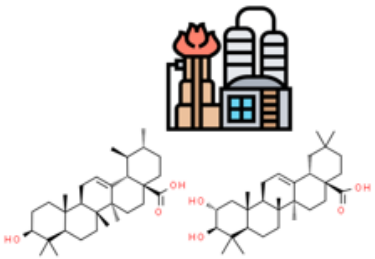
Green chemistry extractions and digital solutions in the **Circular, Sustainable and Digital by Design Biorefinery**



New polyphenol extraction plant



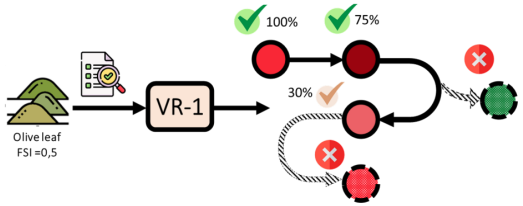
Purification of polyphenols soluble in ethanol



Terpenoids isolation plant

Dynamic analysis

Prediction of the most resource efficient and cost-competitive distribution of the downstream products



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Circular Bio-based Europe Joint Undertaking

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LCA Goal & Scope

Goal: to quantify the environmental aspect and impacts of the biorefining processes and the 12 valorization routes at the biorefinery in Hervás, Extremadura (Spain).

This presentation covers :

- The valorization route from olive leaves to obtain 3 Polyphenol extracts of different concentrations
- 3 Allocation approaches
- 3 Feedstock Suitability Indices (FSI).

SMART DYNAMIC
Analytical BIOREFINERY



END-USE
PRODUCTS



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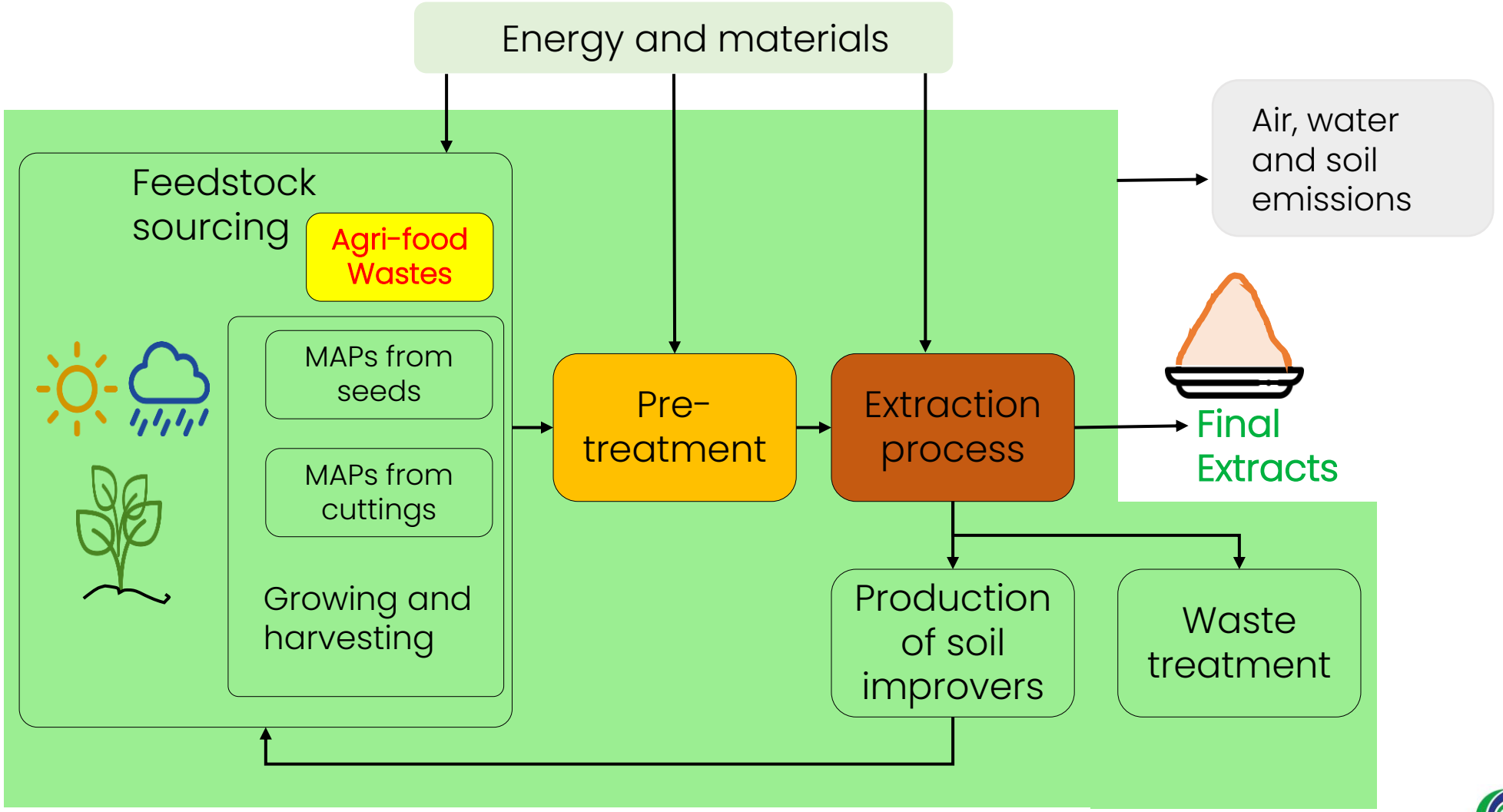
System Boundaries



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Functional Unit & Impact Methods



Mass (1 kg or 1 ton) of Polyphenol Extracts (P.E.) from (agri-food) feedstock.

Extracts with **different concentration of Polyphenols: P.E.20%, P.E.25% and P.E.40%.**

LCA Modelling (completed in 2025):

- Software: SimaPro 9.6.0.1
- Database: ecoinvent 3.10, Cut-off by classification.

Impact Assessment:

- IPCC 2021 GWP100 and Env. Footprint v3.0 (22 indicators for environmental impacts, resource use and waste outputs).
- Mid-point indicators, no aggregation.

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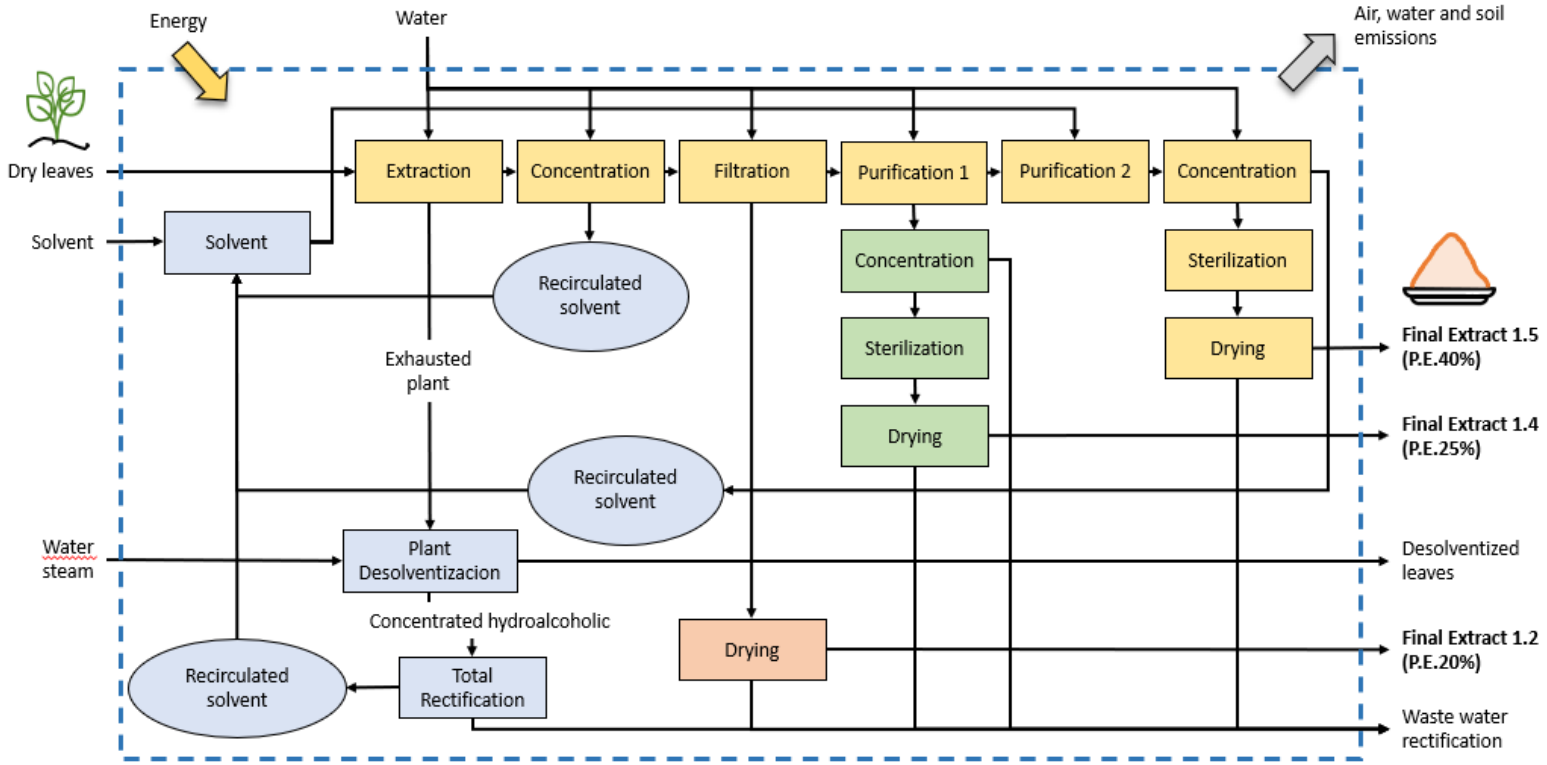
Process modeling

- Different yields for 3 FSIs
- 3 Allocation approaches:

1. Mass based allocation: based on the mass flows of the processes.
2. Economic based allocation: based on the prices of polyphenol extracts.
3. Allocation based on the minimum Polyphenol concentration: based on the polyphenol content in the mass flow.



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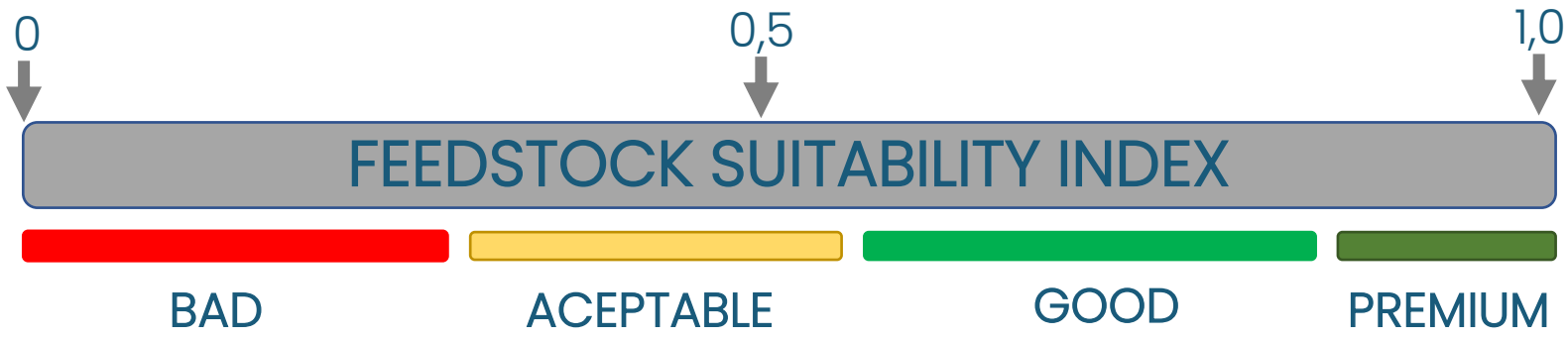
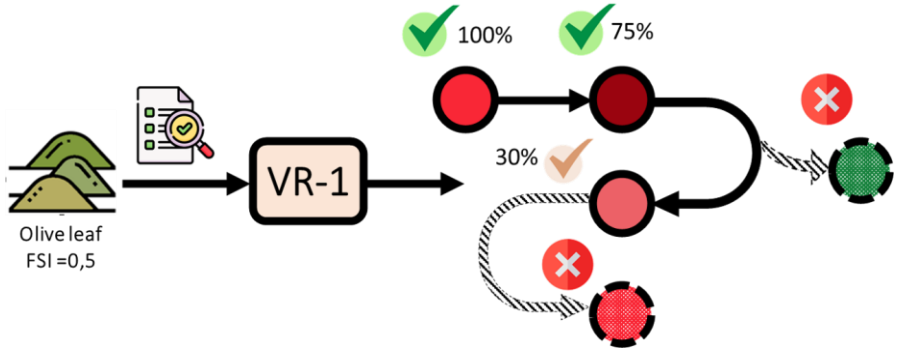
Feedstock Suitability Index – FSI

A **numerical quantifier** expressing the overall suitability of a given feedstock for a specific valorization route.



Example Extract	FSI
P.E.40%	0,7
	0,68
	0,56



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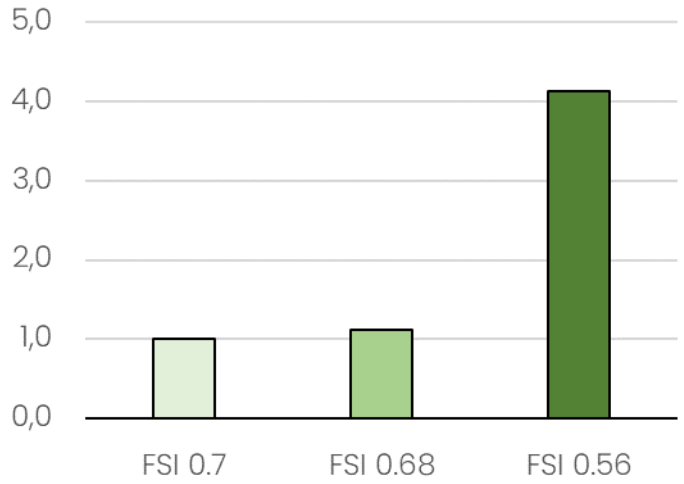
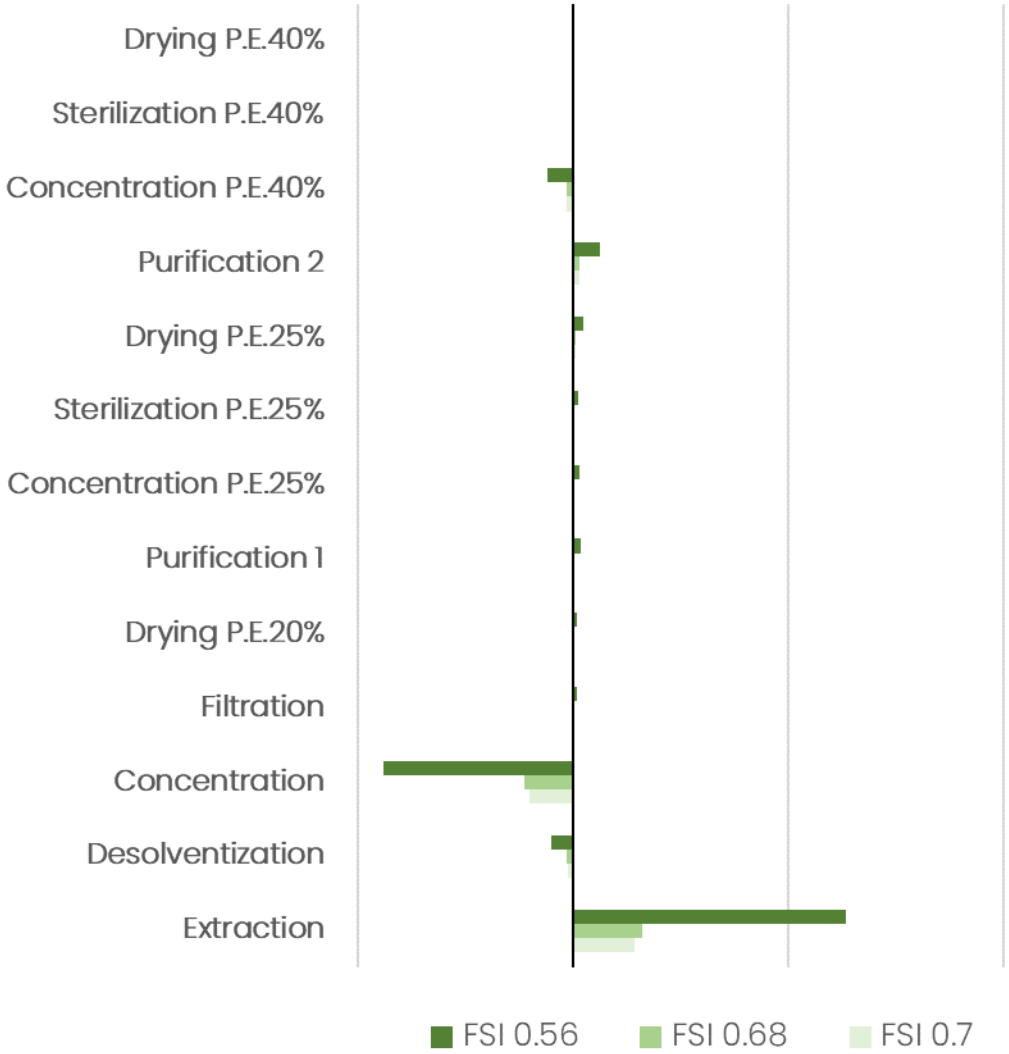
Selected LCA Results – FSIs

Normalized GWP for P.E.40% for the olive leaves with different FSIs (no allocation).



The extraction of 1 ton of P.E.40% from olive leaves with FSI = 0,56 shows almost four-times higher GWP than from a feedstock with FSI = 0,7 → A small amount of the extract with a high polyphenol content is produced, and the process output is low → More feedstock and extraction/concentration processes are needed to obtain more output of the richer Polyphenol extract.



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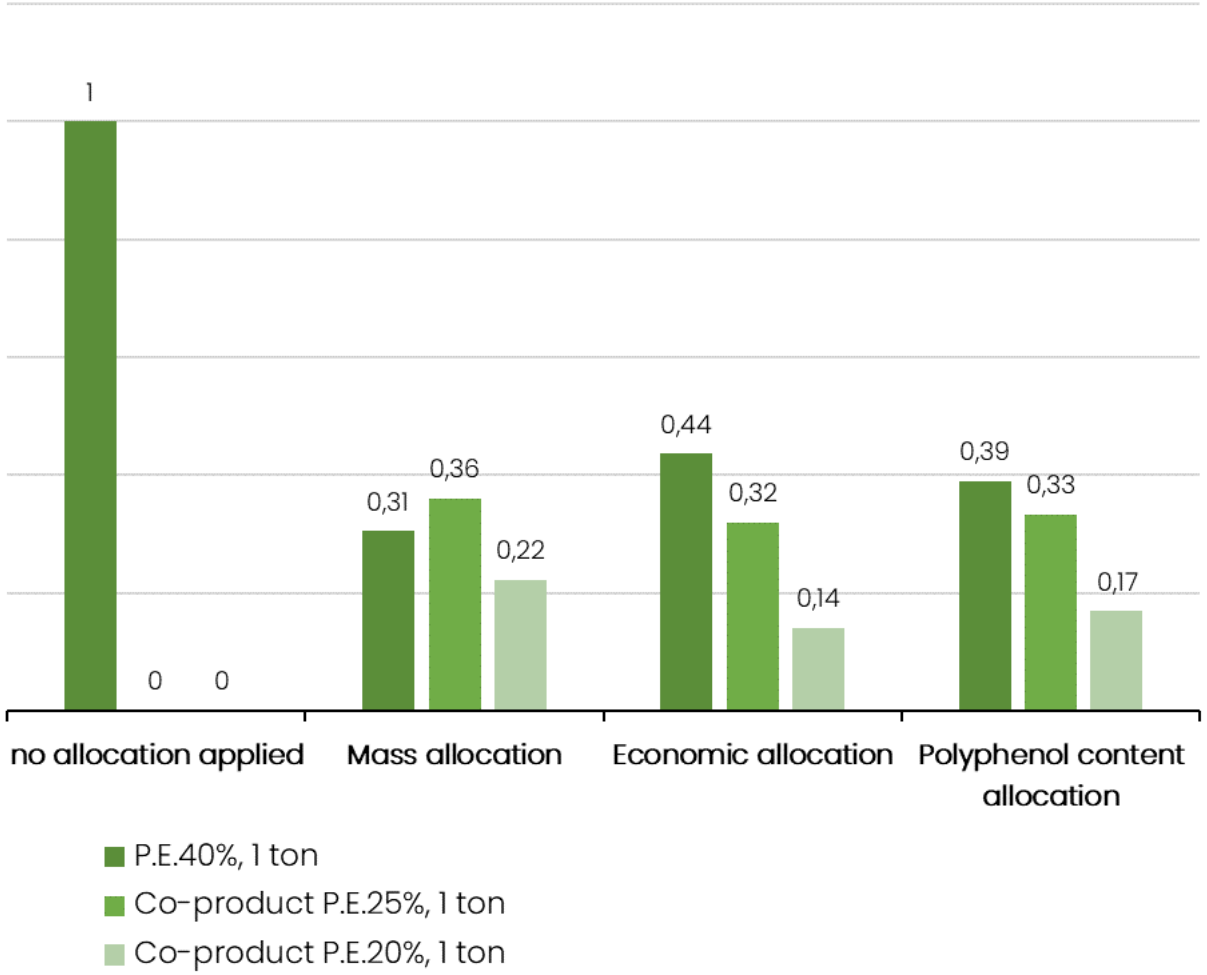
Selected LCA results – 3 Allocations

Normalized GWP for the **product and co-products using Allocations:**

→P.E.40% shows the largest norm. GWP with **the economic based and the polyphenol content allocations** (Similar results for both allocations): *P.E.40% has the highest price and highest content of polyphenols*.

→P.E.25% shows the highest norm. GWP when using mass based allocation.



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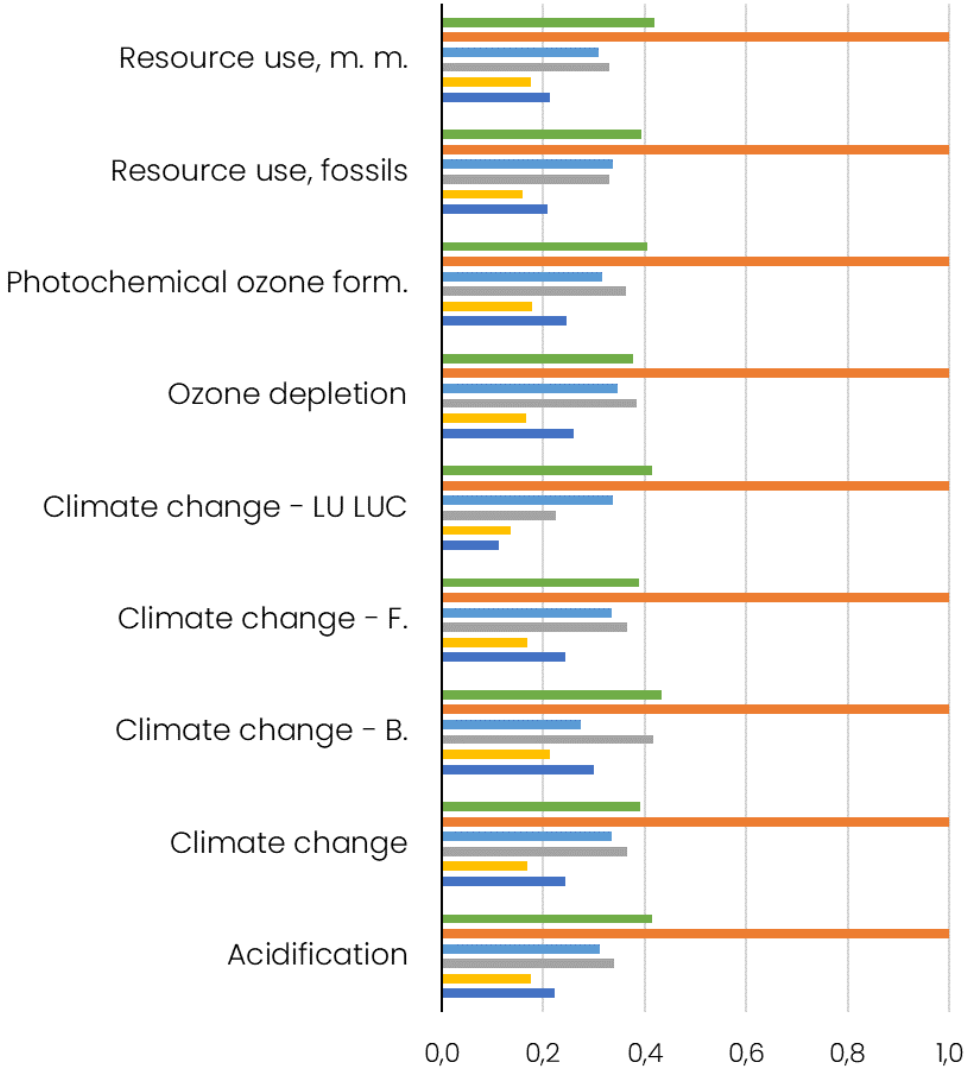
Selected LCA Results – Polyphenol Content Allocation

Normalized GWP for the product and co-products using Polyphenol content allocation

- P.E.40%, FSI0.7, content allocation approach
- P.E.40%, FSI0.7, no allocation applied
- Co-product P.E.25%, FSI0.7, content allocation approach
- P.E.25%, FSI0.7
- Co-product P.E.20%,FSI0.7, content allocation approach
- P.E.20%, FSI0.7



The multi-output process using Polyphenol content allocation shows mostly lower norm. GWP for the same product and co-products.

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Summary

LCA for **the valorization of olive leaves** focused on:

- 3 Polyphenol extracts: P.E.20%, P.E.25% and P.E.40%.
- 3 Allocation approaches: mass flow, economic and Polyphenol content based.
- 3 Feedstock Suitability Indices (FSI): 0,56 – 0,68 – 0,7.





- Results are similar using the Polyphenol content-based and economic-based **allocations**.
- The **FSI** is a key benchmark for extract production → Low FSI of the feedstock leads to e.g., a higher GWP of the final extract (but also a low process output).

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LCA methodology and results are published

World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:19, No:9, 2025

SUSTAINEXT: Validating a Zero-Waste, Dynamic, Multivalorization Route Biorefinery for Plant Extracts

S. Glaser, A. Díaz Triana, S. Robbert Prieto, W. Wimmer

https://publications.waset.org/10014235.pdf



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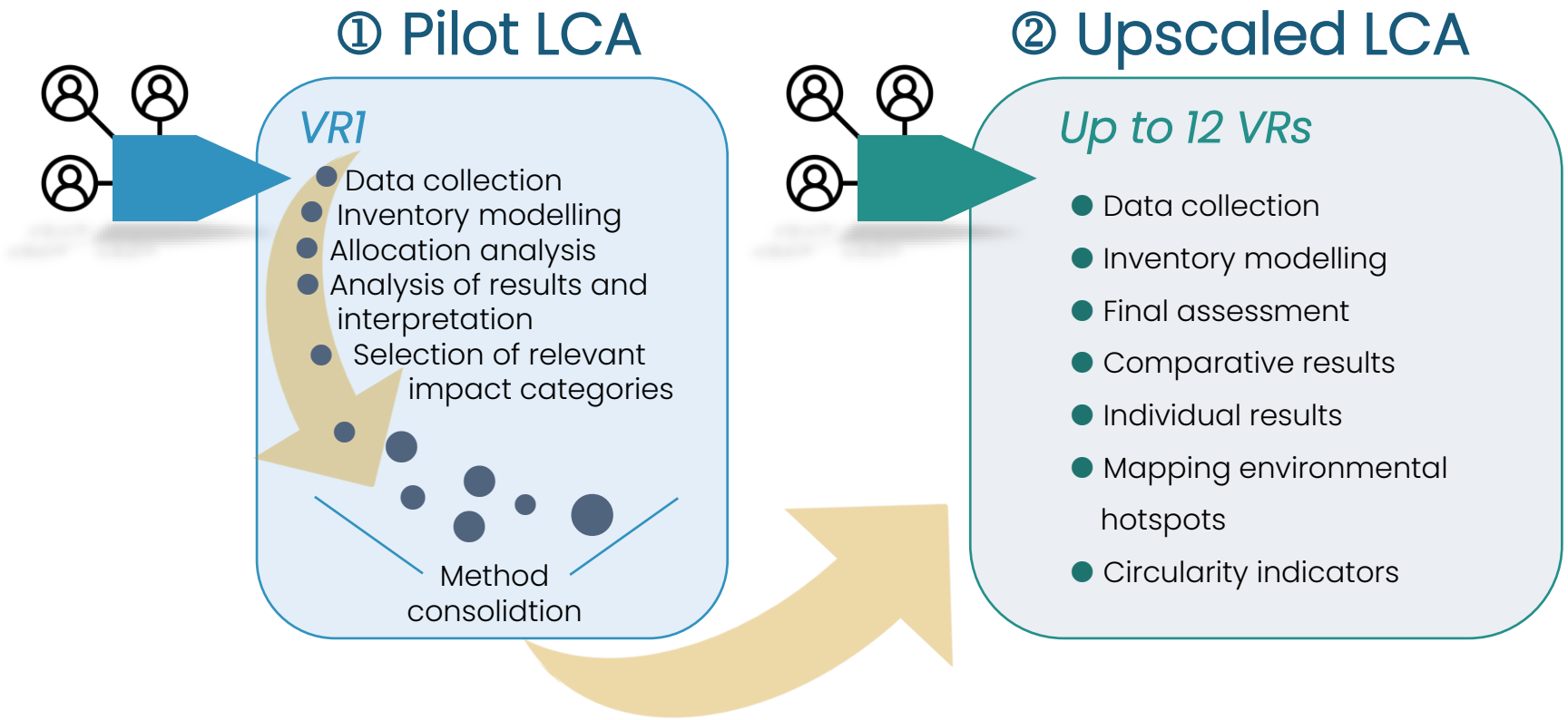
Outlook: Scaling up the LCA

More agri-food industry wastes are used in dedicated valorization routes for **Pomegranate skins, Cardoon plant, Artichoque bracts & plants**.
LCA results on the way.



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Presenter today: Dr Adriana Díaz Triana, ECODESIGN company GmbH.

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