Identifying the environmental hotspots in the production of xylitol to be used as a phase change material

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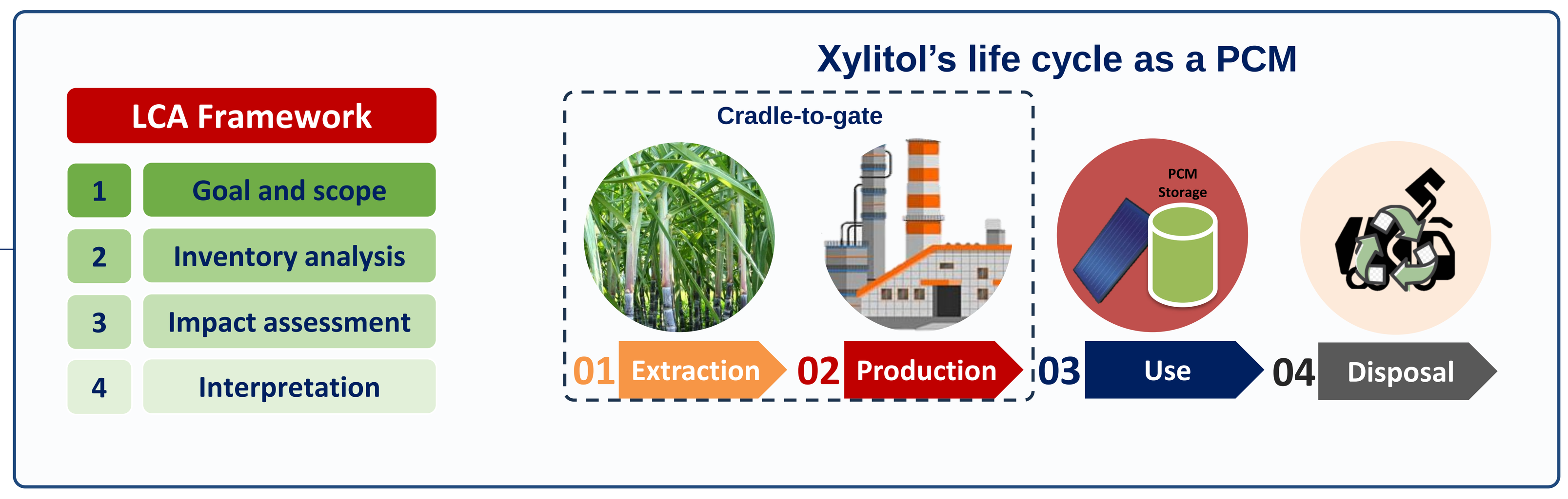
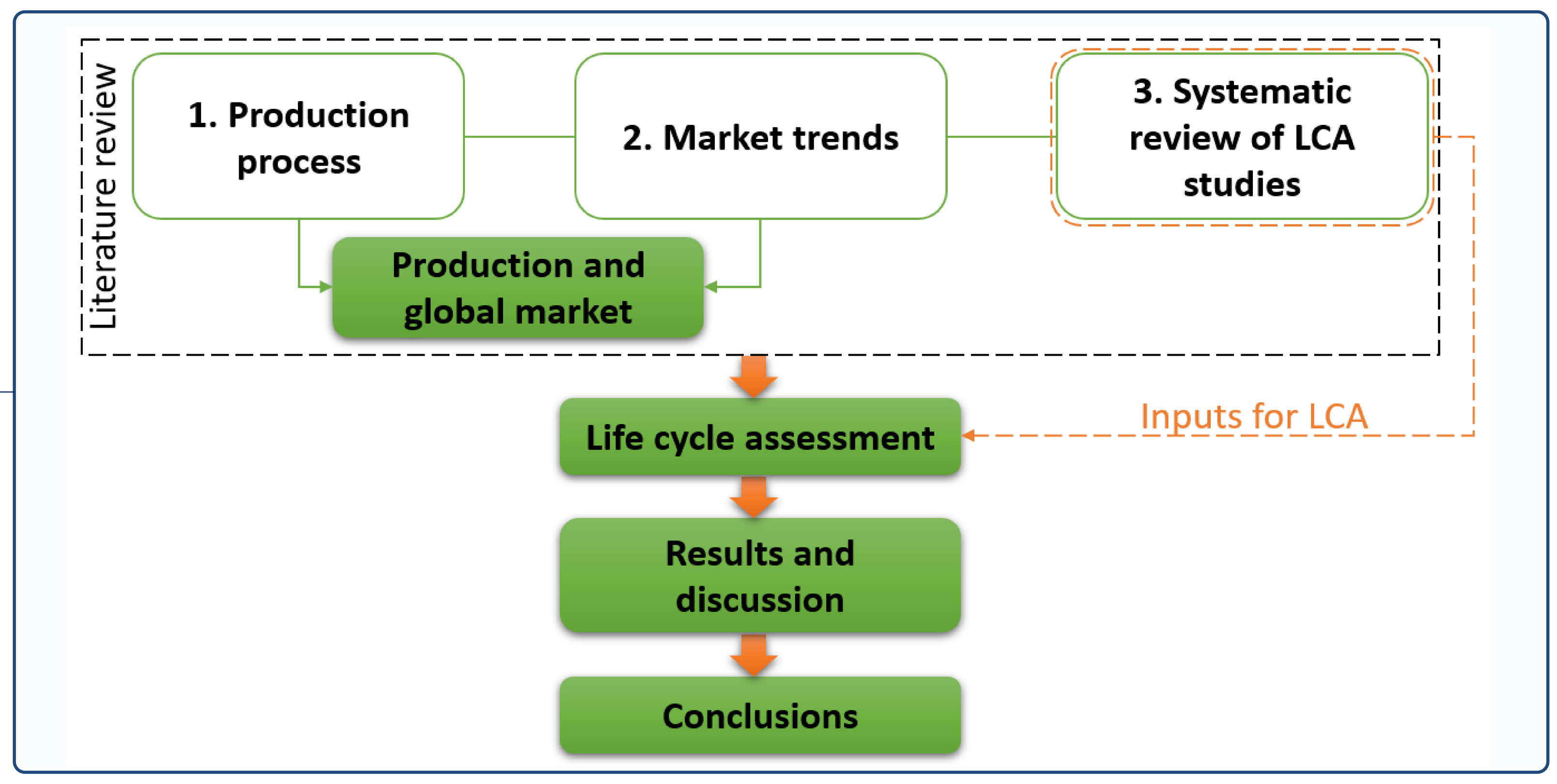
Introduction

Life cycle assessment (LCA) allows the quantification of environmental impacts of the complete life cycle of a product. In line with initiatives to decarbonize the energy sector by using thermal energy storage systems, the objective is to compare the environmental impacts of the chemical and biotechnological production processes of xylitol and identify the environmental hotspots.

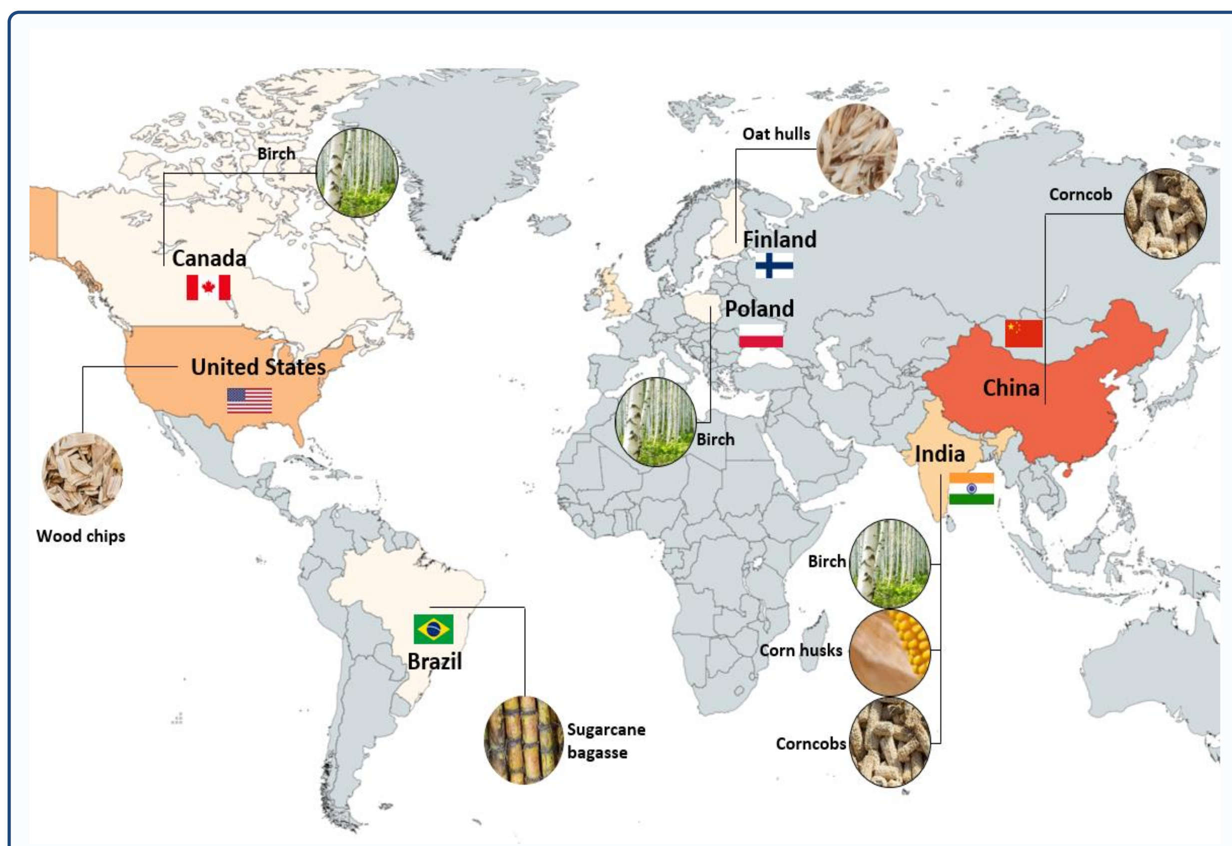


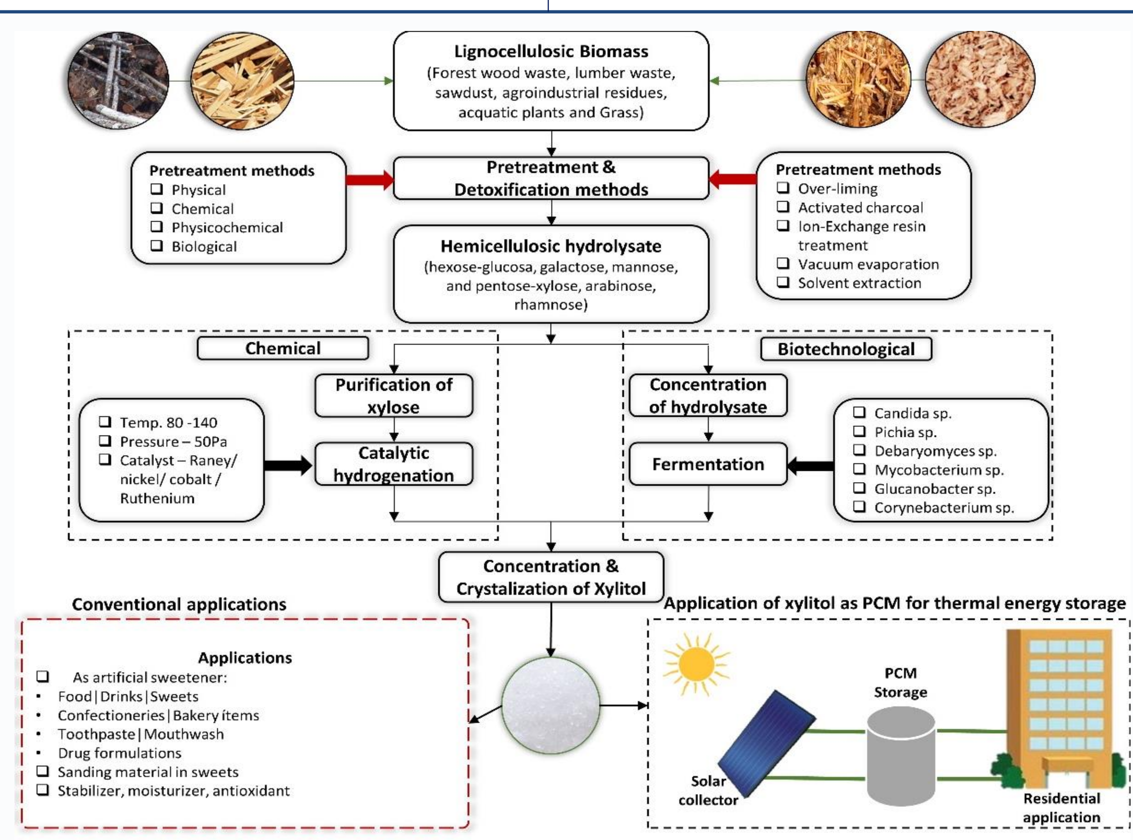
Methodology

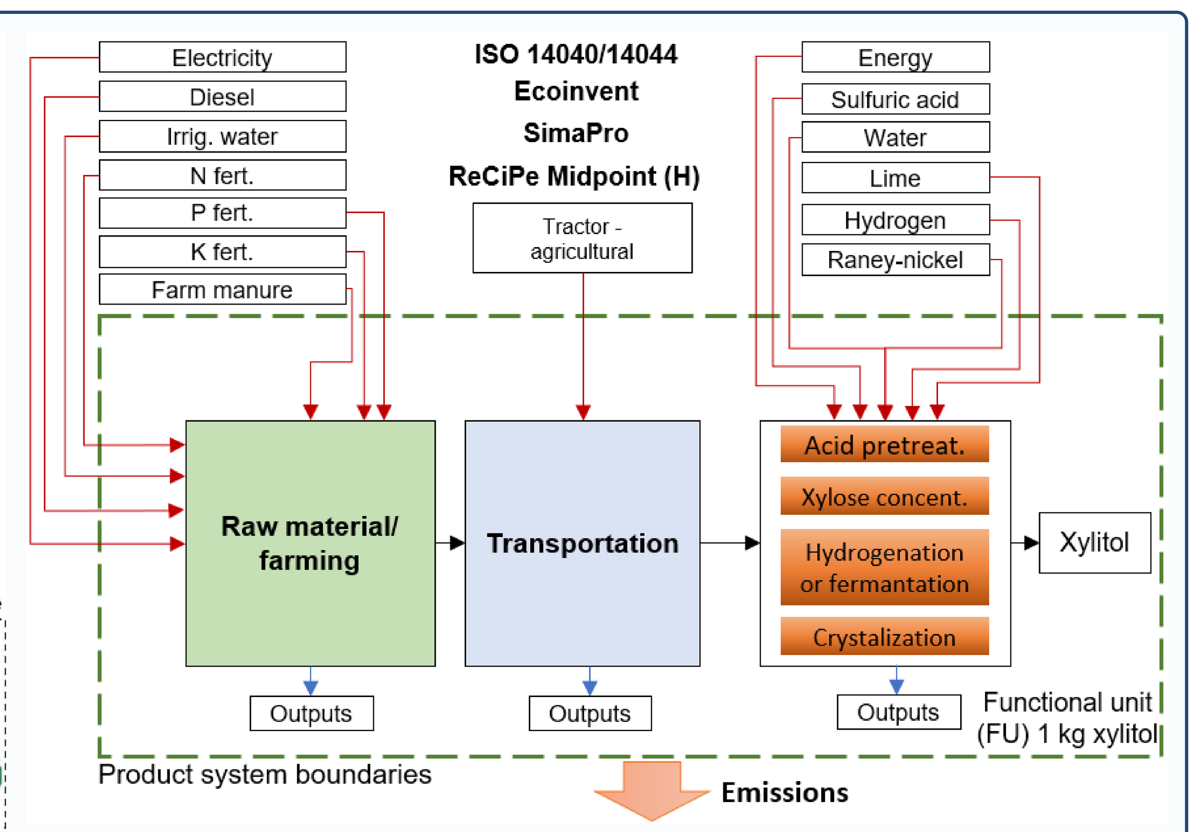
The methodology consisted of collecting literature data of the xylitol production pathways, namely the chemical and biotechnological processes.
The production process and market trends are useful for defining the inputs/outputs of the process and the geographical requirements of the LCA model.
The systematic review was conducted for benchmarking the LCA models already available and identifying improvements the environmental assessment.
A new LCA model was proposed for both production pathways and analysis was conducted based on the ISO 14040 and 14044 standards.



Production and LCA boundaries





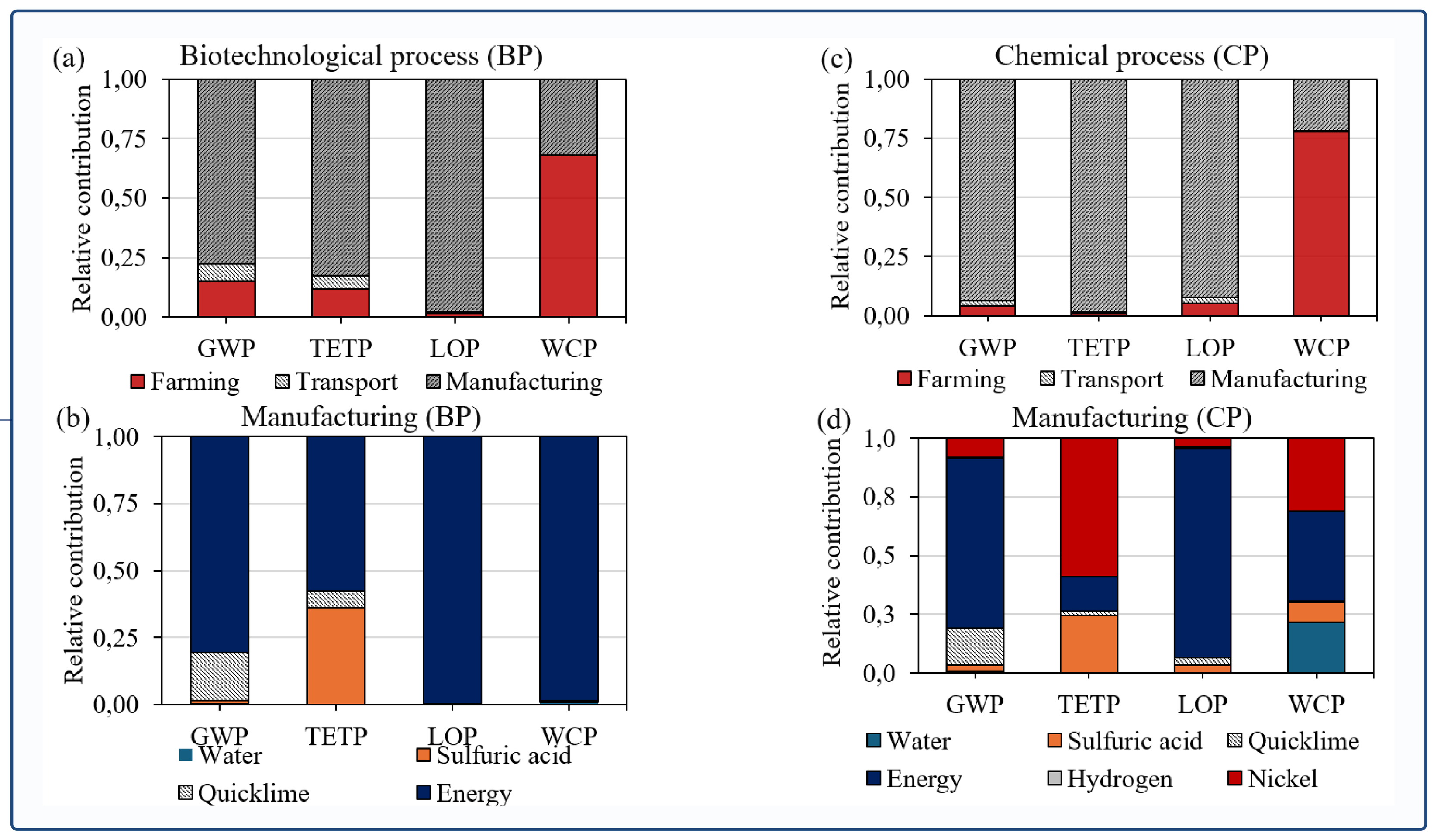


Results

Four impact category indicators are analyzed.

Impact indicator	Unit	Biotec. Process –BP	Chem. Process -CP
Global warming potential (GWP)	Kg CO_2 eq	2.20	8.25
Terrestrial Ecotoxicity Potential (TETP)	kg 1,4-DCB	11.50	144
Land Occupation Potential (LOP)	m^2.yr annual crop land	2.16	0.69
Water consumption potential (WCP)	m^3	0.93	0.98

The biotechnological process is less intensive in terms of energy requirement compared to the chemical process.
In addition to this, the chemical process requires nickel and hydrogen as inputs, increasing the energy requirements for the production process.
Among most of the impacts, in both processes, manufacturing has the highest contribution, except for WCP which is attributed to farming.



Conclusion

The results obtained reveal relevant information that can help researchers in deciding the environmental performance of xylitol as a phase change material.
The biotechnological process presents 4 times less GWP compared to the chemical process, being more attractive to produce xylitol.
Considering the GWP, in both production pathways the manufacturing stage contributes the most, compared to transportation and farming, showing that this stage is the key contributor to climate change.
Energy is the key contributor in the manufacturing of the BP, while energy and nickel are the environmental hotspots in the CP.

Acknowledgement

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