SCALIBUR

LEADING A REVOLUTION
IN BIOWASTE RECYCLING

Economic and environmental advantages of the new technologies

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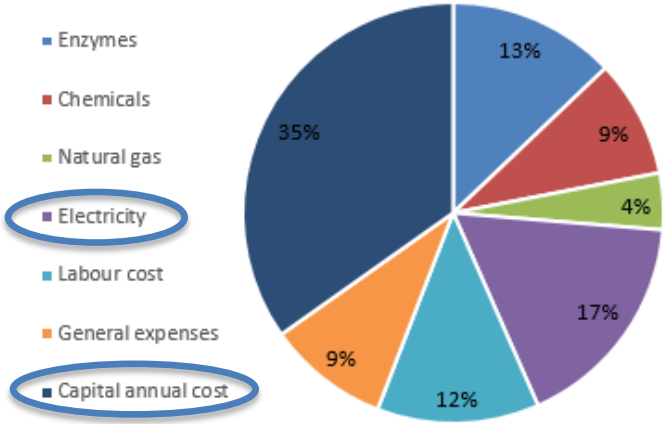
Techno-economic assessment

- Using the ***SuperPro Designer*** software, the modelling and simulation of the different SCALIBUR processes has been carried out.
- Optimisation and scaling up of the processes for the TEA evaluation.
- Based on the simulation, estimation of the Levelized Production Cost (LPC) for each of the SCALIBUR value chains.

$$LPC = \frac{\text{Operating Costs} + \text{Investment Annualized}}{\text{Annual Production}}$$

Techno-economic assessment

- Biopesticides production:



Sensitivity analysis:
LPC between 0,97-1,46 €/kg

Formulation is not included

Production capacity	tonne/hour	0,6700
Operating hours	hours/year	8.000
Annual production	**tonne/year**	**5.360**

Equipment costs	M€	9,15
Investment	M€	35,73
Fees and permitting	%inv	1,0%
	M€	0,36
Total investment	**M€**	**36,1**

Annual raw material consumption	tonne/year	12.000,00
Raw material cost	€/tonne	- 100,00
Annual raw material cost	€/year	- 1.200.000,00
Annual cost consumables	€/year	1.907.765,27
Annual cost electricity	€/year	1.305.702,00
Waste water disposal	€/year	99.284,60
Number of shift supervisors		5,00
Shift supervisors cost	€/year	41.897,54
Number of shift operators		20,00
Shift operators cost	€/year	34.480,33
Number of maintenance supervisors		1,00
Maintenance supervisors cost	€/year	53.123,66
Total labour cost	€/year	952.217,85
General expenses	%inv	2,0%
	€/year	714.647,93
Total operating expenses	**€/year**	**3.782.547,87**

Capital annual cost	**€/year**	**2.655.544,82**

LPC calculation		
Project life	years	20,00
Interest rate	%	4,0%
LPC	**€/kg**	**1,20**

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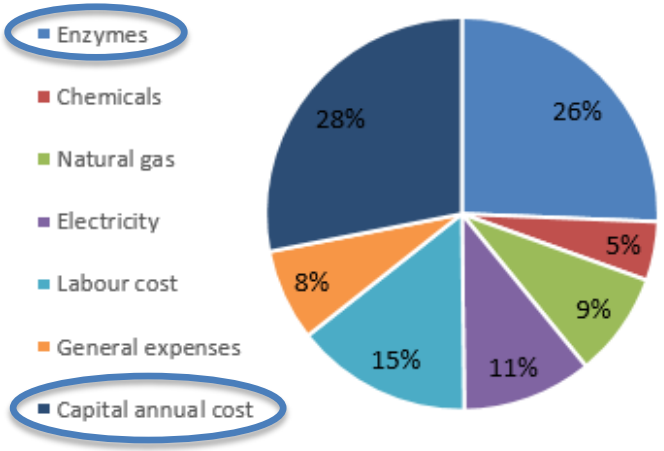
Techno-economic assessment

- Concentrated sugars production:



Reference price of first generation sugars:
between 0,3-0,5 €/kg

Production capacity	tonne/hour	0,2060
Operating hours	hours/year	8.000
Annual production	**tonne/year**	**1.648**

Equipment cost	M€	3,72
Investment	M€	14,51
Fees and permitting	%inv	1,0%
	M€	0,15
Total investment	**M€**	**14,7**

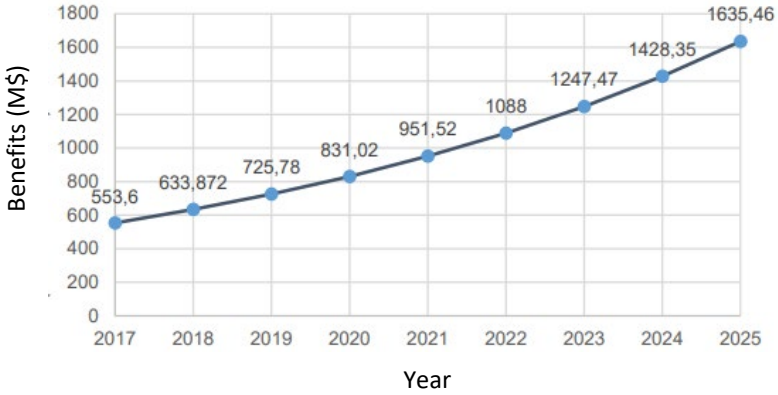
Annual raw material consumption	tonne/year	12.000,00
Raw material cost	€/tonne	- 100,00
Annual raw material cost	€/year	- 1.200.000,00
Annual cost consumables	€/year	1.502.765,27
Annual cost electricity	€/year	411.466,21
Number of supervisors		1,00
Supervisors cost	€/year	41.897,54
Number of operators		15,00
Operators cost	€/year	34.480,33
Total labour cost	€/year	559.102,41
General expenses	%inv	2,0%
	€/year	290.254,97
Total operating expenses	**€/year**	**1.563.588,86**

Capital annual cost	**€/year**	**1.078.552,15**

LPC calculation		
Project life	years	20,00
Interest rate	%	4,0%
LPC	**€/kg**	**1,60**

Techno-economic assessment

- Chitin extracted from BSF larvae:



Price of commercially available **chitosan from shrimp shells** with values close to the Degree of Acetylation: 80-100 €/kg

References: ChiPro GmbH, France-Chitine, Chibio Biotech.

Chitin production per batch	kg/batch	28
Number of batches per year	batchs/year	30
Annual Production	**kg/year**	**840**

Equipment purchase cost	€	284.000
Installation	€	28.400
Process piping	€	28.400
Instrumentation	€	28.400
Electrical	€	28.400
Total Invesment	**€**	**397.600**

Annual cost electricity	€/year	7.803
Number of hours per batch	hours	40
Hourly labour cost	€/hour	28,5
Labour cost	€/year	34.200

Total operating expenses	**€/year**	**42.003**

Capital annual cost	**€/year**	**29.256**

LPC calculation		
Project life	years	20
Interest rate	%	4,0%
LPC	**€/kg**	**84,8**

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Techno-economic assessment

- LPC for bioplasctic production
- BES cost estimation
- LPC for organic acids production
- TEA for the PHA production

Environmental assessment

Goal: Comparison of SCALIBUR processes VS current technologies, including the benefits of GHG avoided. Analise the strengths and weakness for each value chain.

Methodology: ILCD midpoint 2011+: climate change, ozone depletion, human toxicity (non-cancer effect), particulate matter, ionizing radiation (human and ecosystem), acidification, eutrophication (fresh water, marine and terrestrial), land use and resource depletion

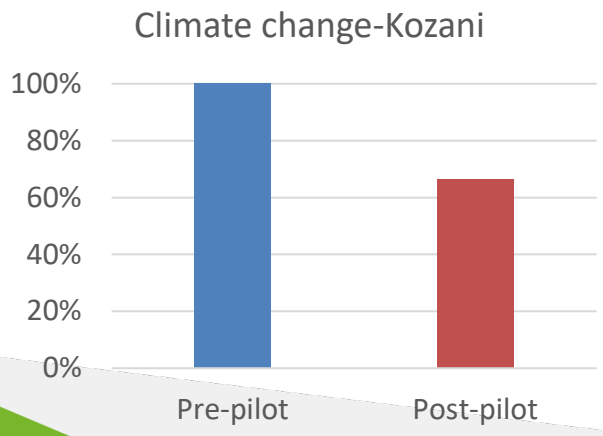
Tools: SimaPro and Ecoinvent database

Environmental assessment

✓ PILOTS

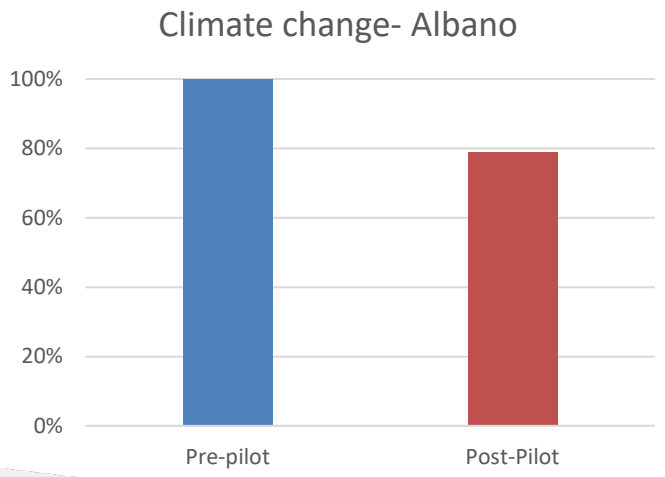
Pre-pilot / Post-pilot comparison Kozani

Reduction rate
Pre-pilot / Post-pilot:
34%
(all impact categories)



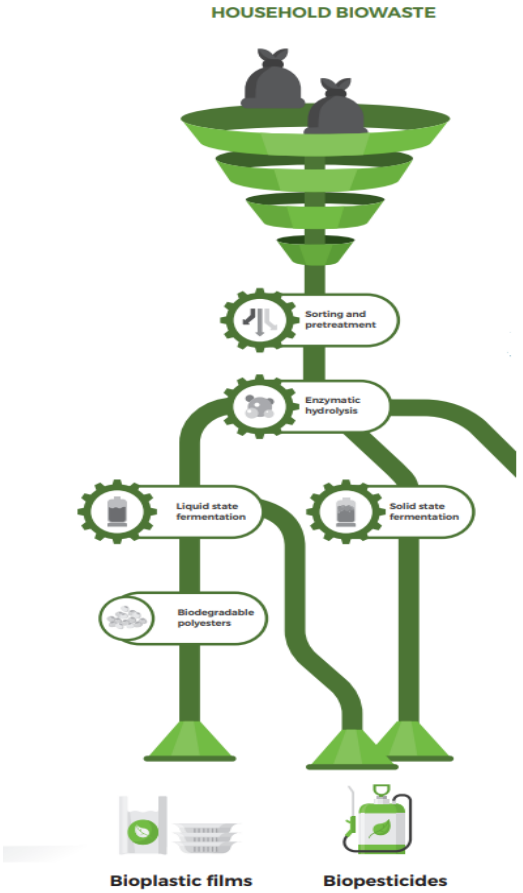
Pre-pilot / Post-pilot comparison Albano

Reduction rate
Pre-pilot / Post-pilot:
21%
(all impact categories)

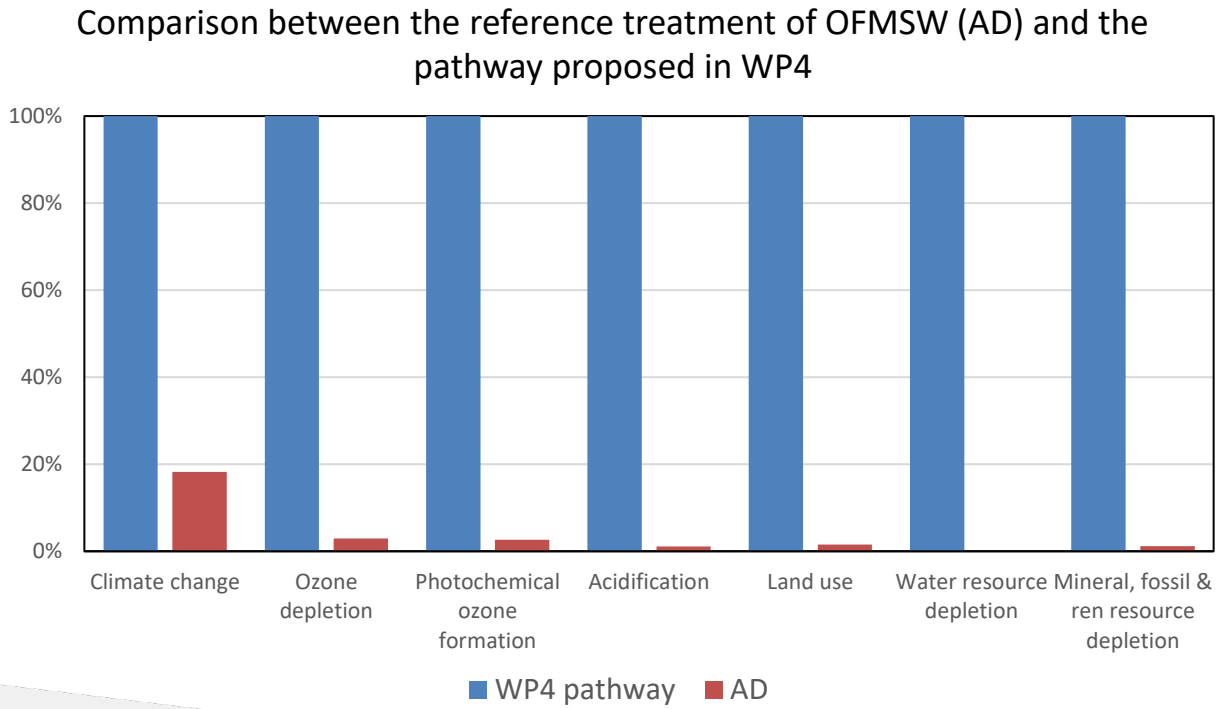


Environmental assessment

- ✓ Biochemical conversion of organic fraction of MSW intro biodegradable polyesters and biopesticides,



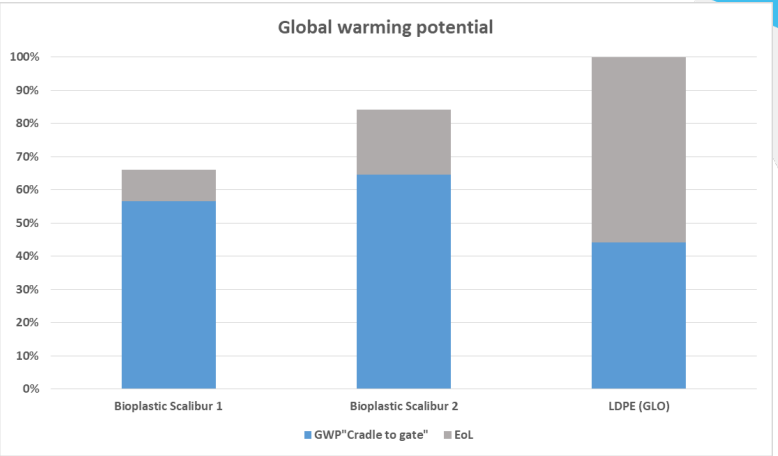
Environmental assessment

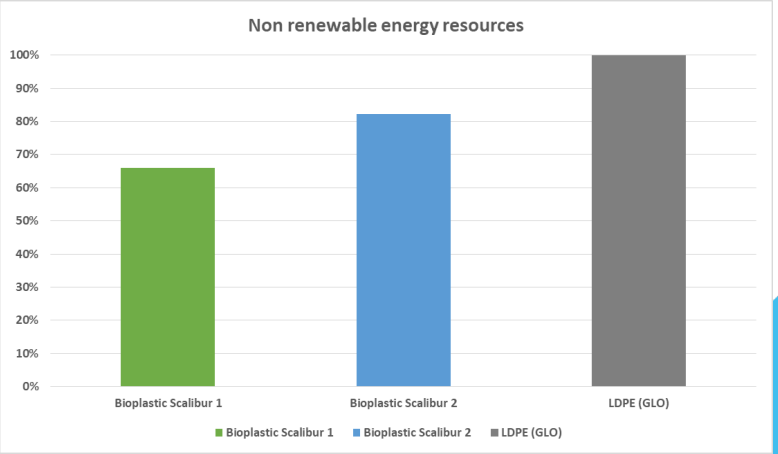


Environmental assessment

Functional Unit (**FU**)	1 kg of plastic material
System boundaries	Cradle-to-grave
End of Life scenarios	Complete mineralization of the embedded carbon
Characterisation model	IPCC GWPa 100 and Non Renewable Energy Resources (NRER)

- **GWP**: a reduction of 34% and 16% respectively for formulation 1 and formulation 2 was achieved in comparison to low-density polyethylene (LDPE);
- **NRER**: a reduction of 34% and 18% respectively for formulation 1 and formulation 2 was achieved in comparison to low-density polyethylene (LDPE).





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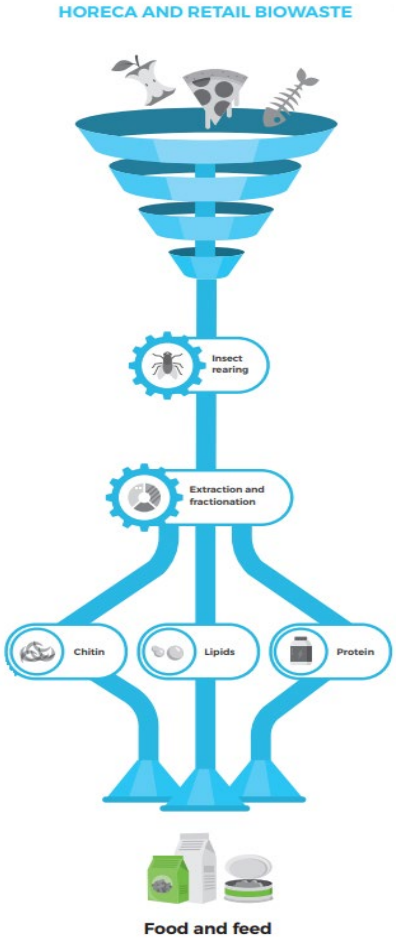
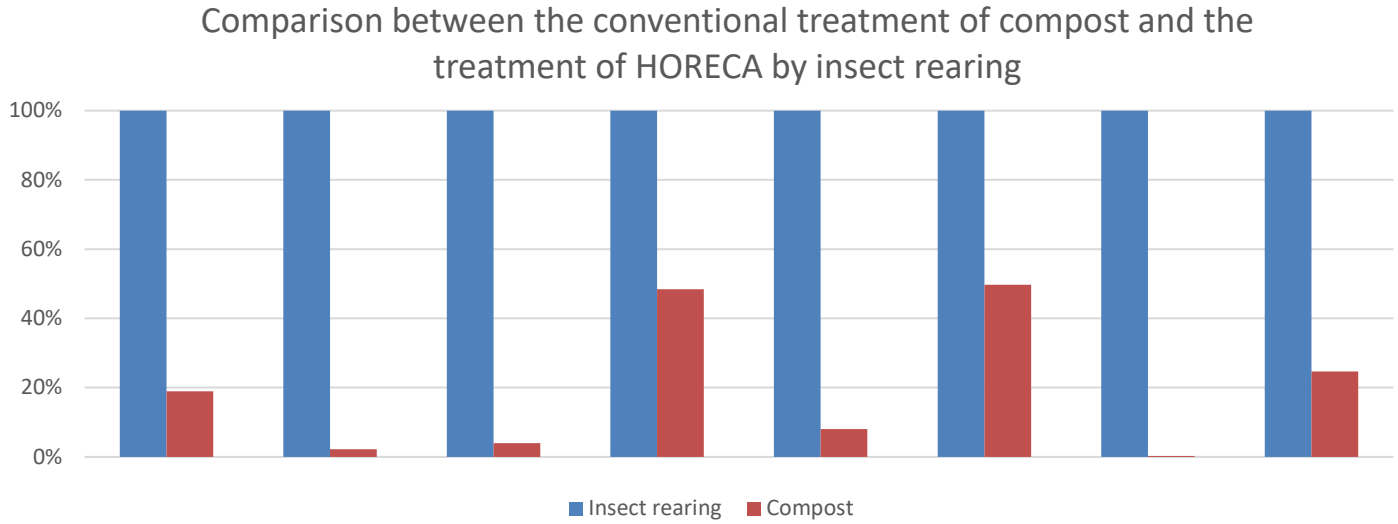
Environmental assessment

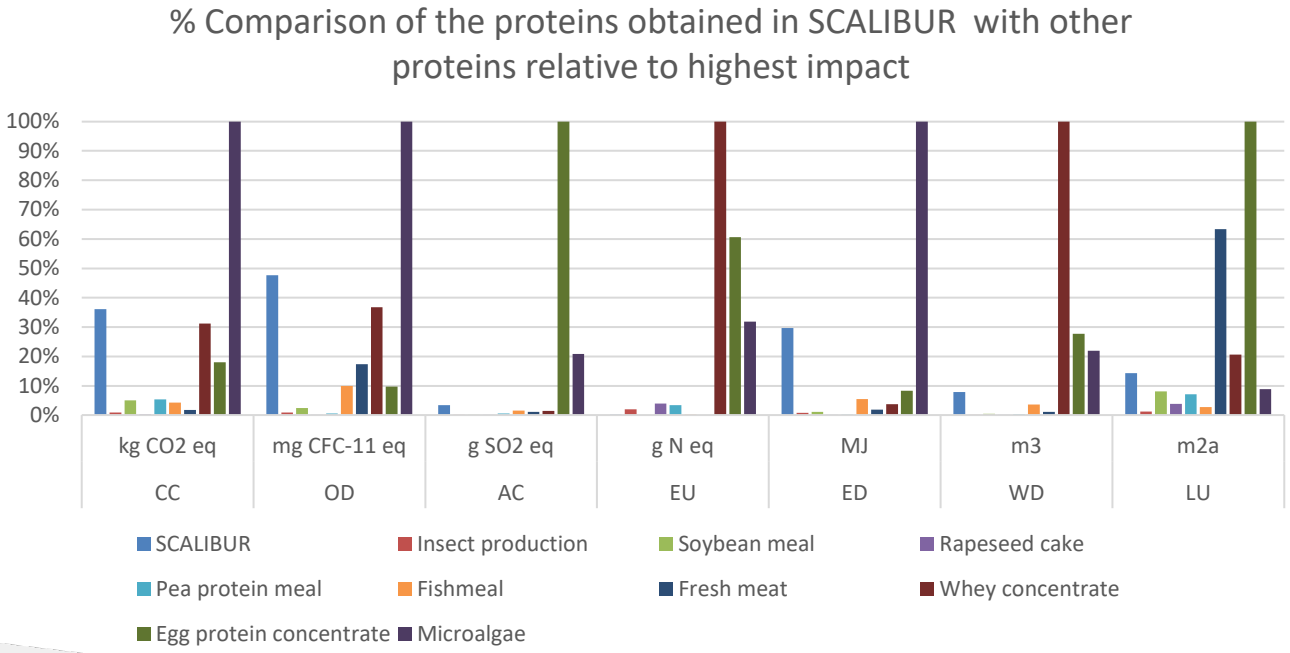
- ✓ HORECA and ROW valorisation by insect rearing



Environmental assessment



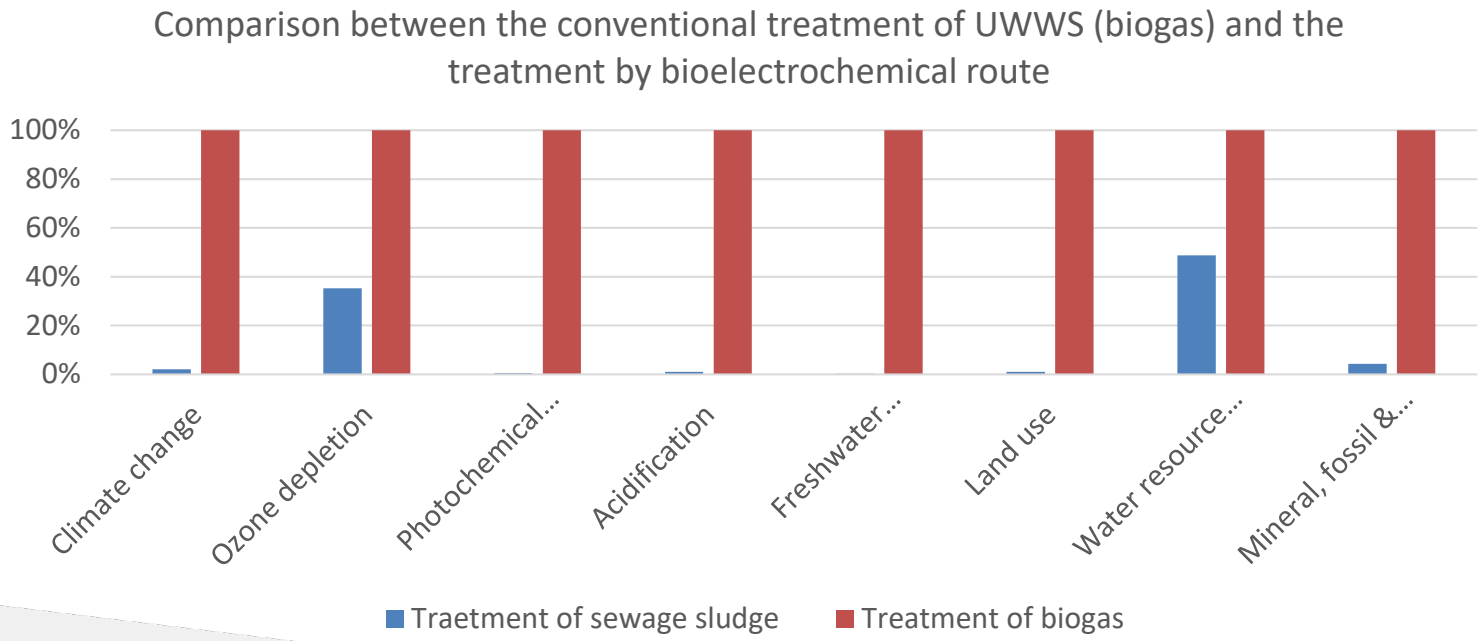
Environmental assessment



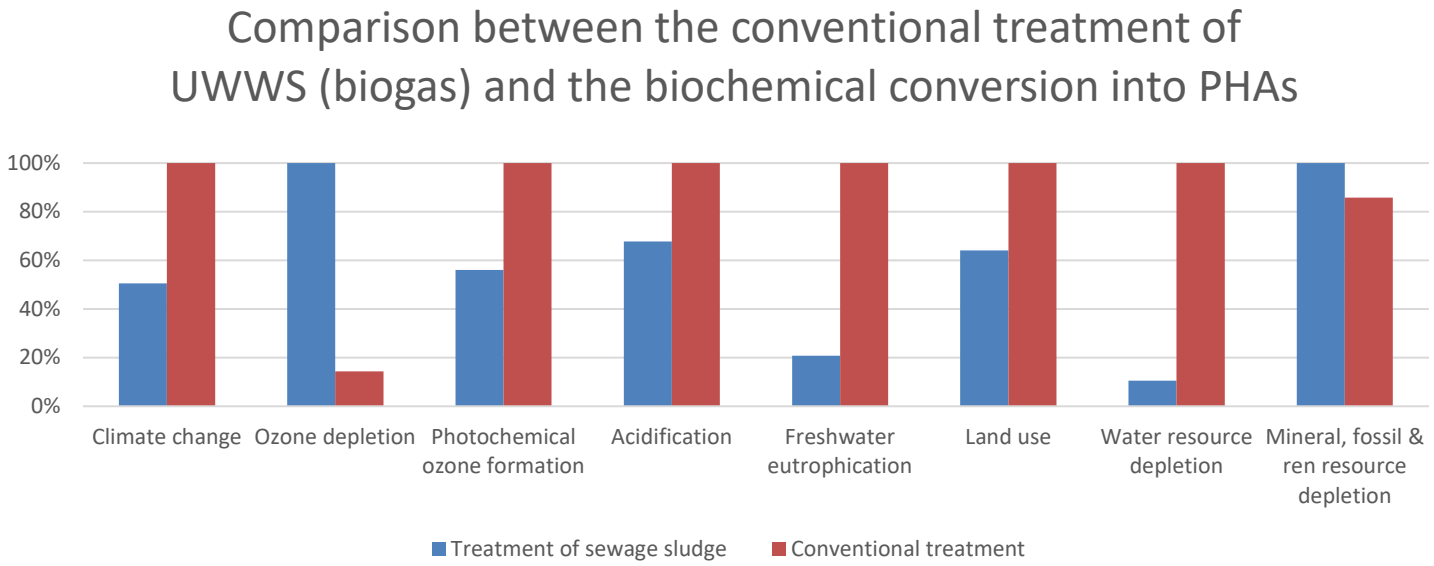
Environmental assessment

- ✓ Bioconversion of sewage sludge through biochemical and biolectrochemical routes

Environmental assessment



Environmental assessment



Social evaluation

Definition

S-LCA aims to assess the social and socio-economic aspects of products and their potential positive and negative impacts along their life cycle.

Method

The UNEP guide "The methodological sheets for subcategories in social life cycle assessment" has been used.

STAKEHOLDERS
Citizens
Workers
Value chain actors

Questionnaries

REFERENCE SCALE		% Responses
+2	Ideal performance	75-100
+1	Intermediate positive performance	50-75
0	Aligned with international standards	50
-1	Intermediate negative performance	25-50
-2	Unacceptable performance	0-25

Impact categories studied
Enviromental pillar
Health and safety
Feedback mechanism
Privacy
End-of-life responsability
Human rights
Freedom of association
Socio-economic repercussions
Working conditions

Social evaluation

- ✓ Indicator: Social acceptability (scale from -2 to +2)

Bioproducts	Citizens Albano	Citizens Kozani	Workers
Higiene items packaging	+2	0	+2
Food packaging	+1	+1	+1
Food-grown with bio-based fertilizers	+2	+1	+2

Social evaluation

✓ Indicator: Local employment and job opportunities

City	Reasons: do bioproducts have an impact in economy?
Albano- Value chain actors (+2)	• Higher employment levels • Construction of new plants and production of bioproducts will create jobs • Biowaste is currently a high cost for Lazio municipalities and this condition must be reversed • Production of bioproducts generated employment • There is ample room and need to create entrepreneurial solutions related to products made from organic waste
Kozani-Value chain actors (+2)	• It is very important to be able to produce secondary products from bio-waste • Construction of new plants and production of bioproducts will create jobs • They are a promising new sector receiving support from national and European programs

Social evaluation

✓ Indicator: Local employment and job opportunities

Answers from the workers

New workers associated to the project	Responses %
Between 1-3	31%
Between 3-5	8%
>5	3%
No new workers	18%
I do not know but for surely it has increased the job opportunities	23%
I do not know	18%

42%

Conclusions

- The LPC for the production of biopesticides and chitin from OFMSW and HORECA respectively is competitive with the reference price.
- Better quality of the OFMSW is needed to improve the costs of the second generation sugars production
- The environmental performance of the SCALIBUR value chains has been compared with the conventional treatments for 1 ton of waste treated. Even when in some cases the impacts are higher for the processes developed, the comparison for the products obtained is positive.
- There is potential for creating new job opportunities by the creation of this new value chains.
- There is a high acceptability among the citizens of the biobased products

Thank you for your attention!

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