9th International Conference on Sustainable Solid Waste Management (CORFU 2022)

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Closing the loop through the valorization of glycerol as a substrate in the production of hyperthermophilic-glucosidase. A Life Cycle Perspective

· **H.Feijoo, A. Arias, M.T. Moreira**

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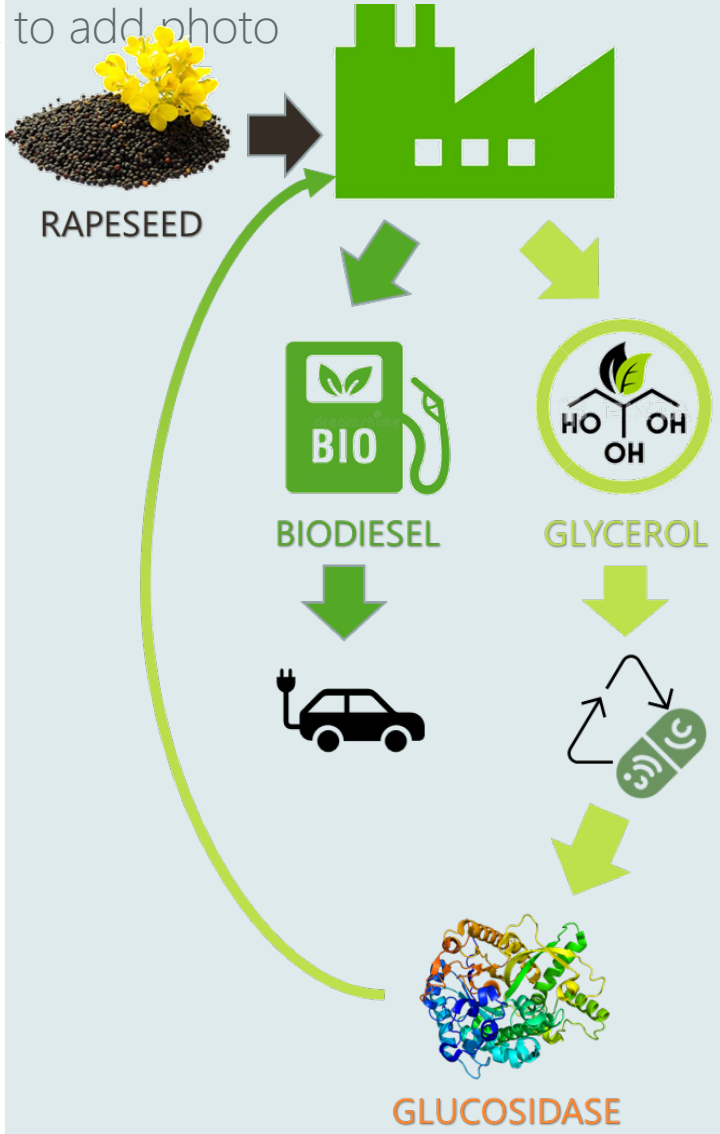

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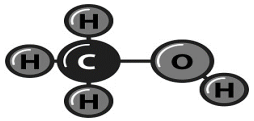
The problem

Rapeseed crop

Seeds

Crude Vegetable oil

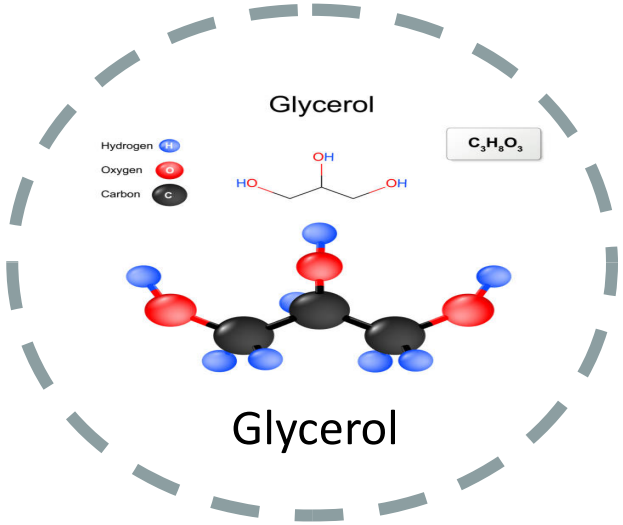
Refined Vegetable oil



Methanol

Catalyst

1 kg of glycerol are obtained per **10 kg** of biodiesel
Glycerol has **low purity**



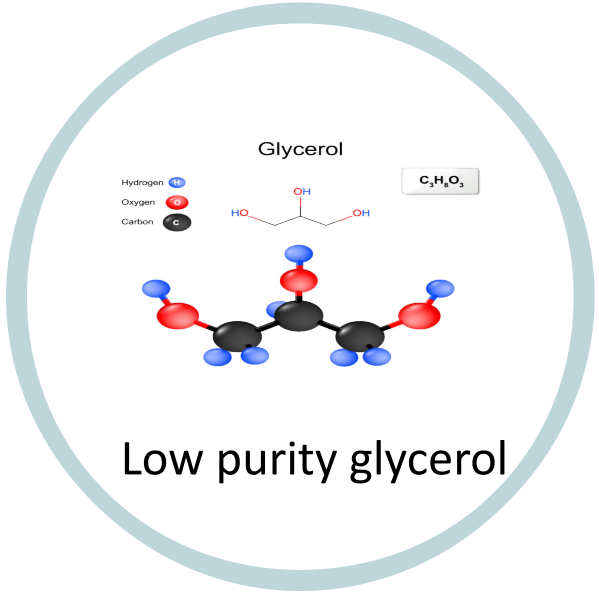
Glycerol

Biodiesel

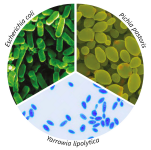
From LOW PURITY GLYCEROL

TO ENZYME PRODUCTION

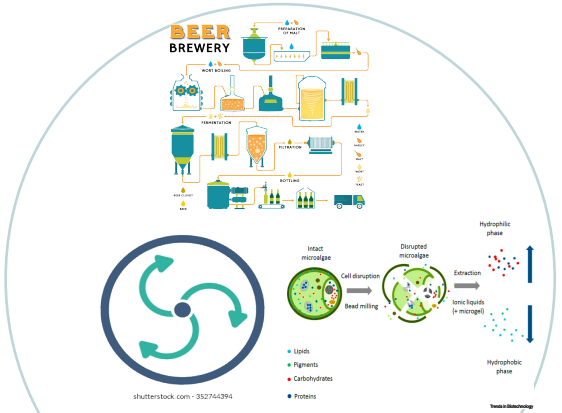
Yarrowia lipolytica



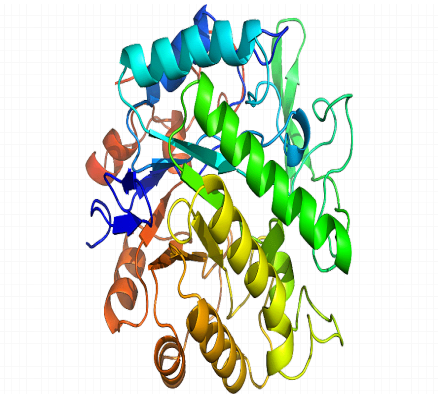
Low purity glycerol



Fermentation



Purification



β-glucosidase

2187 kg of enzymatic cocktail/batch

5200 kg of waste glycerol per batch process

30°C

0.5 vvm

pH 4

45 h

Filtration

Cell disruption

Ion exchange

Life cycle assessment

Stage I Definition

Stage II LCA inventory

Stage III Environmental analysis

Stage IV Interpretation

OBJECTIVES

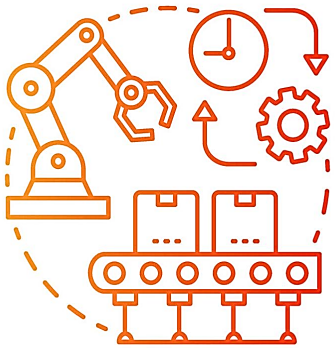
Environmental assessment of the production of β-glucosidase under a life cycle perspective

SYSTEM FUNCTION

Bio-based β-glucosidase production from the valorization of residual glycerol from biodiesel production

FUNCTIONAL UNIT

1 kg Enzymatic cocktail



Batch production

Life cycle assessment

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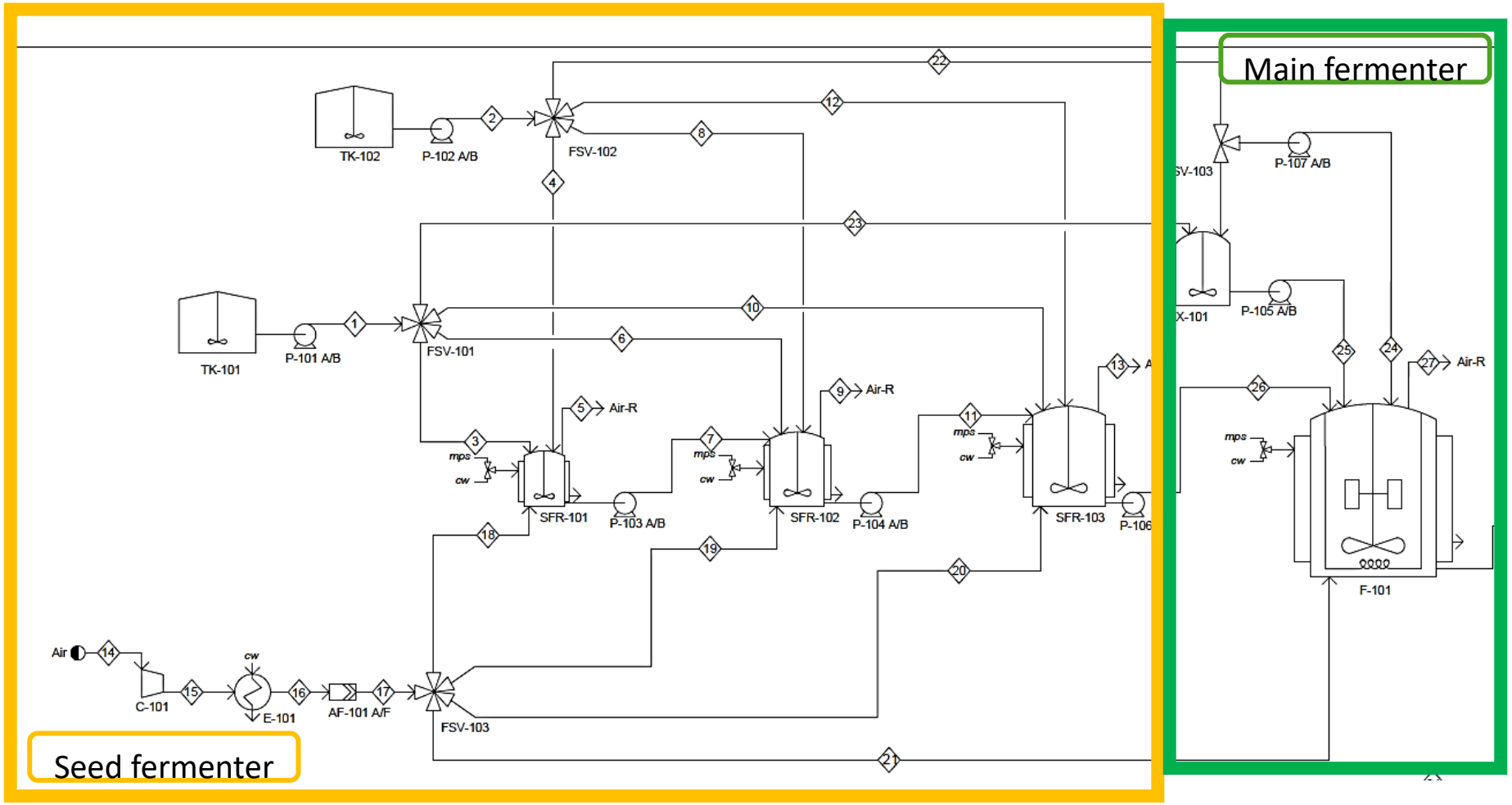
PROCESS



Life cycle assessment

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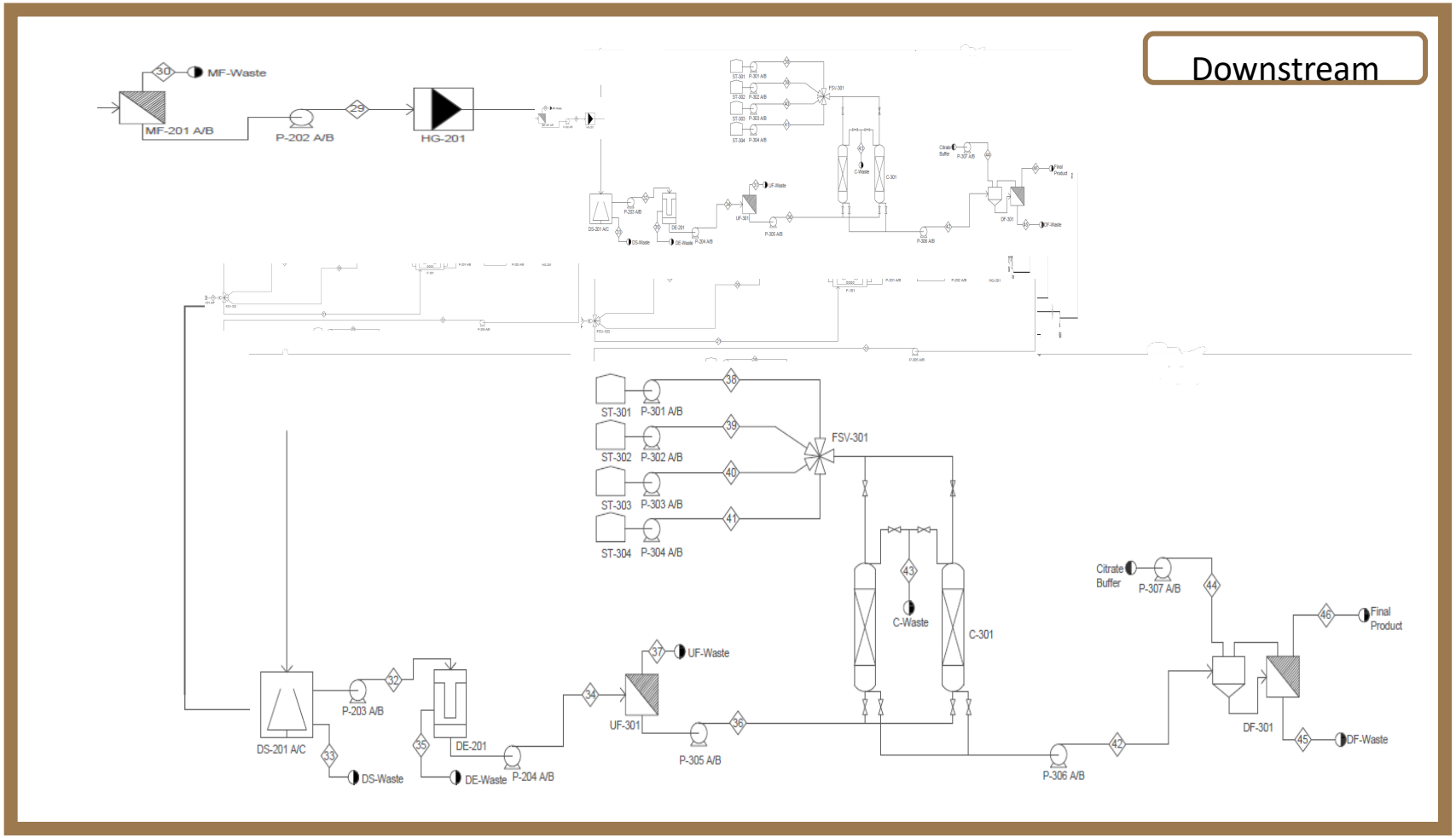


Life cycle assessment

Stage I Definition

Stage II LCA inventory

1 Raw materials extraction

2 Energy requirements

3 On-site emissions

4 Waste to treatment

System boundary

Stage III Environmental analysis

1 Seed fermenter

2 Main fermenter

3 Microfiltration

4 Cell disruption

5 Ion Exchange

6 Ultrafiltration

7 Dead-end filtration

8 Centrifugation

9 Diafiltration

Stage IV Interpretation

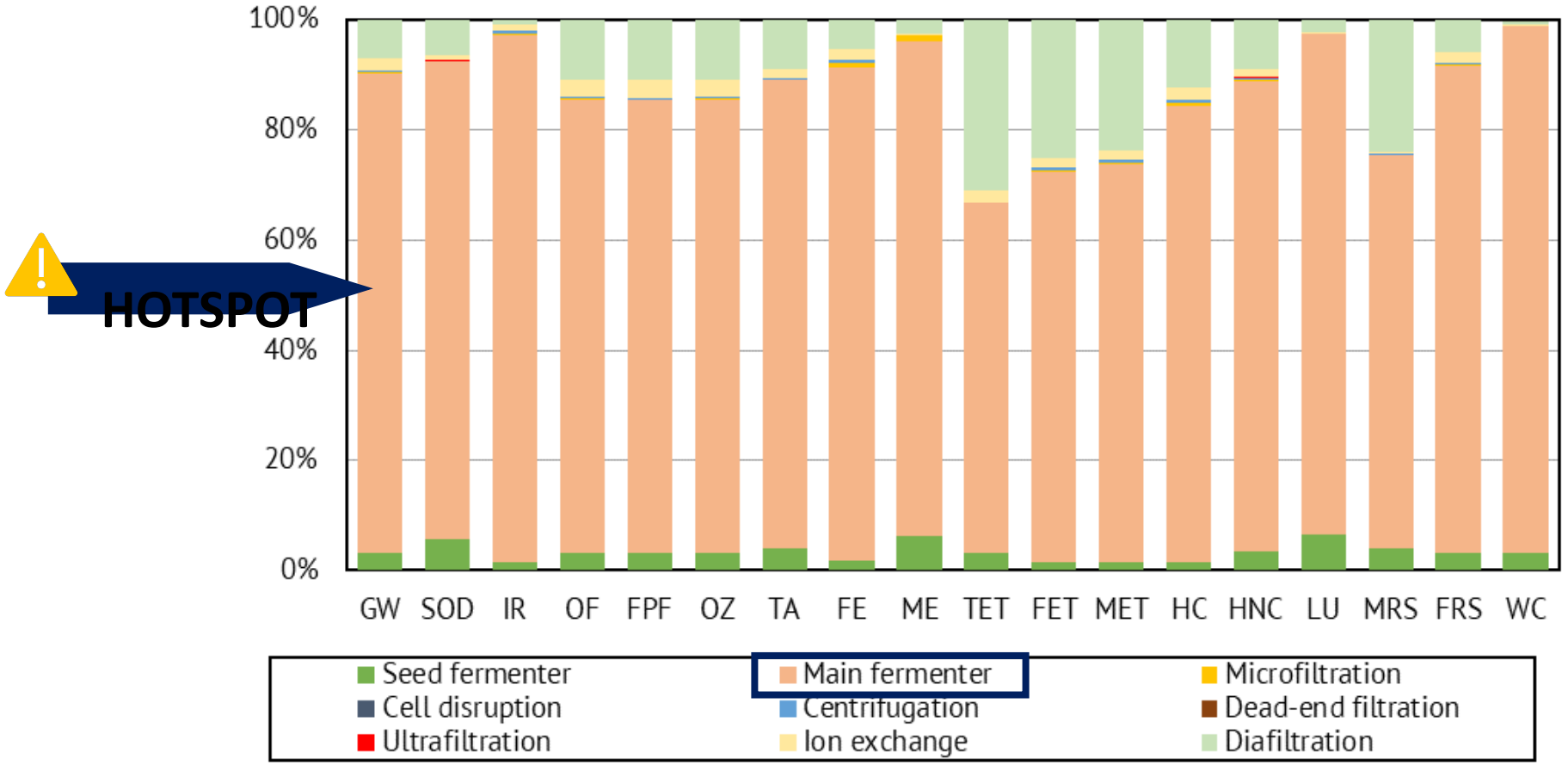
Life cycle assessment

Stage I – Definition

Stage II – LCA inventory

Stage III – Environmental analysis

Stage IV – Interpretation



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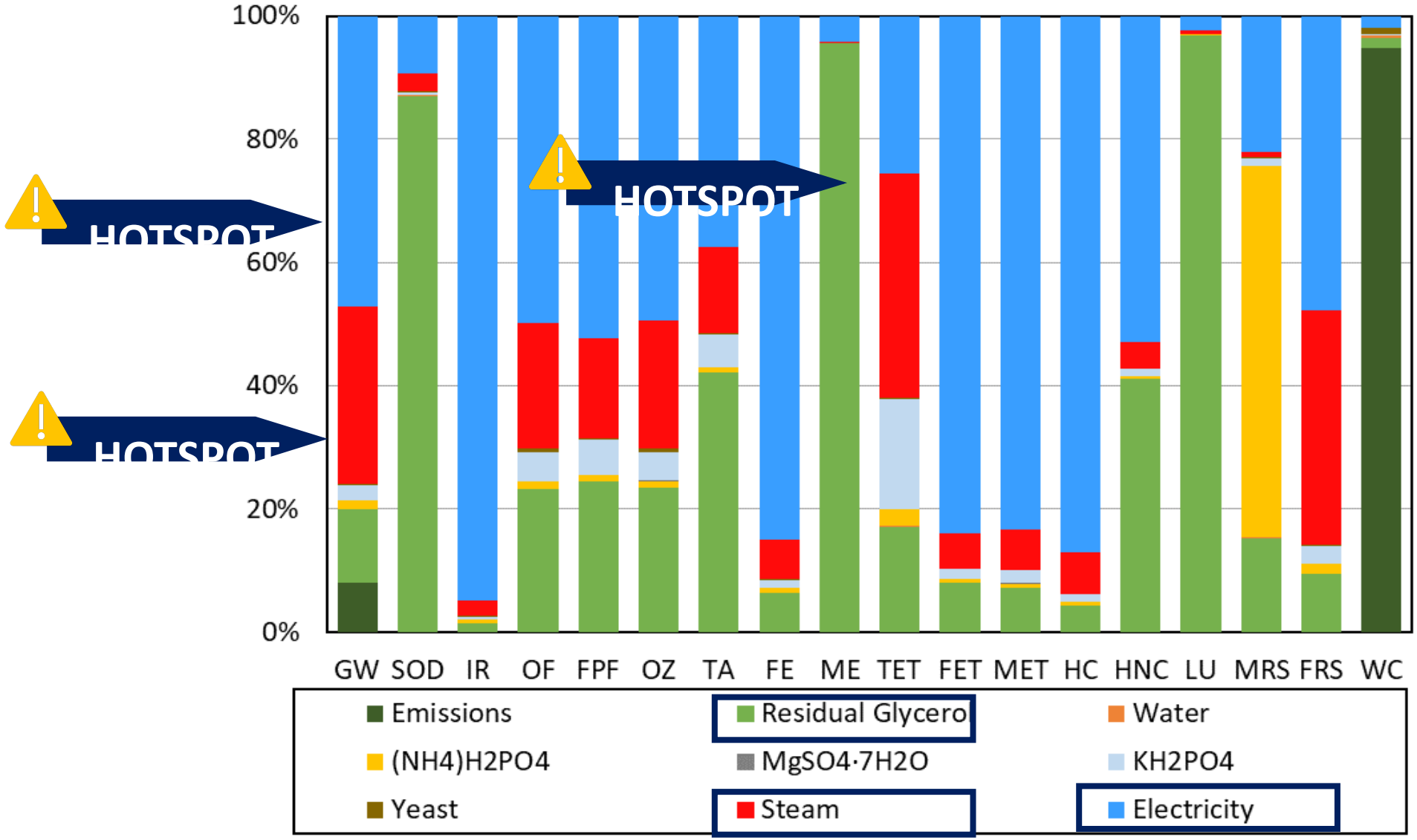

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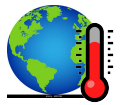
 Climate change	19.37 kg CO2 eq	 Marine eutrophication	0.02 kg N eq	 Human carcinogenic	0.59 kg 1.4-DCB
 Acidification	0.09 kg SO2 eq	 Terrestrial ecotoxicity	29.41 kg 1.4-DCB	 Freshwate recotoxicity	0.35 kg 1.4-DCB
 Freshwater eutrophication	0.01 kg P eq	 Fossil resource scarcity	5.06 kg oil eq	 Marine ecotoxicity	0.48 kg 1.4-DCB

ASSESSING SCENARIOS

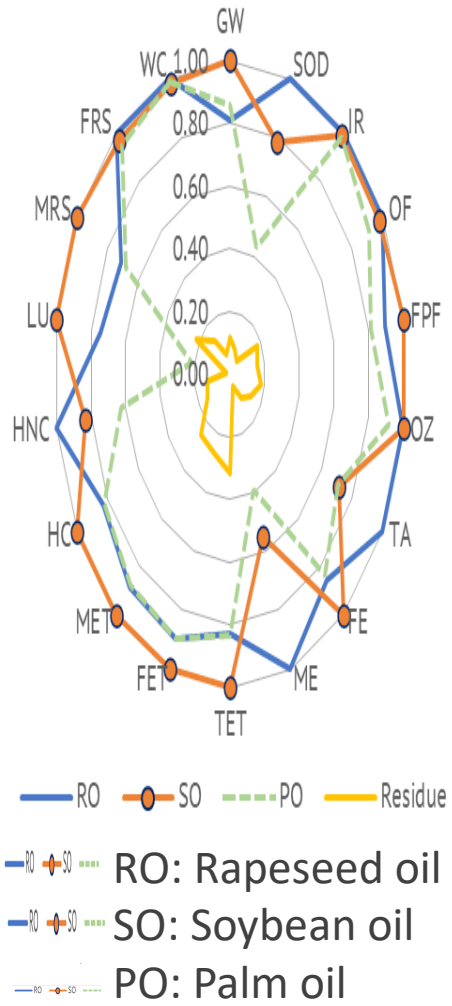
Stage I Definition

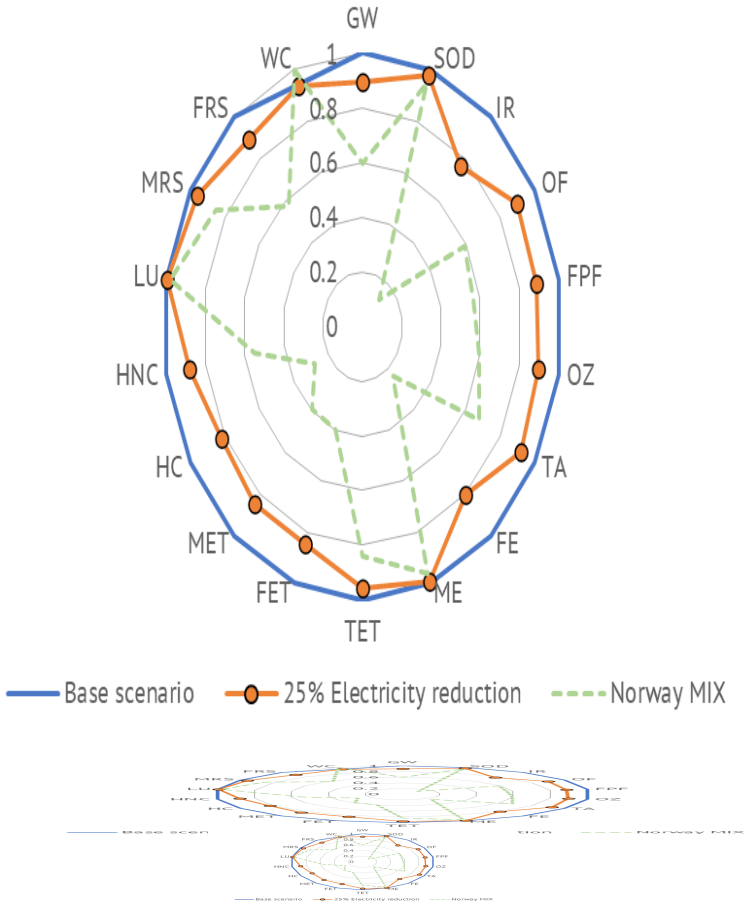
Stage II LCA inventory

Stage III Environmental analysis

Stage IV

Interpretation





Main conclusions

The production scenario proposed could be considered as an **innovative and environmentally friendly alternative** for obtaining enzymes used in bioethanol production.

Hotspots: energy requirements and certain chemicals are the ones with the highest environmental contribution

Reduced impacts of the biotech industry will be possible with **fully optimized** biotransformations, carbon-based media from waste resources, minimized use of chemicals and the implementation of energy integration measures

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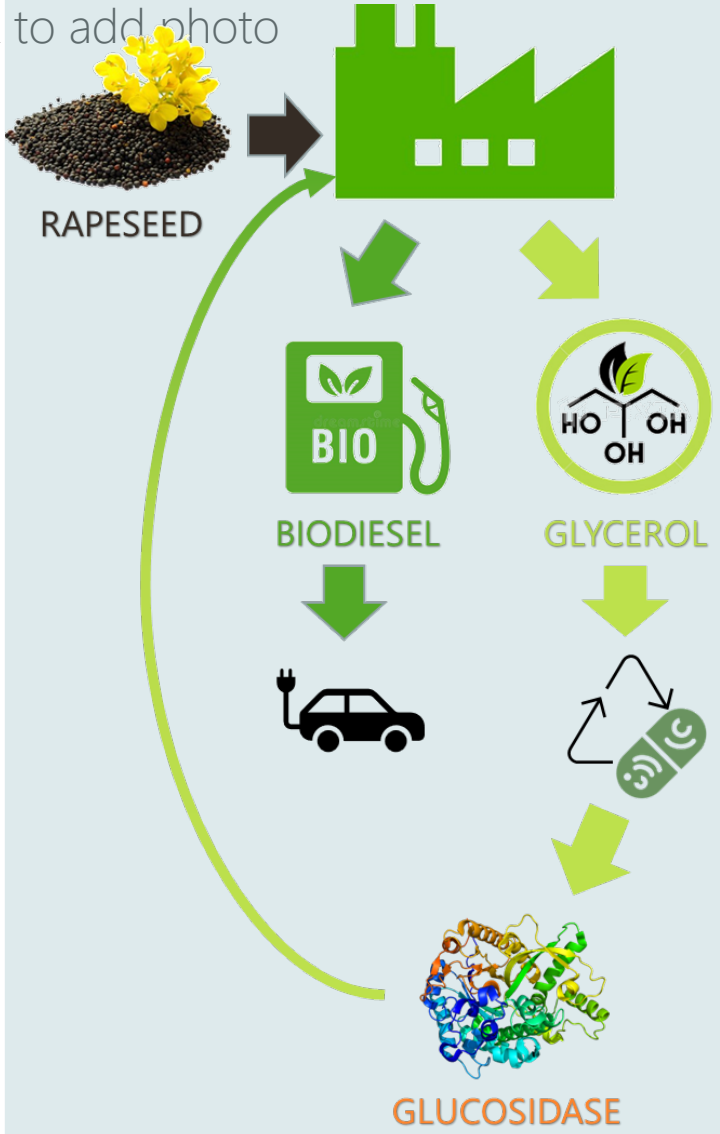

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