Prospective Life Cycle Assessment of emerging technologies for bio-based materials

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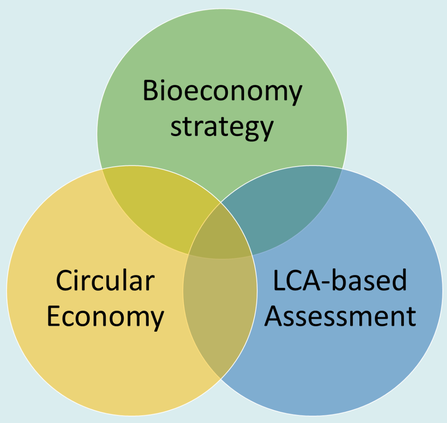
1. CONTEXT



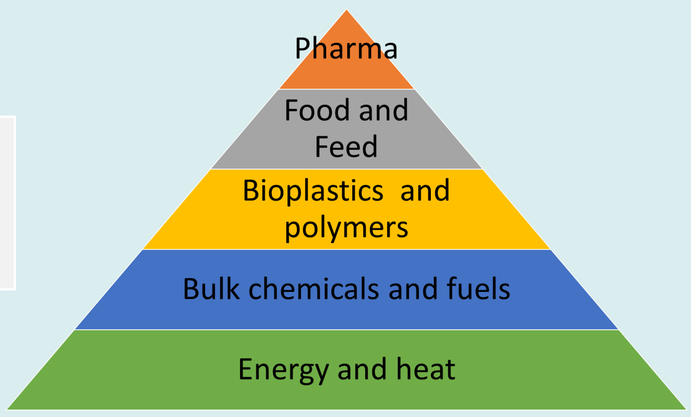
New technologies have been recently developed to **valorize bio-waste** and to provide **bio-based materials**.

Bio-waste valorization strategies should follow the **waste valorization hierarchy** and increase the **cascade use of waste.**

Technical feasibility, economic profitability as well as **environmental preferability** of these emerging technologies should be carefully assessed.

EMERGING TECHNOLOGIES FOR FOOD WASTE VALORIZATION

WASTE VALORIZATION HIERARCHY



Prospective LCA can be used to **assess the environmental performance of an emerging technology** to:

(1) inform technology developers of beneficial changes at a early stage of development,

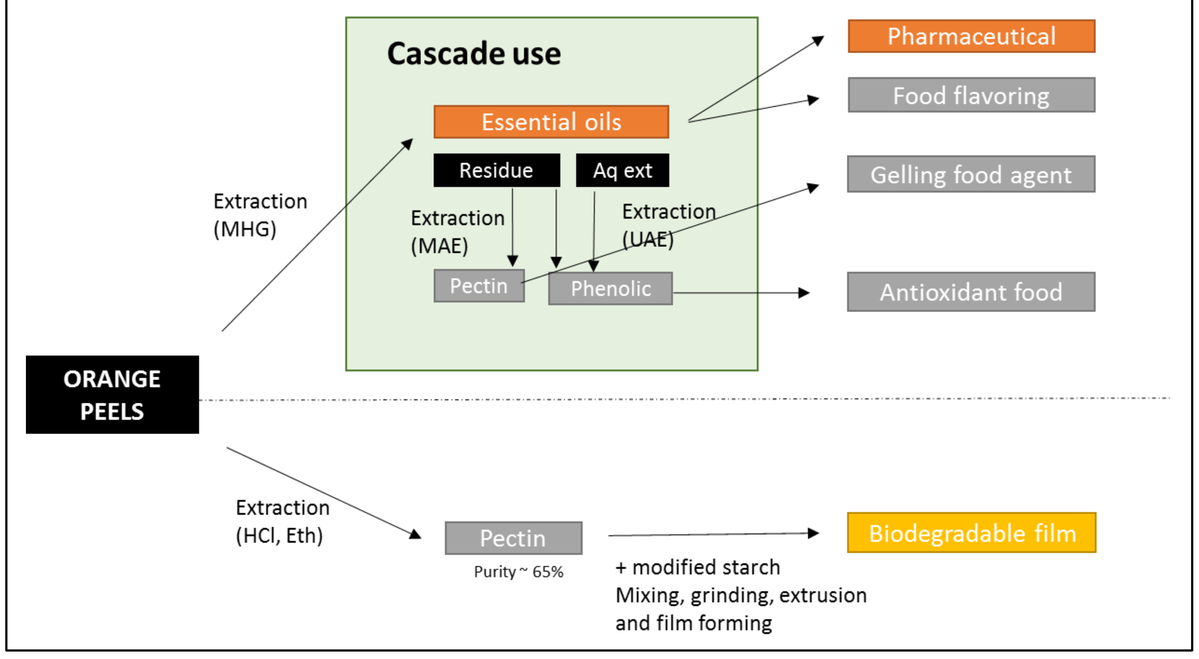
(2) support decisions of policy makers looking to fund projects, and

(3) push manufacturers toward the most sustainable application of a technology [1].

2. THE EXAMPLE OF ORANGES WASTE VALORIZATION

A preliminary study on the techno-economic and profitability analysis of a biorefinery to produce value-added products from industrial food wastes identified orange wastes as the most economically profitable among the feedstock analyzed [2].

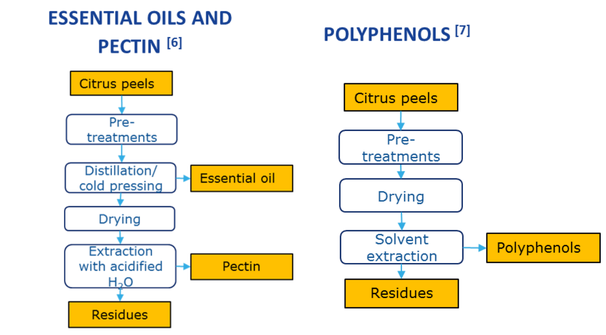
The follow-up of this study is to assess the environmental performance of the valorization pathway considered [3]. As the technology is still at lab scale, prospective LCA has to be used in the assessment. Additionally, an alternative pathway [4] to valorize this type of waste is compared. The scheme of the systems considered is presented below.



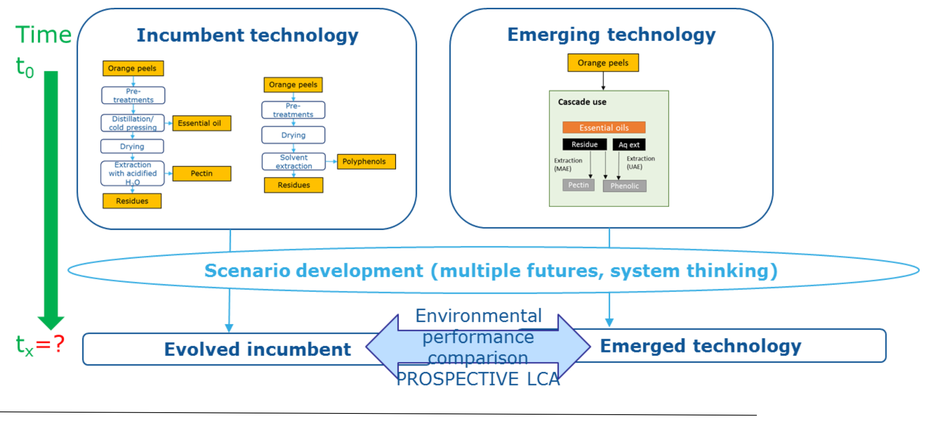
3. CHALLENGES AND RESEARCH OUTLOOK

As highlighted by Cucurachi et al. [5], the environmental assessment of emerging technology poses several challenges, including:

- **Identification of the incumbent technology = best available technology performing the same function and system functionality**



- **Model the evolution of incumbent and emerging technologies**



- **Data Availability**

Uncertainty in the modelling (e.g. missing a clear description of the average incumbent situation)
Distribution functions can be used rather than point values to model the evolved incumbent and the emerged technology.

Upscale of emerging technology to industrial applications
Piccinno et al. [8] developed a scale-up process for chemical processes in LCA but some processes are missing (e.g. microwave and ultrasound assisted extractions). Other information on innovative industrial applications can be gathered in literature for other feedstocks and adapted to the specific situation.

Adapt background data to future
Representativeness of secondary datasets should be considered. Sensitive processes (e.g. energy mix at tx) can be modelled according to existing scenarios (e.g. EU reference scenario 2016).

Missing inventory data and characterization factors for innovative substances (e.g. chemicals)
Synthetic data models are available to estimate life cycle impacts of chemicals, based on chemical similarity of substances (e.g. Chemical Life Cycle Collaborative, funded by US EPA).

The development of this case study is the starting point for the development of a framework for prospective LCA of emerging technologies for bio-based materials, according to the following steps:

1. Identification of emerging technologies being used in biomaterials production
2. Characterization and classification of these technologies, evaluating the best scale-up methodology
3. Provide guidelines for the environmental evaluation of emerging technologies for biomaterials production

References

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