Horizon 2020
European Union Funding
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Bio-based Industries
Consortium

BIO CIRCULAR CITIES

Exploring the circular bioeconomy potential in cities

Biocircularcities unlocked!
The Brussels stop

Final conference of the Biocircularcities project
Brussels, 28 September 2023

This project has received funding from the Bio-based Industries Joint Undertaking (JU) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101023516.
The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio-based Industries Consortium.

Why and how to unlock a local and circular bioeconomy – Barriers and solutions

Moderated by Jean-Benoit Bel (ACR+)

Amalia Zucaro (ENEA)
Karin Meisterl (ENT)
Laurène Chochois (LIST)

Biocircularcities unlocked! The Brussels stop

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The Biocircularcities project in a nutshell

Karin Meisterl, Fundació ENT

28 September 2023

Bio-based Industries Consortium

Horizon 2020 European Union Funding for Research & Innovation

BBI JU

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BIOCIRCULARCITIES (BCC)

Exploring the circular bioeconomy potential in cities.
Proactive tools for implementation by policy makers and stakeholders.

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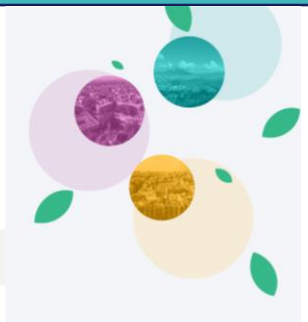
Coordination and Support Action

BBI JU — Bio-based Industries Consortium — Horizon 2020 European Union Funding for Research & Innovation

circular bioeconomy loading

2021 — 2023

Final Conference
28 September 2023



Aims

- Supporting the development of innovative regulatory frameworks aligned with circular bioeconomy principles
- Exploring the CBE potential of unexploited bio-based waste streams in 3 pilot areas

8 consortium partners

Fundació ent — Città Metropolitana di Napoli — AMB Àrea Metropolitana de Barcelona — Regional Energy Agency - Pazardzik (REAP) — ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development — Luxembourg Institute of Science and Technology (LIST) — ACR+ — CIVITTA

3 BCC pilot areas with different value chains

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Metropolitan Area of Barcelona (MAB, Spain)
Separarely collected biowaste

Metropolitan Area of Barcelona (ES)

- → Improving separate biowaste collection
- → Upgrading biogas from anaerobic digestion into biomethane for the local gas grid

Pazardzhik Province (PP, Bulgaria)
Forestry residues

Region of Pazardzhik (BG)

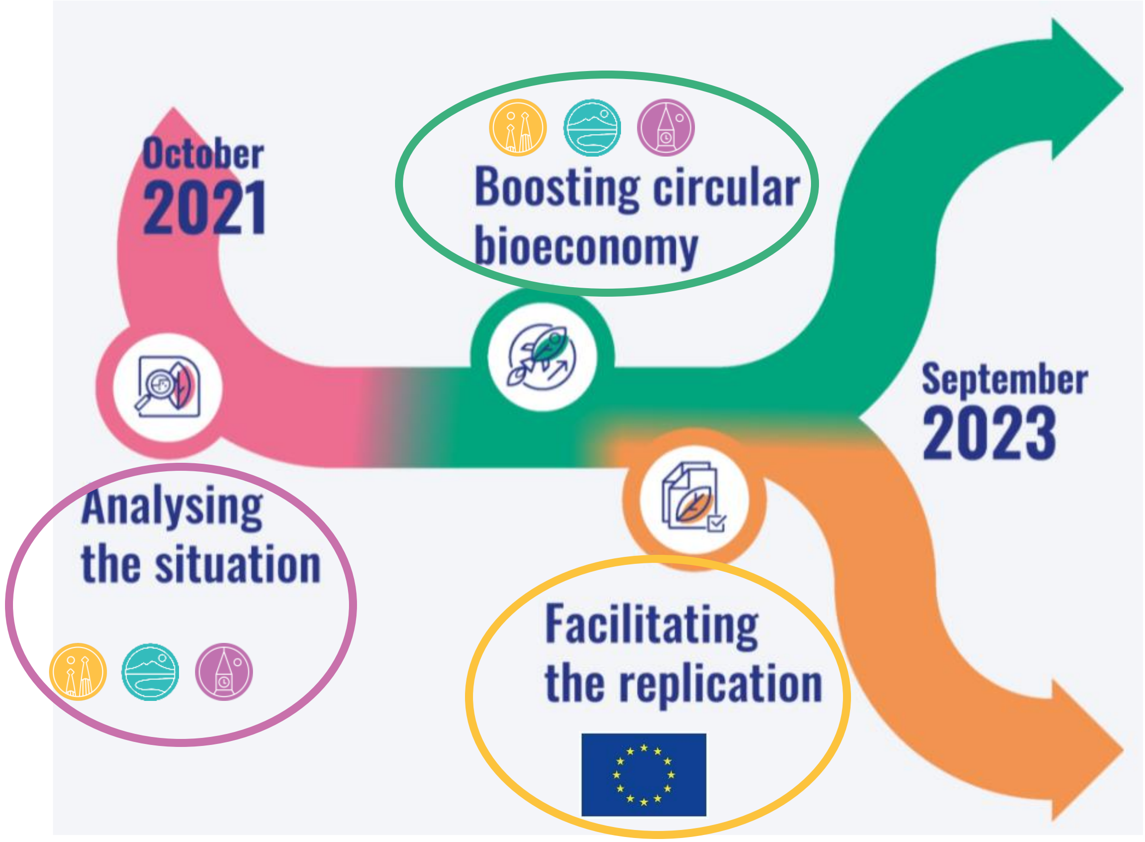
- → Lignocellulosic valorisation (production of bio-based chemicals)
- → CHP plant (bioenergy)

Metropolitan City of Naples (MCN, Italy)
Agro-industrial organic waste

Metropolitan City of Naples (IT)

- → Processing coffee roasting residues (coffee silverskin) into functional ingredients

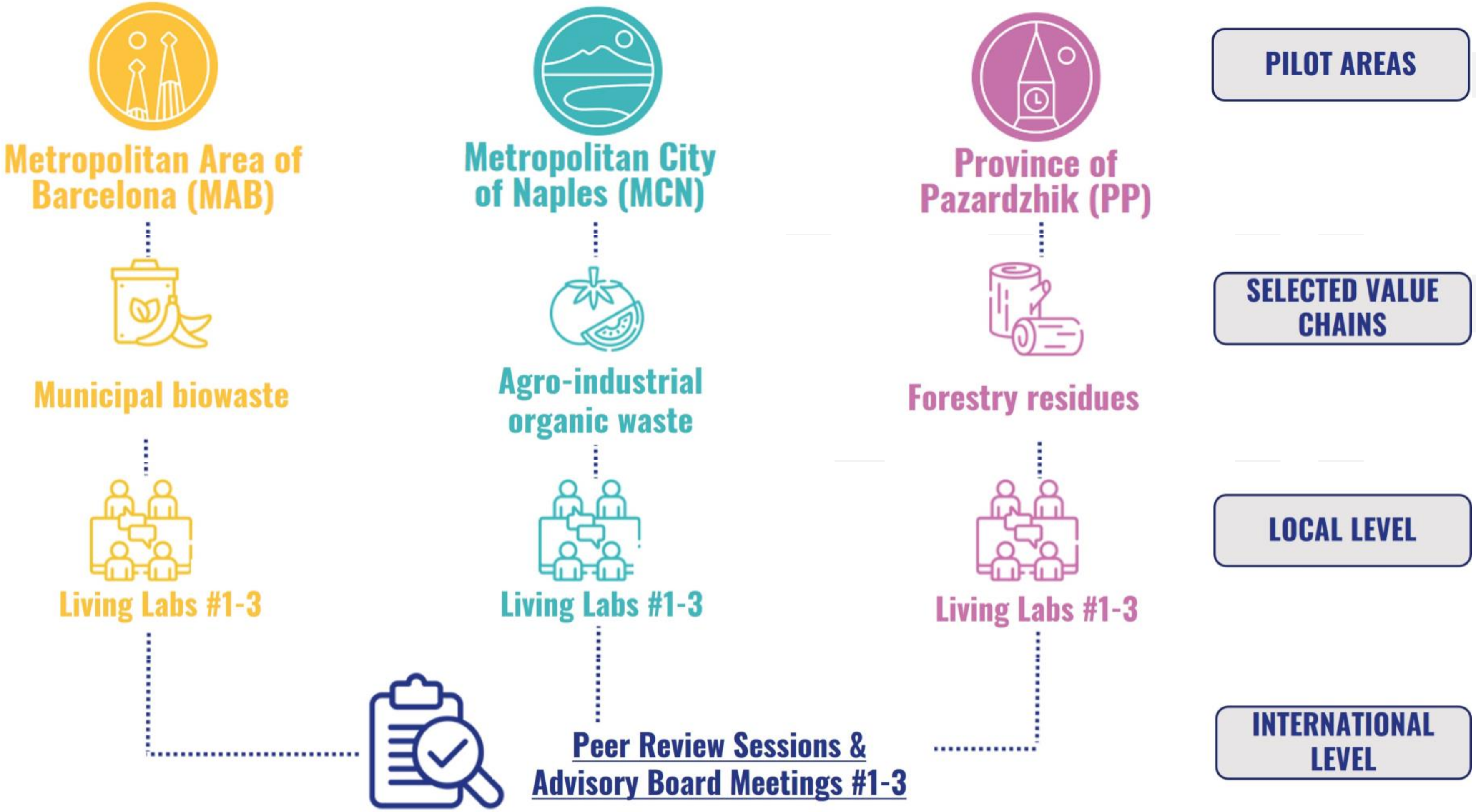
BBC Main outcomes



- **LCA and LCC** of the 3 selected pilot value chains to compare the current state with the alternative scenarios.
- **Policy recommendations** based on drivers and barriers identified in the policy framework of the 3 selected value chains
- **Web-based tool (guidelines)** to assist policy makers and industry in designing biowaste management strategies

→ **Multi-actor approach:** Continuous involvement of local and international stakeholders in the project outcomes.

BCC multi-actor contribution



Discover Biocircularcities in video: https://youtu.be/kMQp_vmIWqE (EN)

Watch this video also in Bulgarian, Catalan, Italian, or Spanish.

Roundtable: Why and how to unlock a local and circular bioeconomy – Barriers and solutions

Moderated by Jean-Benoit Bel (ACR+)

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The benefit of unlocking local bioeconomy

Amalia Zucaro, ENEA

28 September 2023

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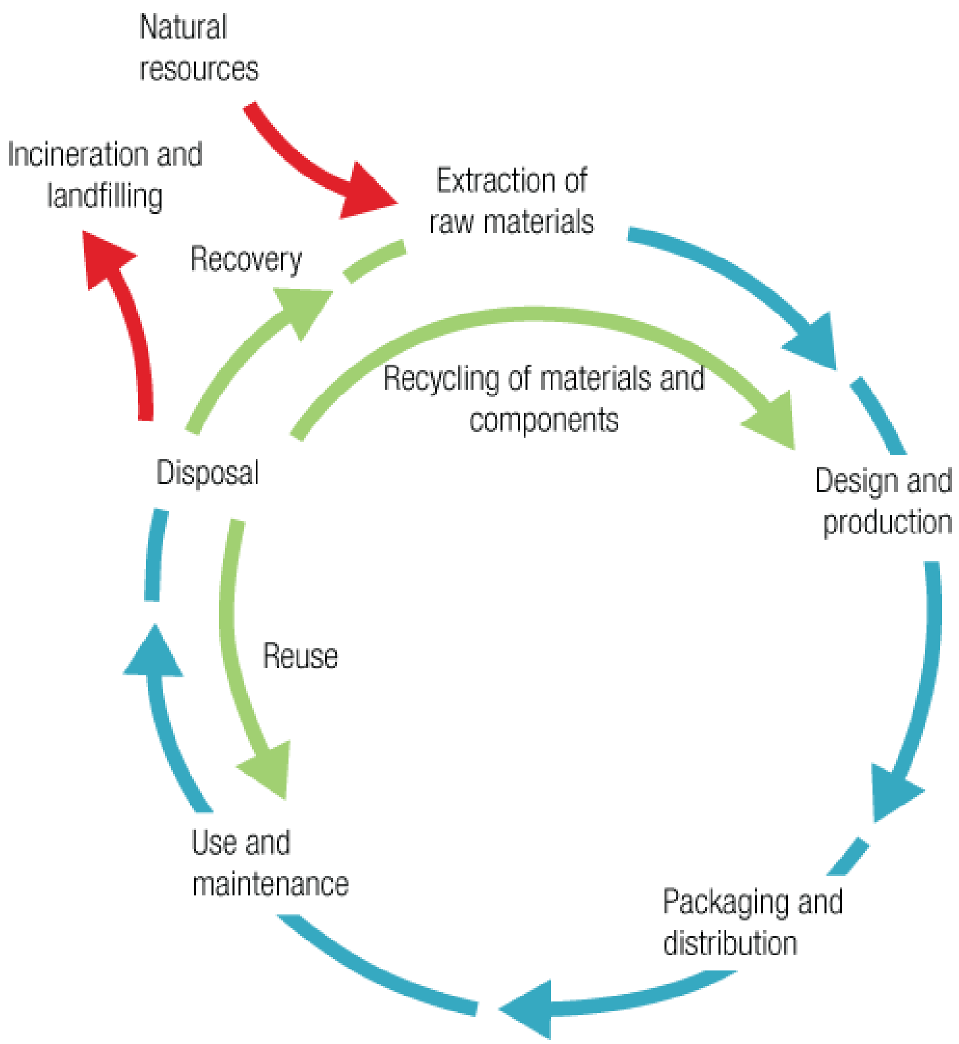
LIFE CYCLE THINKING (LCT)



- PRE-PRODUCTION (procurement of raw materials)
- PRODUCTION (transformation of materials, assembly and finish)
- DISTRIBUTION (logistics, sales and packaging)
- USE AND CONSUMPTION (including maintenance)
- END OF LIFE (Reuse, Recycle, Recovery, Disposal)

The forestry residues chain in Pazardzhik Province (PP)

Life Cycle Assessment (LCA) and
Life Cycle Costing (LCC) results

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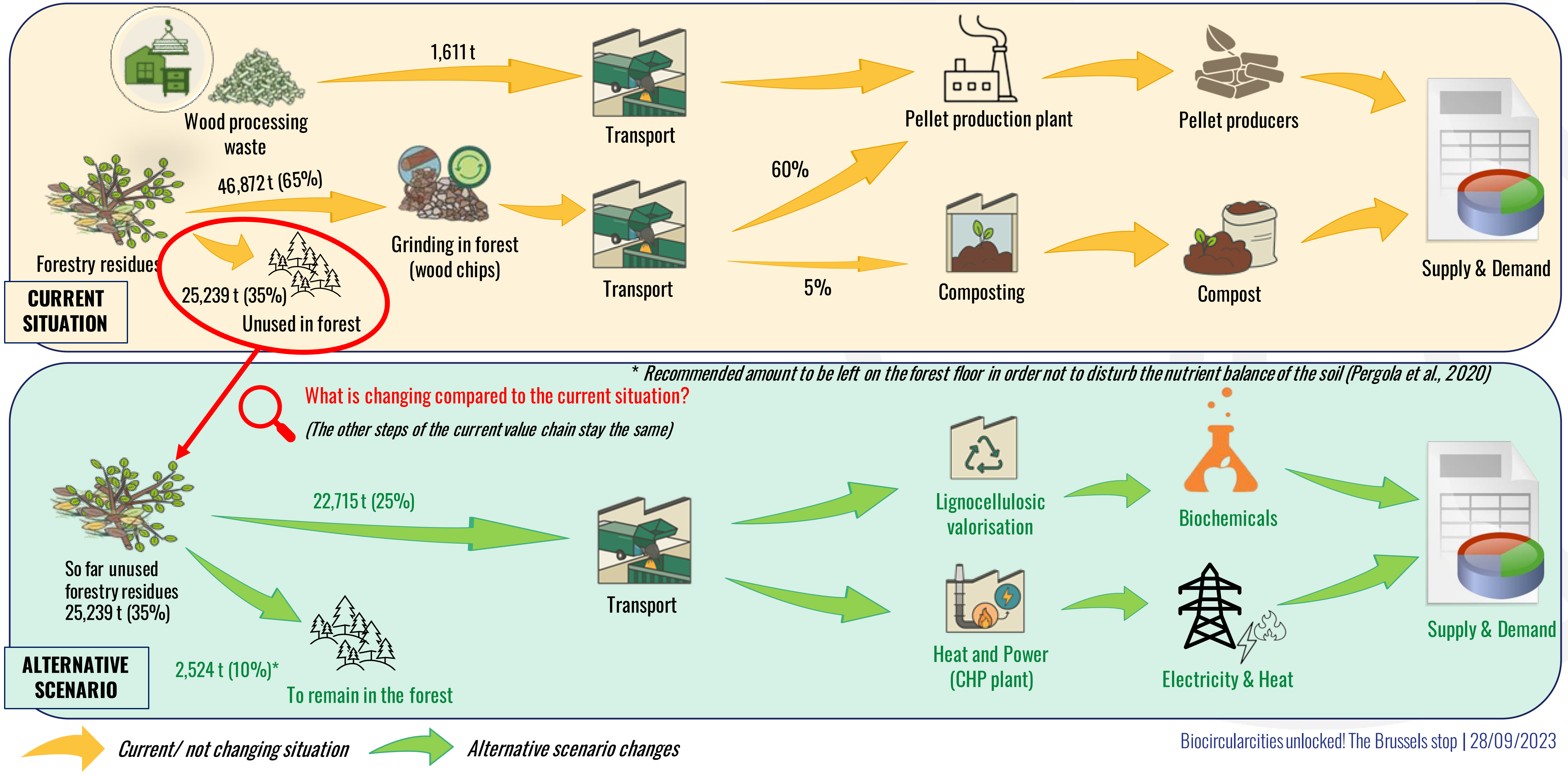
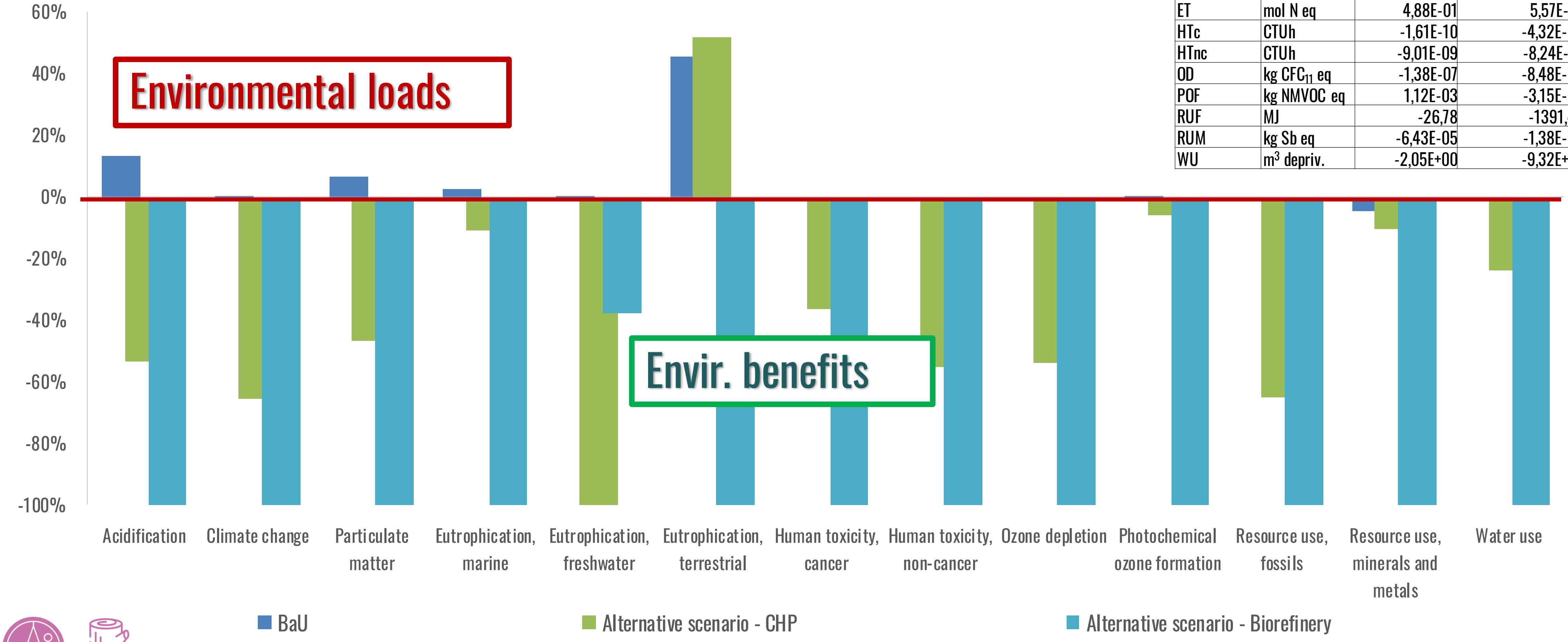
The selected chain in PP

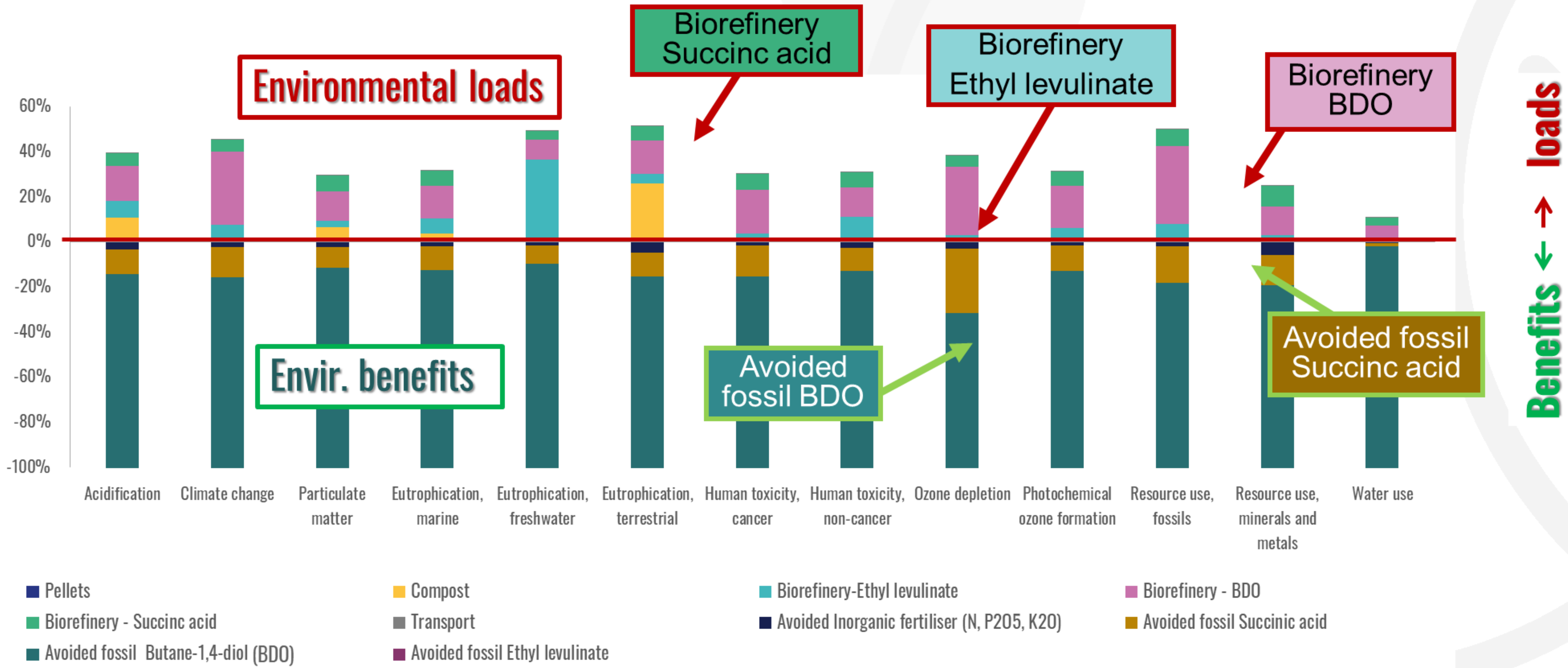


Net environmental impacts of the three scenarios

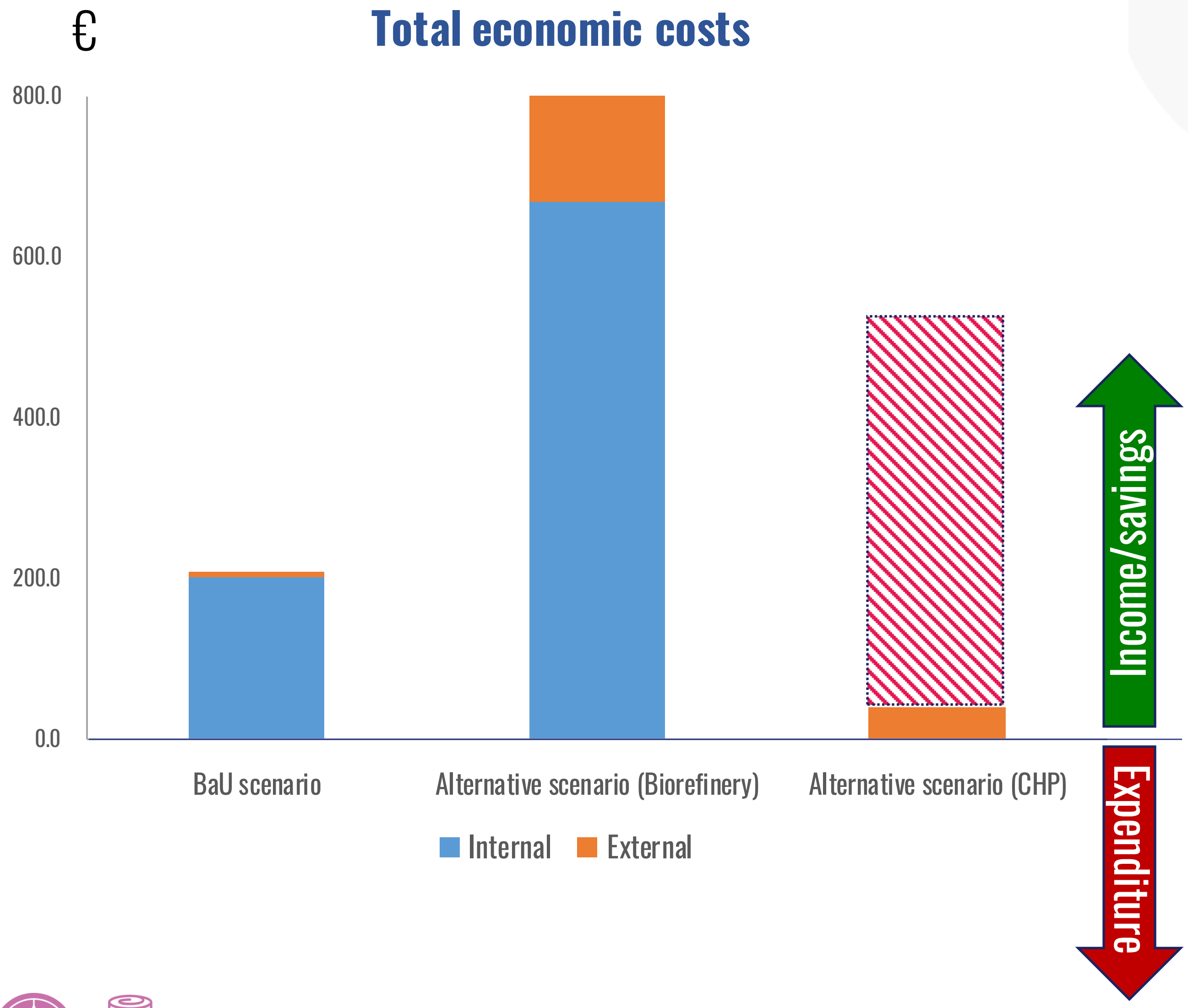
Impact category	Unit	BaU	Alternative scenario CHP	Alternative scenario Biorefinery
AC	mol H^+ eq	9,94E-02	-4,01E-01	-7,51E-01
CC	kg CO_2 eq	1,70E-02	-8,34E+01	-1,27E+02
PM	disease inc.	5,60E-07	-4,08E-06	-8,73E-06
EF	kg N eq	3,70E-03	-1,52E-02	-1,41E-01
EF	kg P eq	3,77E-04	-9,96E-02	-3,74E-02
ET	mol N eq	4,88E-01	5,57E-01	-1,07E+00
HTc	CTUh	-1,61E-10	-4,32E-08	-1,18E-07
HTnc	CTUh	-9,01E-09	-8,24E-07	-1,50E-06
OD	kg CFC_{11} eq	-1,38E-07	-8,48E-06	-1,57E-05
POF	kg NMVOC eq	1,12E-03	-3,15E-02	-5,19E-01
RUF	MJ	-26,78	-1391,49	-2133,44
RUM	kg Sb eq	-6,43E-05	-1,38E-04	-1,34E-03
WU	m^3 depriv.	-2,05E+00	-9,32E+01	-3,91E+02



Net environmemtal impacts of the Biorefinery scenario



eLCC: Total economic costs for PP system (F.U. 1 ton of forestry residues)



Total BaU scenario economic costs		
Category	**Unit**	**Cost**
NET INTERNAL COSTS (income)	€/ton	202,5
NET EXTERNAL COSTS (savings)	€/ton	7,0
TOTAL NET BALANCE	€/ton	**209,5**

Total Alternative scenario (Biorefinery) economic costs		
Category	**Unit**	**Cost**
NET INTERNAL COSTS (income)	€/ton	670,1
NET EXTERNAL COSTS (savings)	€/ton	165,6
TOTAL NET BALANCE	€/ton	**835,7**

Total Alternative scenario (CHP) economic costs		
Category	**Unit**	**Cost**
NET INTERNAL COSTS (income or expenditure?)	€/ton	?
NET EXTERNAL COSTS (savings)	€/ton	39,3
TOTAL NET BALANCE	€/ton	**39,3**

Conclusions from LCA & LCC in PP chain

- The Biorefinery scenario turns out to be the most sustainable, thanks to the benefits deriving from the production of bio-based chemicals.
- The greatest environmental advantages come from the avoided production of fossil BDO.
- The highest impact (hotspot) is due to electricity consumption.
- The valorization of 25% of currently unused forest waste, through its conversion into biochemicals (Alternative scenario - Biorefinery), would allow to quadruple the economic benefits, considering both the earnings from all the valorization activities and the savings of environmental remediation costs.

These results suggest:

- Increasing the production of bio-based BDO.
- Increasing the use of renewable energy and/or of low energy consumption machinery.

The agro-industrial organic waste chain in the Metropolitan City of Naples (MCN)

Life Cycle Assessment (LCA) and
Life Cycle Costing (LCC) results

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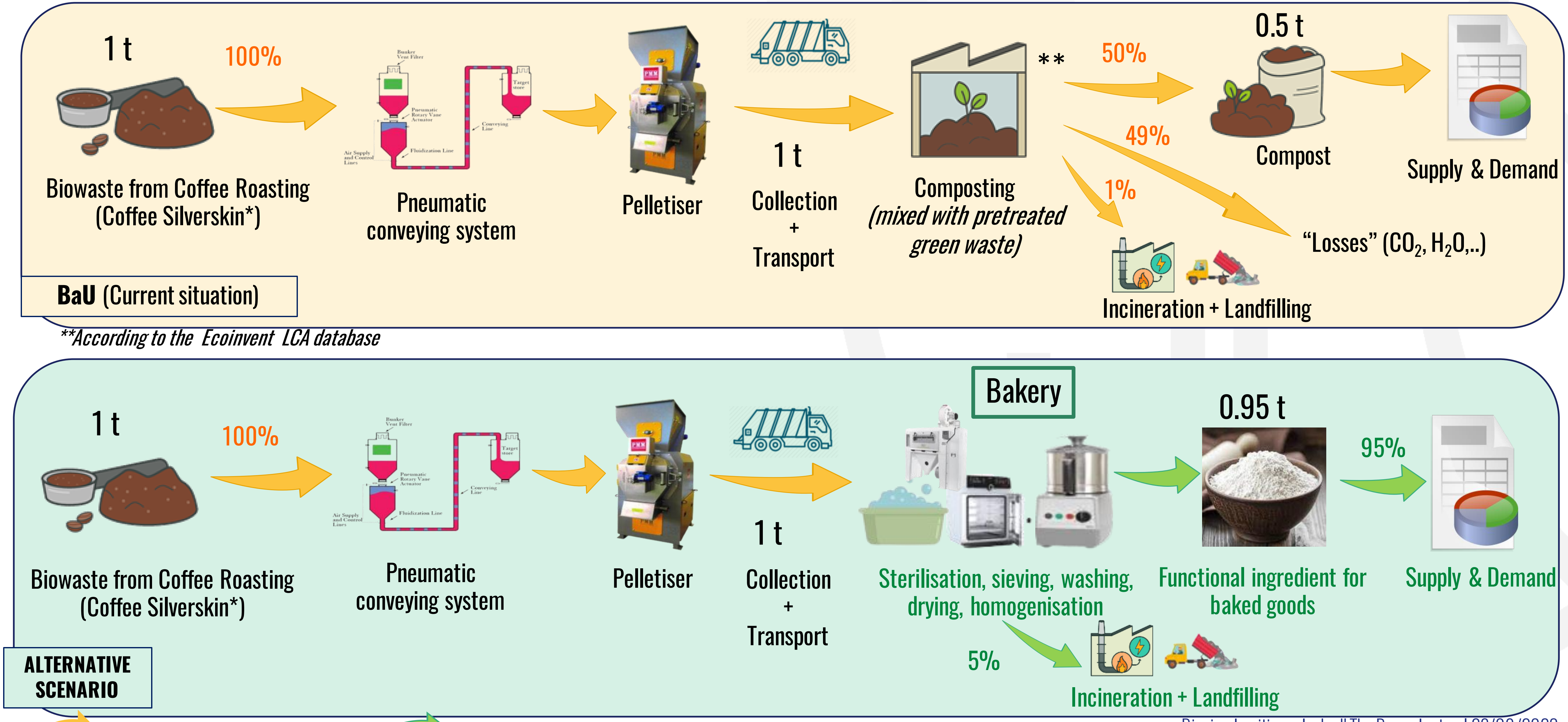
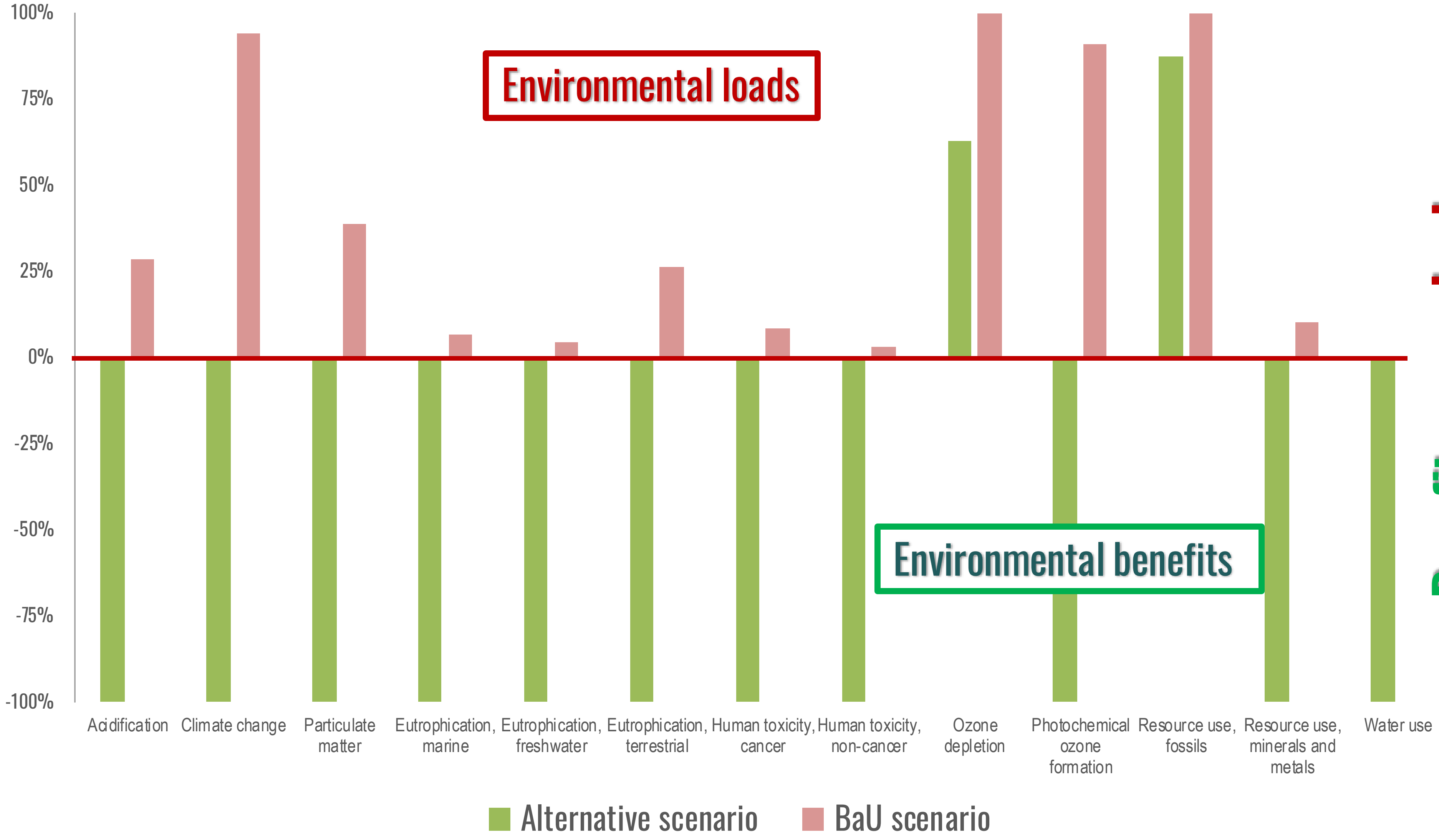
The selected chain in MCN



Current/ not changing situation *Alternative scenario changes*

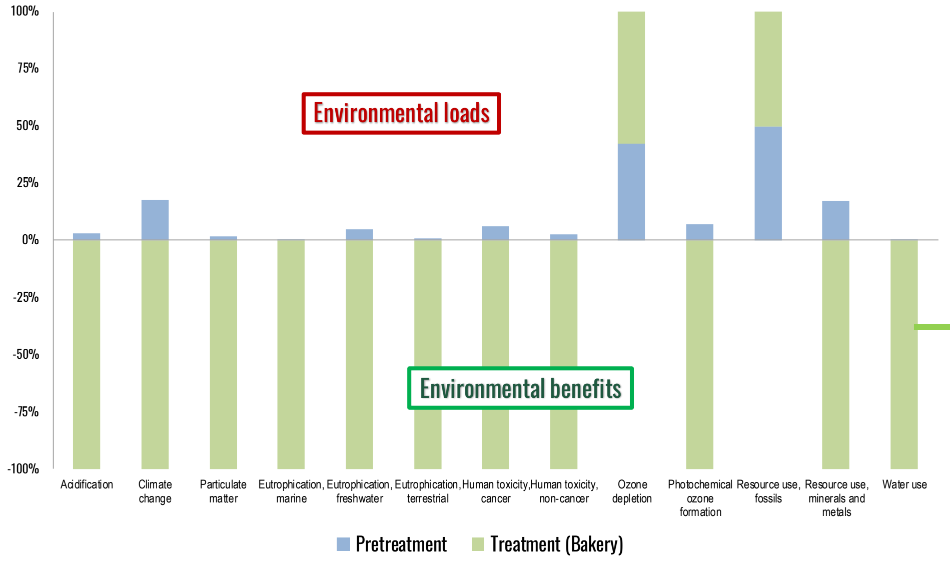
* About 90% of total biowaste from coffee roasting (besides discarded beans)

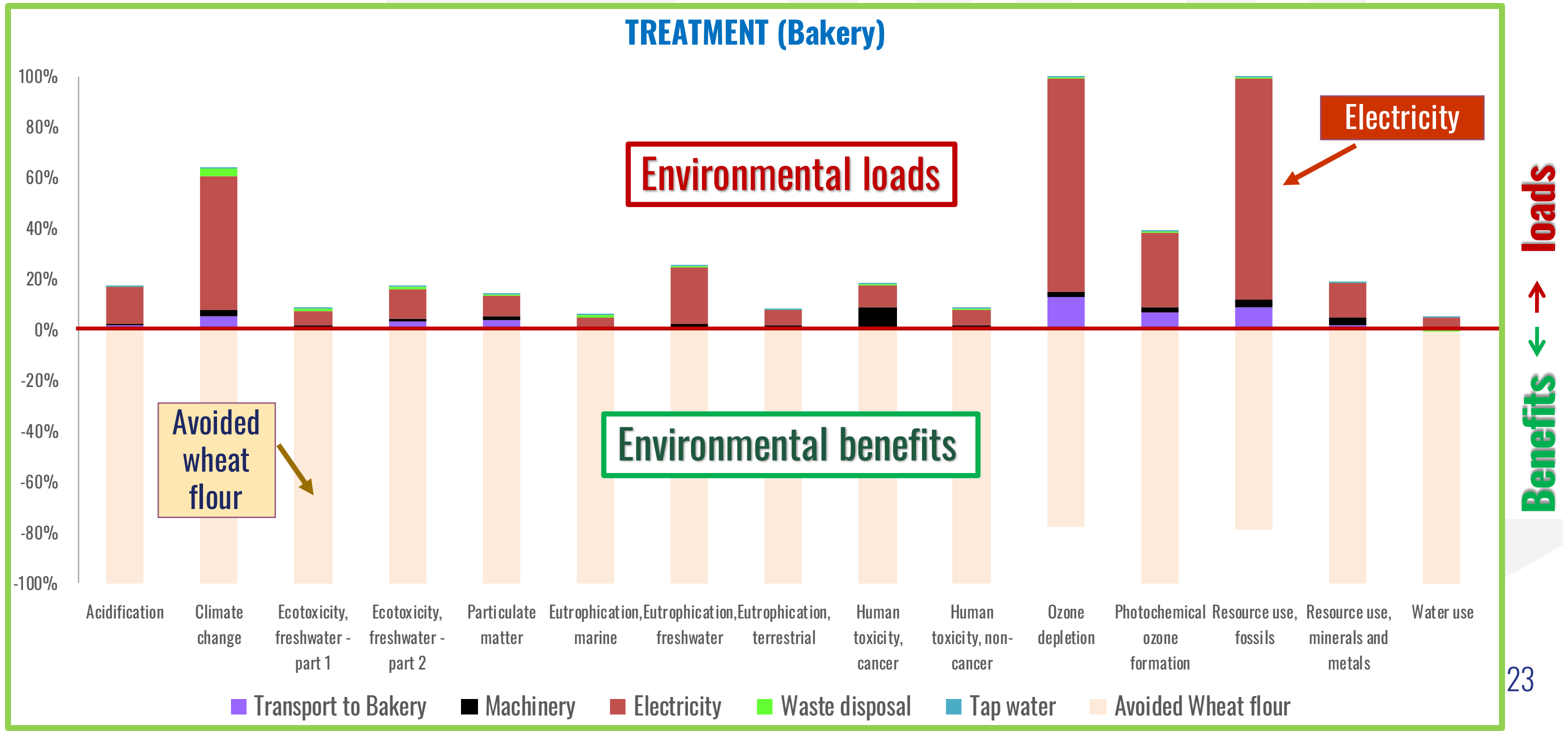
Net environmemtal impacts of BaU and Alternative scenarios



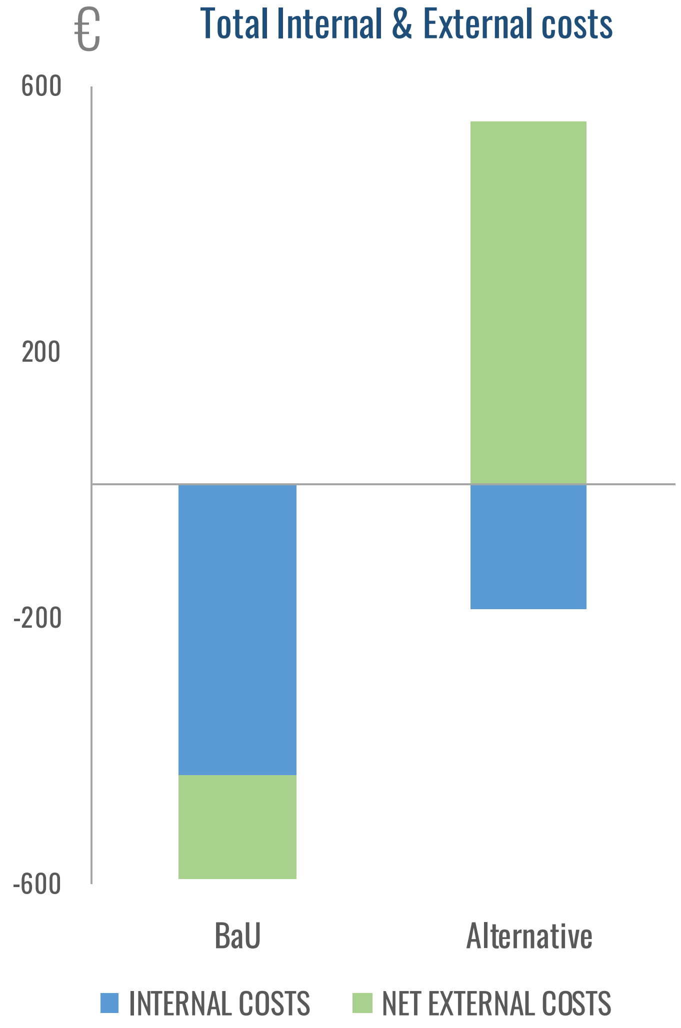
Impact category	Unit	Alternative scenario	BaU scenario
Acidification	mol H+ eq	-1,14E+01	3,29E+00
Climate change	kg CO_2 eq	-2,50E+02	2,36E+02
Particulate matter	disease inc.	-8,81E-05	3,41E-05
Eutrophication, marine	kg N eq	-8,21E+00	5,32E-01
Eutrophication, freshwater	kg P eq	-3,96E-01	1,68E-02
Eutrophication, terrestrial	mol N eq	-5,41E+01	1,43E+01
Human toxicity, cancer	CTUh	-1,00E-06	8,63E-08
Human toxicity, non-cancer	CTUh	-3,61E-05	1,09E-06
Ozone depletion	kg CFC11 eq	2,59E-05	4,11E-05
Photochemical ozone formation	kg NMVOC eq	-1,99E+00	1,81E+00
Resource use, fossils	MJ	2,50E+03	2,86E+03
Resource use, minerals and metals	kg Sb eq	-5,18E-03	5,27E-04
Water use	m^3 depriv.	-7,92E+03	1,17E+01

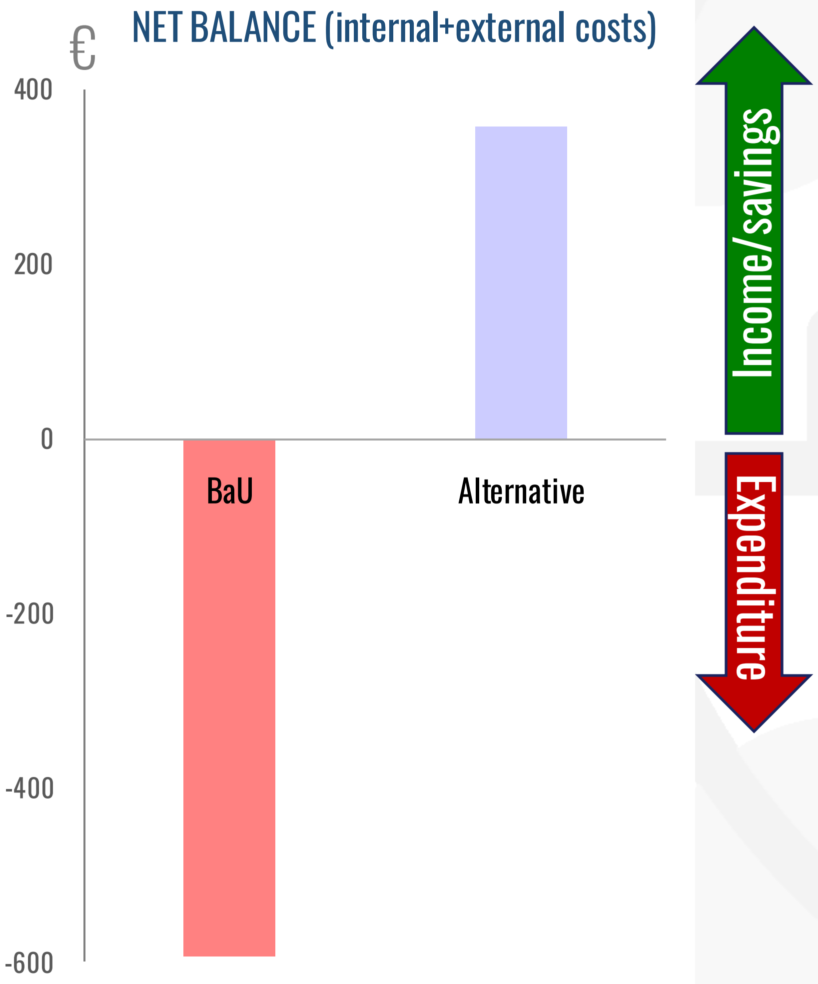
Net environmental impacts of the Alternative scenario





eLCC: Total economic costs for MCN system (F.U. 1 ton of C.S.)





Coffee company total costs

Total BaU scenario economic costs

Category	Unit	Cost
NET INTERNAL COSTS	€/ton	-438.6
NET EXTERNAL COSTS	€/ton	-155.8
TOTAL NET BALANCE	€/ton	**-593.8**

Total Alternative scenario economic costs

Category	Unit	Cost
NET INTERNAL COSTS (expenditures)	€/ton	-118.6
NET EXTERNAL COSTS (savings)	€/ton	545.8
TOTAL NET BALANCE	€/ton	**+357.8**

Conclusions from LCA & LCC in the MCN chain

- The Alternative scenario turns out to be the most sustainable, thanks to the benefits deriving from the avoided production of flour.
- The most impacting processes are electricity consumption and transport.
- The Alternative scenario results to be more economically convenient than the BaU, in terms of savings in both biowaste disposal costs and environmental remediation costs.

These results suggest:

- increasing the use of renewable energy and/or of low energy consumption machinery;
- having local treatment facilities (less transport);
- there are more economically convenient solutions than the public system for disposing of biowaste from the agro-industrial sector.

The municipal biowaste chain in the Metropolitan Area of Barcelona (MAB)

Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) results

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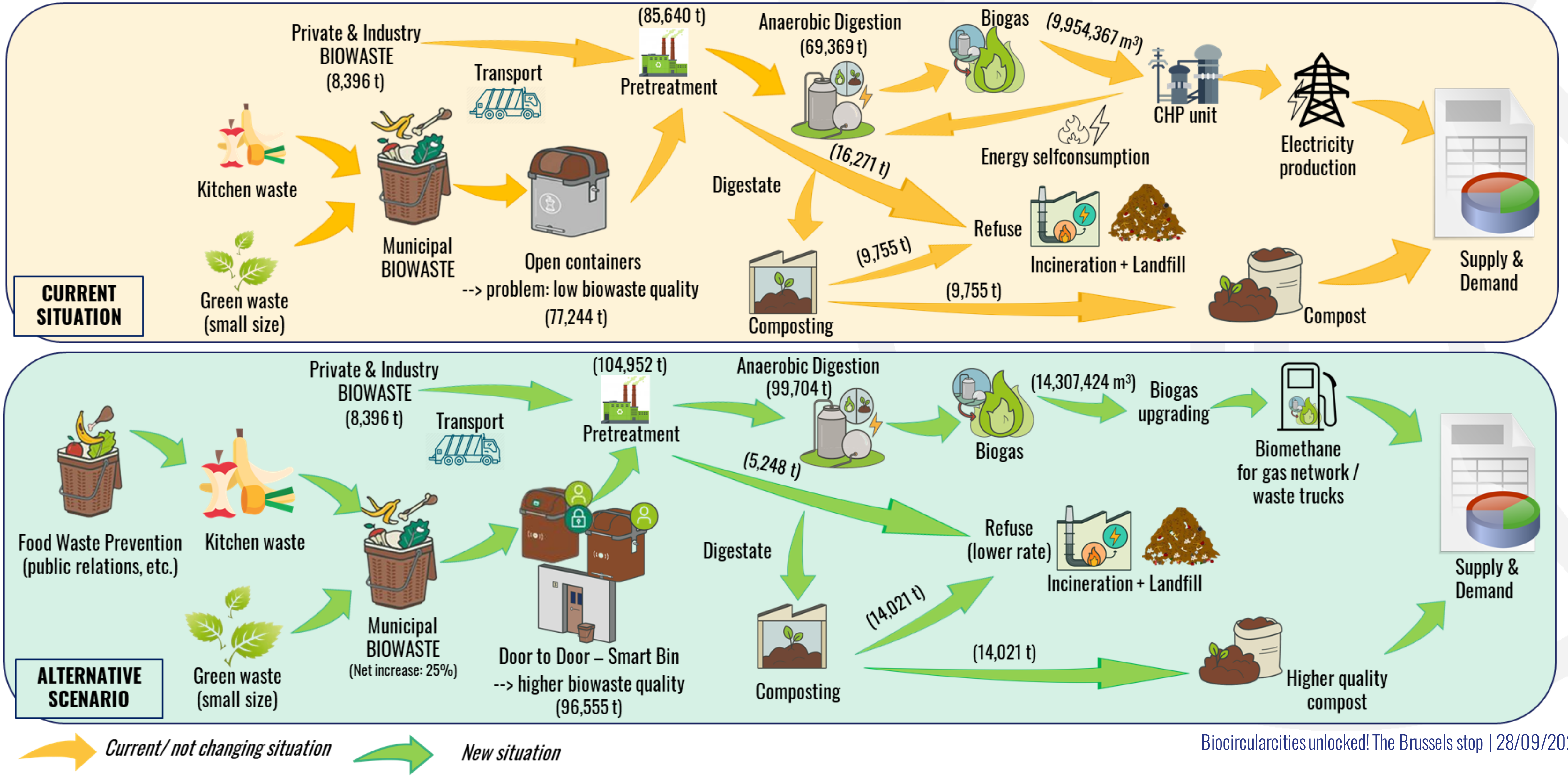
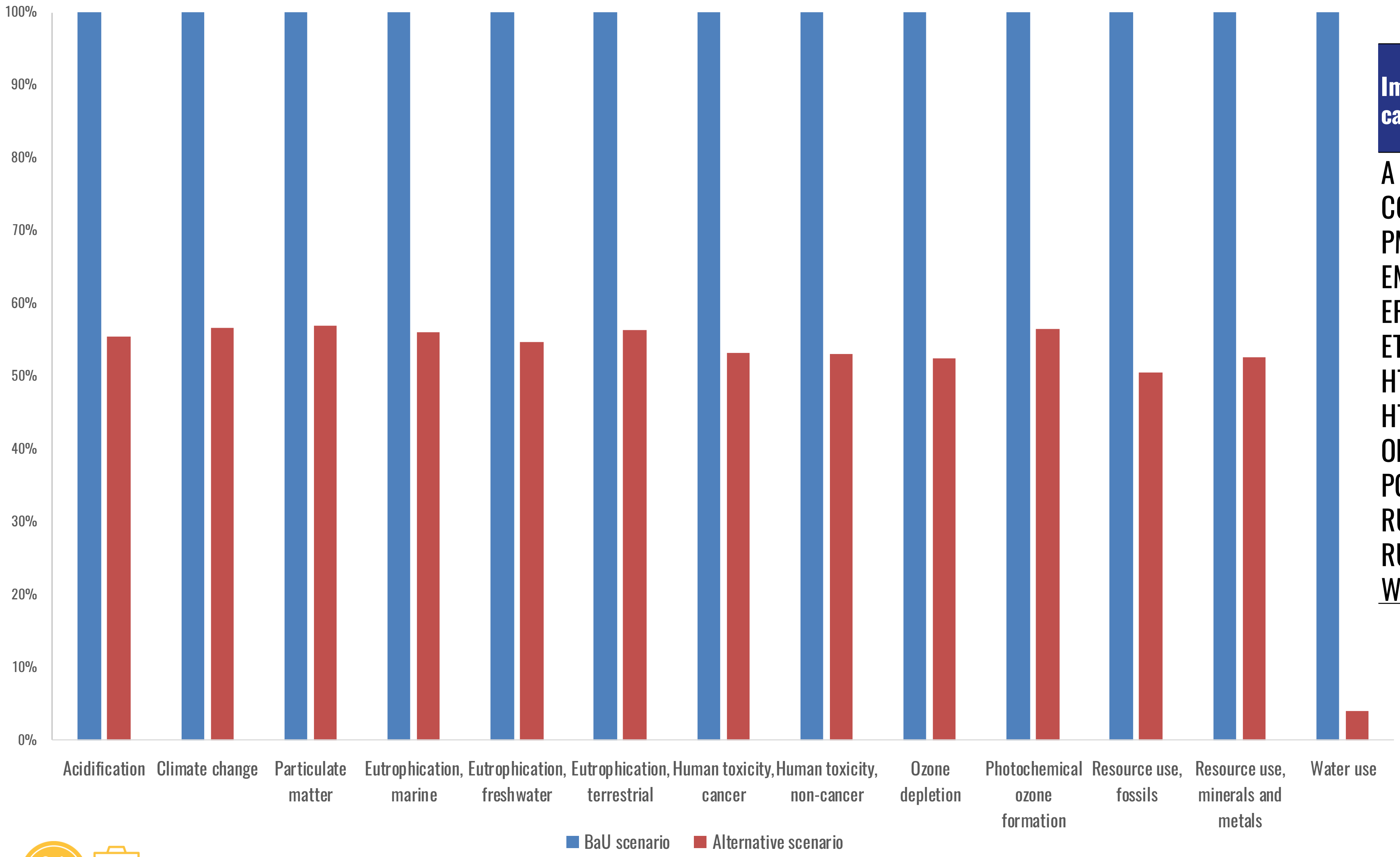
The selected chain in the MAB



Environmental impacts of the two scenarios

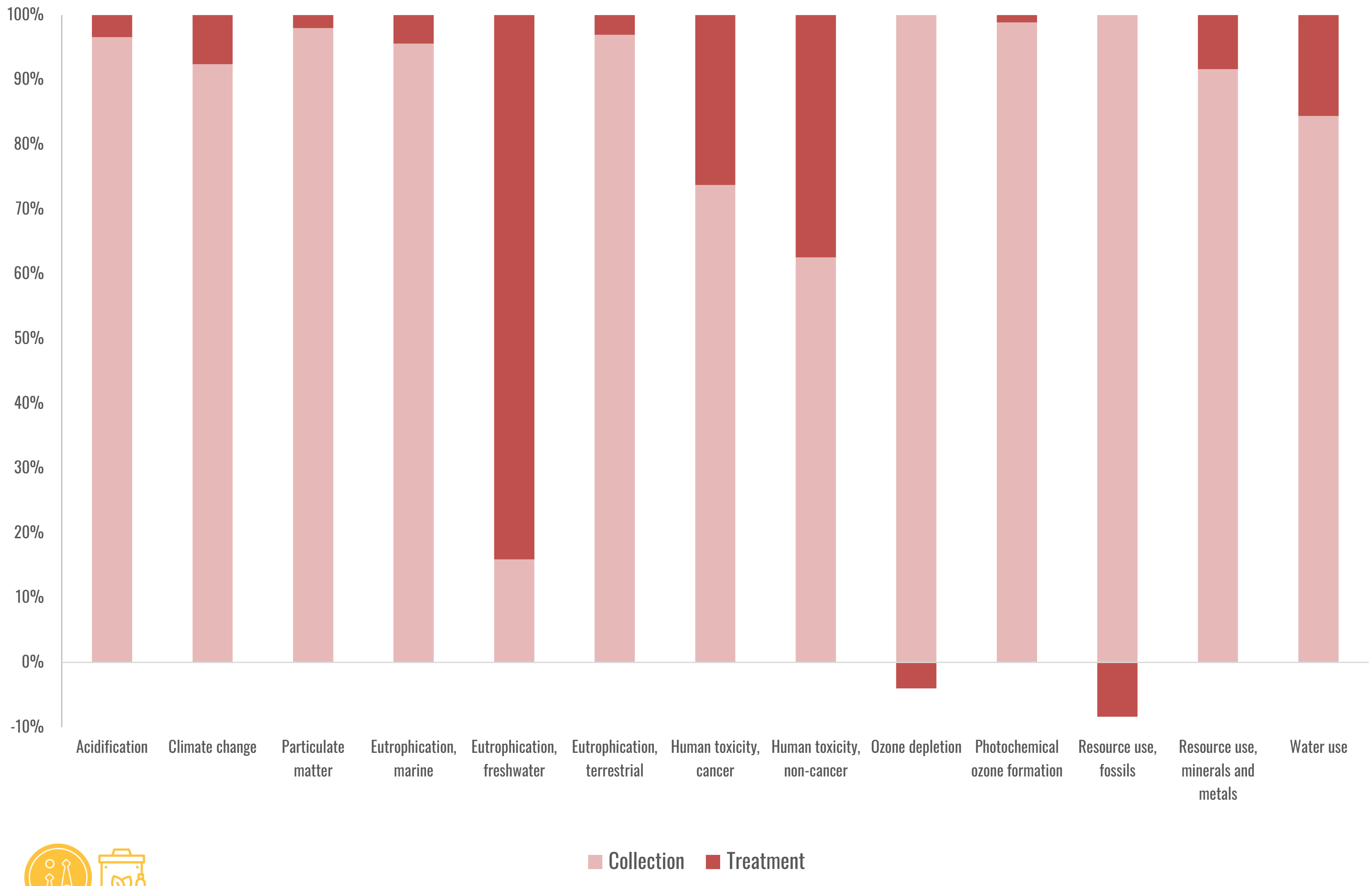


Impact category	Unit	BaU scenario	Alternative scenario
A	mol H^+ eq	3.15E+01	1.75E+01
CC	kg CO_2 eq	5.06E+03	2.87E+03
PM	disease inc.	6.74E-04	3.84E-04
EM	kg N eq	1.26E+01	7.09E+00
EF	kg P eq	5.47E-01	2.99E-01
ET	mol N eq	1.36E+02	7.67E+01
HTc	CTUh	8.60E-07	4.57E-07
HTnc	CTUh	1.75E-05	9.26E-06
OD	kg CFC_{11} eq	1.06E-03	5.56E-04
POF	kg NMVOC eq	4.68E+01	2.65E+01
RUF	MJ	6.59E+04	3.33E+04
RUM	kg Sb eq	4.53E-03	2.38E-03
WU	m^3 depriv.	9.87E+02	3.93E+01

Reduction of impacts

from 43% in PM and CC up to 96% in WU

Environmental impacts of the Alternative scenario



Impact category	Unit	Collection	Treatment
A	mol H^+ eq	1.69E+01	5.96E-01
CC	kg CO_2 eq	2.65E+03	2.17E+02
PM	disease inc.	3.77E-04	7.73E-06
EM	kg N eq	6.78E+00	3.12E-01
EF	kg P eq	4.77E-02	2.52E-01
ET	mol N eq	7.44E+01	2.34E+00
HTc	CTUh	3.37E-07	1.20E-07
HTnc	CTUh	5.79E-06	3.47E-06
OD	kg CFC_{11} eq	5.79E-04	-2.32E-05
POF	kg NMVOC eq	2.62E+01	3.01E-01
RUF	MJ	3.63E+04	-3.05E+03
RUM	kg Sb eq	2.18E-03	1.99E-04
WU	m^3 depriv.	3.32E+01	6.14E+00

Environmental benefits

Life Cycle Costing (LCC) analysis

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Total economic costs: internal costs and environmental damage costs (externalities)
(F.U. 1 ton of collected biowaste).

BaU scenario TOTAL COSTS		
Category	**Unit**	**Cost**
Internal costs (only for collection)	€/ton	268,17
External costs	€/ton	2.7E+03
TOTAL COSTS	€/ton	**2,97E+03**

Alternative scenario TOTAL COSTS		
Category	**Unit**	**Cost**
Internal costs (only for collection)	€/ton	205,61
External costs	€/ton	1.4E+03
TOTAL COSTS	€/ton	**1,61E+03**

Conclusions from LCA & LCC in the MAB chain

- The solutions proposed (prevention measures, different collection systems and treatment) in the Alternative scenario resulted to be more sustainable than the current solutions in the BaU scenario from both the environmental and economic point of view.
- The environmental and economic impacts generated by the collection activities, in both investigated scenarios, are greater than those generated by the treatment processes.
- The highest environmental and economic benefits come from the biomethane production and the consequently avoided supply of fossil methane.
- The Ozone depletion and Resource use (fossils) impact categories record a NET benefit from the proposed solutions.
- The Alternative scenario allows for an average reduction of 70% in the environmental impacts.

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The Brussels stop

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Policy recommendations

Karin Meisterl, Fundació ENT

28 September 2023

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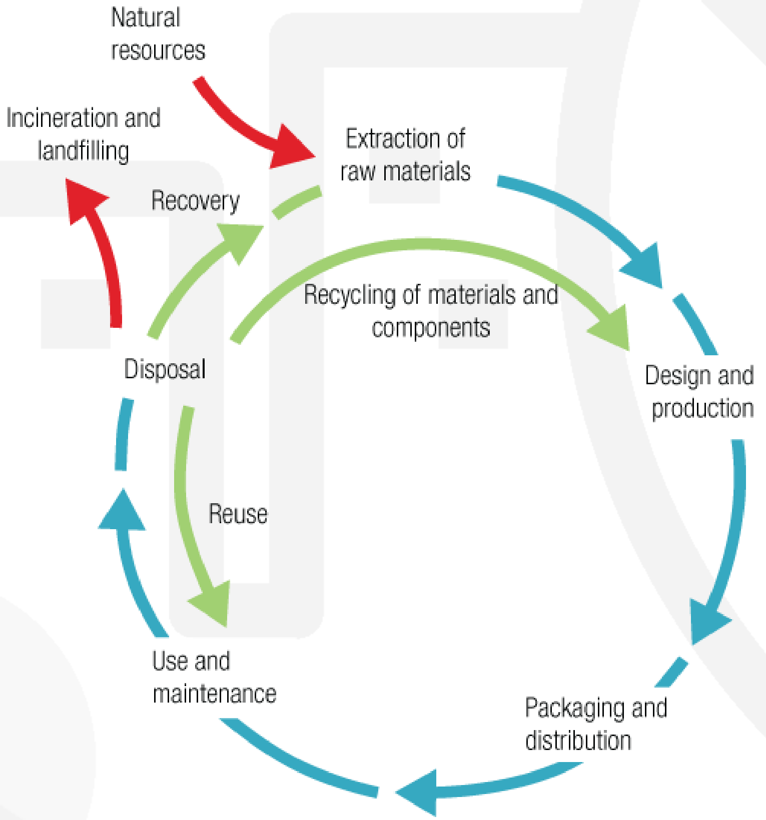
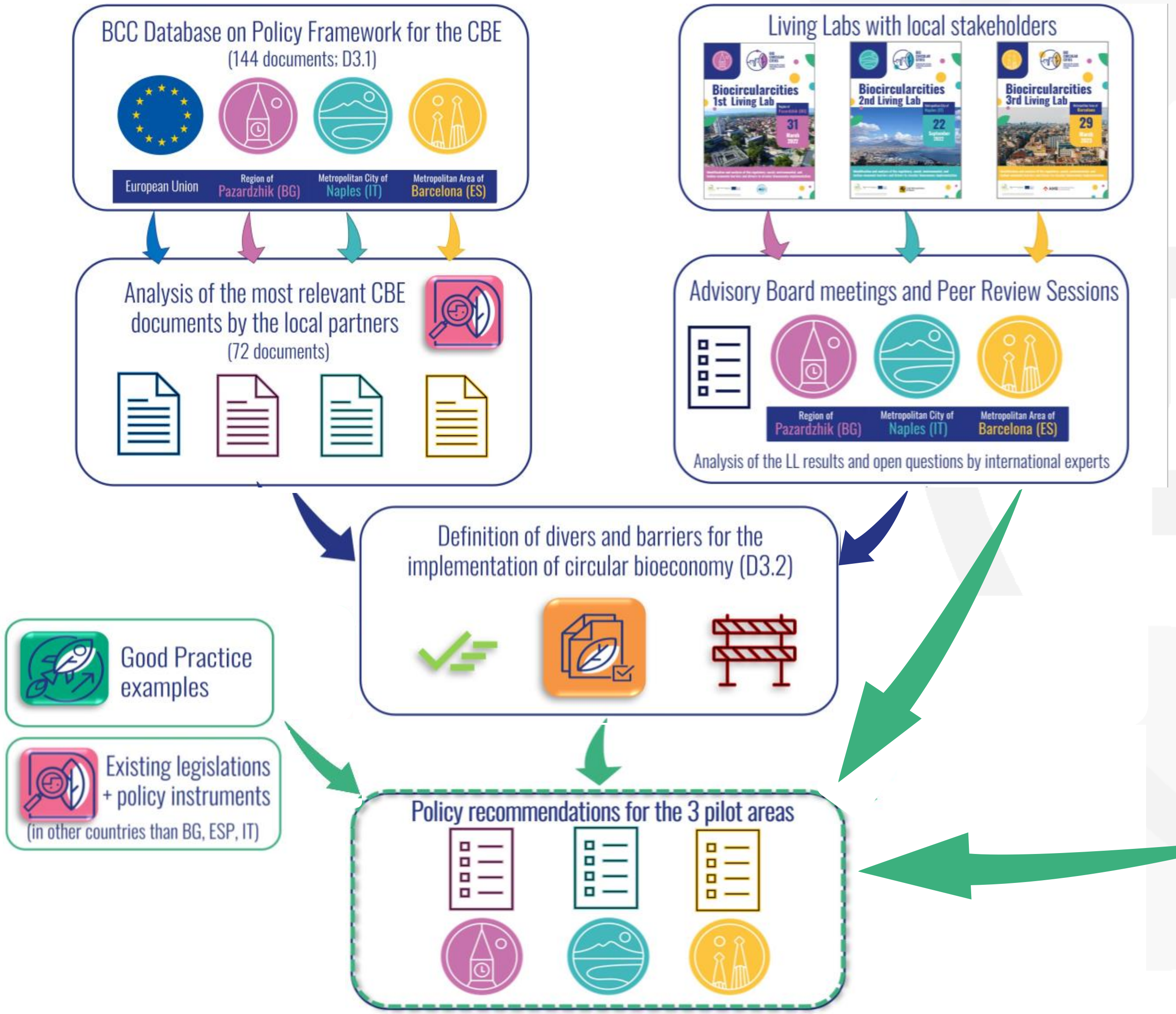
LCA/LCC based Policy recommendations

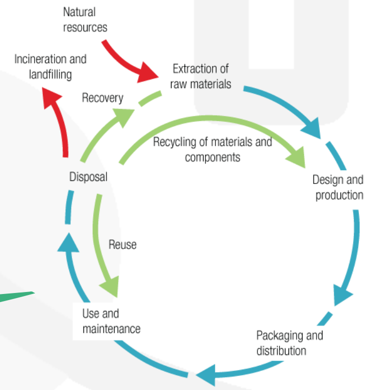
- Use renewable energy sources in the valorisation processes
- Purchase energy-efficient machinery
- Optimise transport
- Reuse and recycle, take action against planned obsolescence, and promote the spread of eco-design (to facilitate repair and recycling)
- Fiscal and financial incentives to realize these actions



Methodology: Policy Recommendations (PR)



LCT based PR



94 BCC policy recommendations

In total 30 general PR relevant to all three pilot areas on the topics of:

- Data management
- Organic waste treatment and sustainable biorefineries
- Market incentives for bio-based products
- Public awareness and support
- Stakeholder involvement
- (Bioplastics)

In total 64 PR specific to different pilot areas, including:

- Forestry residues (collection; biochemicals & bioenergy production)
- Agro-industrial organic waste & novel food
- Municipal biowaste (food waste prevention, separate collection. AD/biogas/biomethane)

Data management

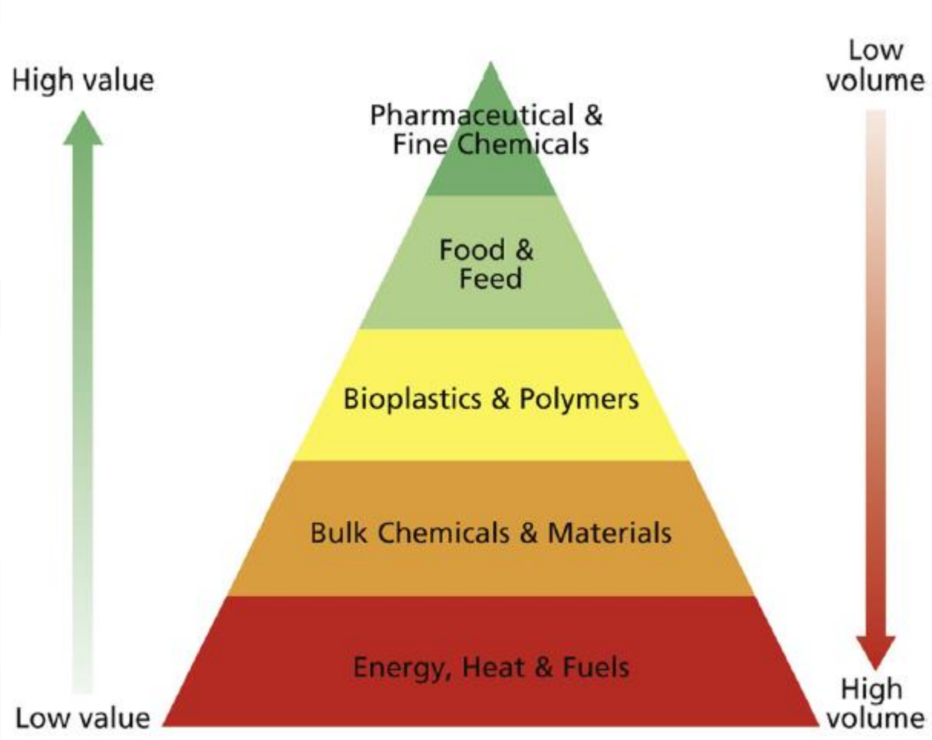
- **At EU level, introduce standardised guidelines for data collection and analysis** for all types of organic waste.

- **At national and regional level, introduce into law annually updated, comprehensive, transparent, and freely accessible databases** on municipal biowaste streams using European standardised guidelines.

- **At national level**, consolidate and accelerate the development of **national electronic platforms for waste management** regarding the documentation, registration, and reporting obligations in the waste management sector and data exchange between all regions in one country.

Organic waste treatment and sustainable biorefineries

- **At EU and national level, ensure planning security with regard to legal framework conditions and subsidies**, and phase out subsidies not consistent with the EU waste hierarchy and CBE targets.
- **At regional level, introduce financial incentives for technical improvements of existing treatment plants, the use of BAT and for the construction of new biorefineries**, giving preference to bio-based products according to the "cascading use of biomass principle".
- **At national level, build capacity in the municipalities** to **speed up the permitting process for new biorefineries.**



Source: *Stegman, P., Londo, M., & M. Junginger (2019): The circular bioeconomy: Its elements and role in European bioeconomy clusters. Resources, Conservation & Recycling: X 6 (2020) 100029*

Market incentives for sustainable bio-based products

- **At national, regional, and local level, support Green Public Procurement to stimulate the growth of the sustainable bio-based product market**, using the EU guidance for bio-based products in procurement.

- **At EU or national level, introduce VAT reductions for bio-based products (e.g., biochemicals)** and other environmentally friendly products and services produced in the EU compared to fossil-based alternatives (integrated approach) and products from outside the EU.

Public awareness and support

- **At regional and local level, finance well-developed, continuous environmental education programmes** on food waste prevention, separate collection, and the benefits of bio-based products.

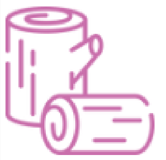
- **At regional and local level, monitor the success of awareness raising campaigns using common indicators for MSW management.**

Stakeholder involvement

- **At regional or local level, promote the participative approach by enshrining stakeholder involvement in legislation.**

- **At EU and regional level, promote technology and innovation clusters and networking platforms** (e.g., Biomethane Industrial Partnership) for policy makers, researchers, and market players.

Pazardzhik Province



- **At national level, funding should be made available for local environmental impact assessments** to determine the range between forestry residues that must remain on the ground to preserve soil quality and biodiversity and residues that can be used to produce new bio-based products.

- **At national level, introduce a fee and incentive scheme to promote the pre-treatment and sustainable collection of forestry waste** for biorefineries – especially in difficult terrain – also with a view to reducing the costs of firefighting and reforestation after fires.

- **At EU level, introduce incentives for bioenergy compared to fossil energy** through measures such disincentives for the use of **fossil energy (e.g., increasing taxes)** or an incentive mechanism based on **carbon footprint assessment.*** The lower the carbon footprint [CO_2 g/MJ], the higher the price/incentive should be for this product/energy source.

**according to the International Sustainability and Carbon Certification (ISCC).*

Metropolitan City of Naples

- **At national level, introduce financial incentives and administrative and technical support for companies to use their by-products** (e.g., coffee silverskin) **internally** for the production of new products (e.g., functional food) to avoid classification as waste.

- **At regional and local level, incentivise local industrial symbiosis**, i.e., the physical exchange of resources, energy and/or by-products among different industries

- **At national level, set up collection systems for agro-industrial organic waste:** Give financial incentives to companies or businesses to collect and store a certain waste stream (e.g., collection of spent coffee grounds in cafeterias)

- **<u>Novel food:</u> At national level, provide financial support for laboratory analyses in support of risks assessments for EFSA** (European Food Safety Authority), which provides independent scientific advice and informs on existing and emerging risks in the food chain with a view to granting market authorisation (minimum 2-year process).

Metropolitan Area of Barcelona: Separate biowaste collection

- **At national level, introduce mandatory door-to-door (DtD) or smart bin collection systems.**
  The introduction of new "open bins" should be prohibited.

https://www.municipalwasteeurope.eu/sites/default/files/6.Danilo%20Vismara.pdf

- **At the local level, DtD collection controls should be introduced - with fines for non-compliance.**
- **At national level, introduce the mandatory application of the pay-as-you-throw (PAYT) principle.**

Metropolitan Area of Barcelona

- **At national and regional level, introduce stricter limits for biowaste impurities** (CAT:5%; ESP: 10% by 2027) → **Low impurity levels are important for obtaining high-quality compost!**

- **At national level**, integrate a **higher minimum biogas target** (at least 5 bcm by 2030) and **biomethane target** (at least 5% of the total gas consumed) linked to the target for new plants to be built into the **Spanish Biogas Roadmap 2022.**[1]

- **At national level, promoting biomethane demand by awareness raising campaigns about the guarantee of origin certificate (by Enagás)** [2] **for energy produced from renewable sources** (when and where it was produced, the type of production facility and energy source).

[1] https://energia.gob.es/es-es/Novedades/Documents/00HR_Biogas_V6.pdf

[3] https://www.miteco.gob.es/es/prensa/220517_cm_ndpelgobiernoapruebaelsistemadegarantiasdeorigenparalosgasesrenovables_tcm30-540454.pdf

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BioCircularCities guidelines (webtool)

Laurène Chochois, LIST

28 September 2023

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European Union Funding
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BBI JU

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BCC guidelines: Methodological approach

BCC webtool: https://bcc.list.lu/

- ✓ Analysis of the **scope of the global Circularity and Bioeconomy concepts**, the associated **European targets** and incentives, and the correlations which can be established between them.
- ✓ Analysis of the **main drivers and barriers** towards the development of sustainable circular bioeconomy value chains (D4.1 literature review; D3.2 policy framework analysis at EU and pilot level).
- ✓ **Review of the existing supporting approaches, guidelines and tools** in order to position the BCC guidelines and clearly define its objectives.
- ✓ D4.2 “Report documenting the definition of the decision tree background logic”.
- → D4.3 “Webtool in practice: short guidance for the practitioner”.
  Soon available at https://biocircularcities.eu/resources/

Objective and scope of the BCC Guidelines

Target group: Biowaste managers/technicians reporting to public/private decision makers.

Different feedstock

Municipal biowaste

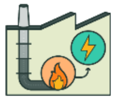
Forestry residues

Agro-industrial organic waste

How to avoid landfill and create added-value?

Which valorisation option is the most suitable?

Some examples:

- Recycling into high-value biochemicals 
- Recycling into biogas or biomethane and/or compost 
- Incineration with energy recovery 

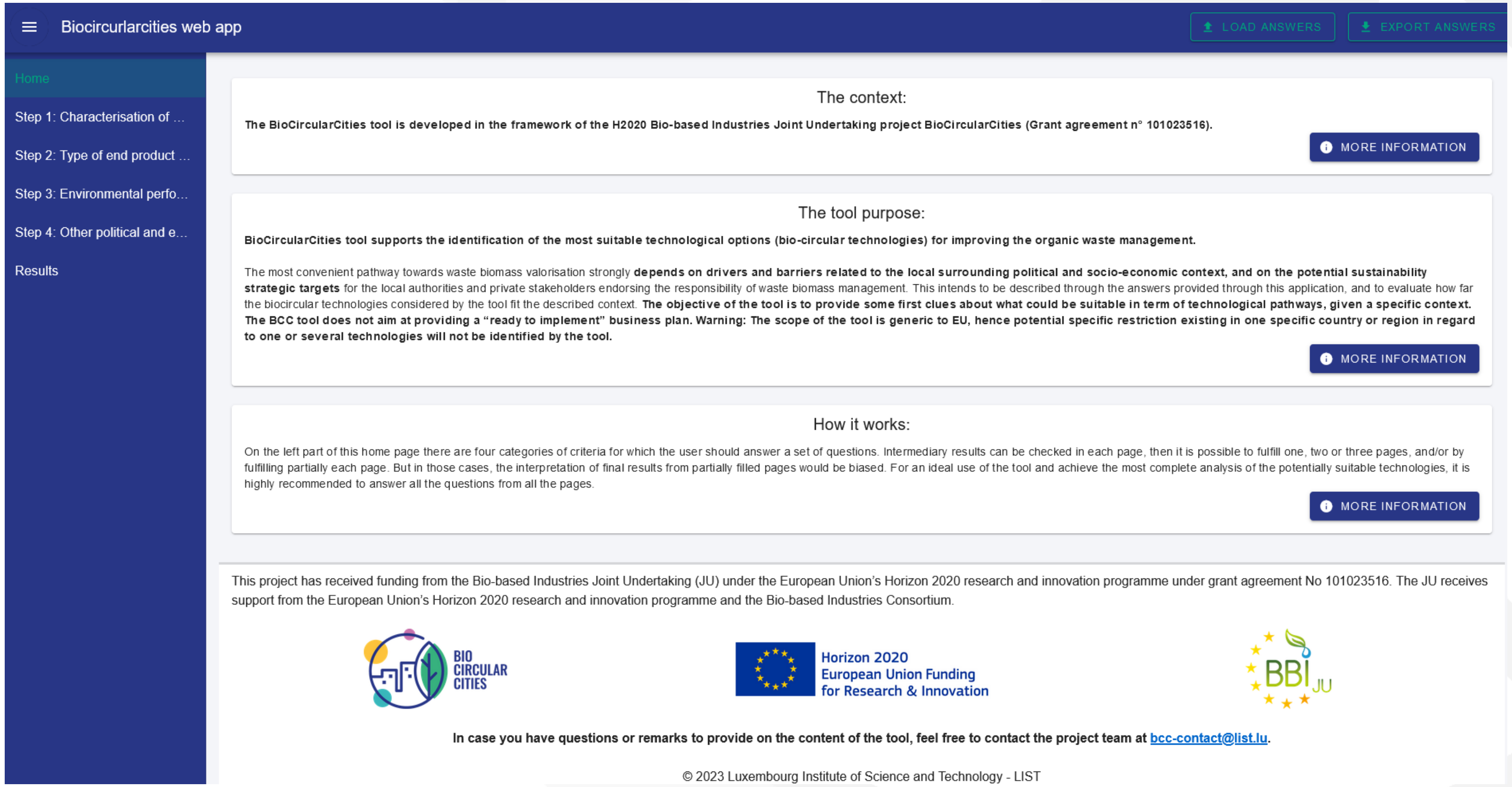
BBC webtool -> Identification of the most suitable bio-circular valorisation technology considering the specific context

Setting guidelines for identifying the most suitable biowaste treatment options

➢ **BCC Guidelines format:**

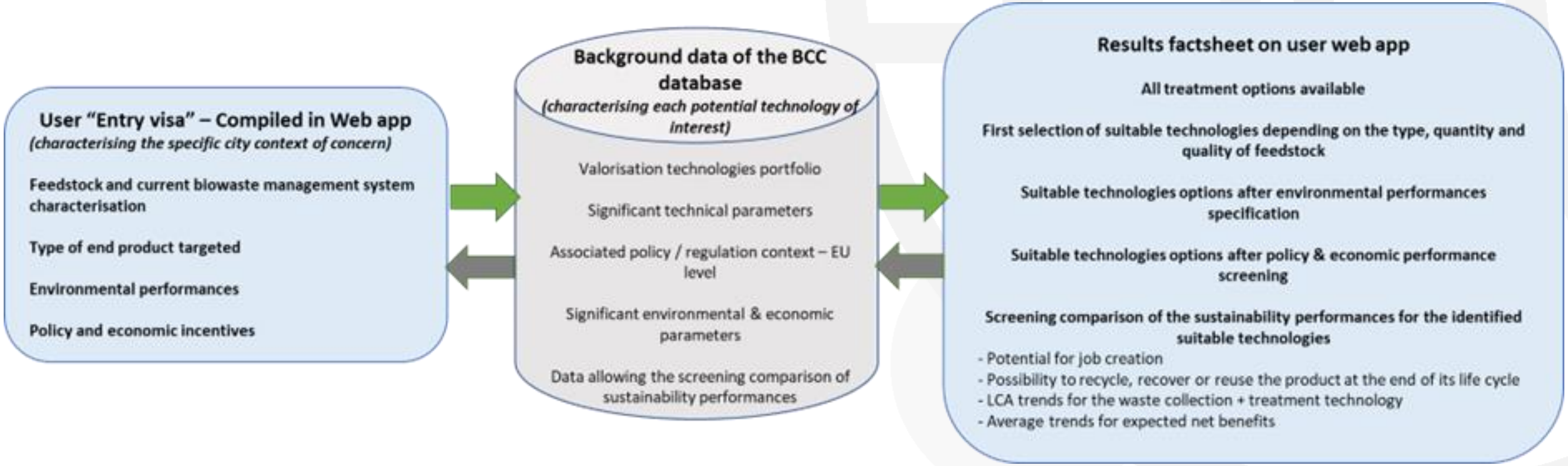
Webtool supporting the identification of the most relevant options in terms of biowaste management and valorisation technologies.

https://bcc.list.lu/



Setting guidelines for identifying the most suitable biowaste treatment options

➢ **BCC Guidelines format: Webtool** supporting the identification of the most relevant options in terms of biowaste management and valorisation technologies.



BCC webtool: 14 technologies considered

Type of bio-based product	Type of processes: Biochemical processes	Thermochemical processes	Chemical processes	Other
Bulk/Specialty chemicals	Enzymatic hydrolysis Industrial fermentation Solid state fermentation	Gasification Hydrothermal process* Pyrolysis**	Heterogeneous catalysis	Pulping
Bio-based functional ingredients (novel) food				
Biogas			Anaerobic digestion (AD) Mechanical Biological Treatment (MBT) + AD	
Biomethane			Anaerobic digestion + Biomethanation	
Compost			MBT + Composting	
Other				Landfilling Incineration of MSW (containing biowaste) + energy recovery

** only applicable to food related waste*

*** only applicable to wood processing waste and forestry residues*

BCC webtool: data entry by the user

Access: https://bcc.list.lu/

Step 1: Feedstock and current system characterisation

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Step 2: Type of bio-based product targeted

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Step 3: Environmental performances

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Step 4: Political and economic incentives

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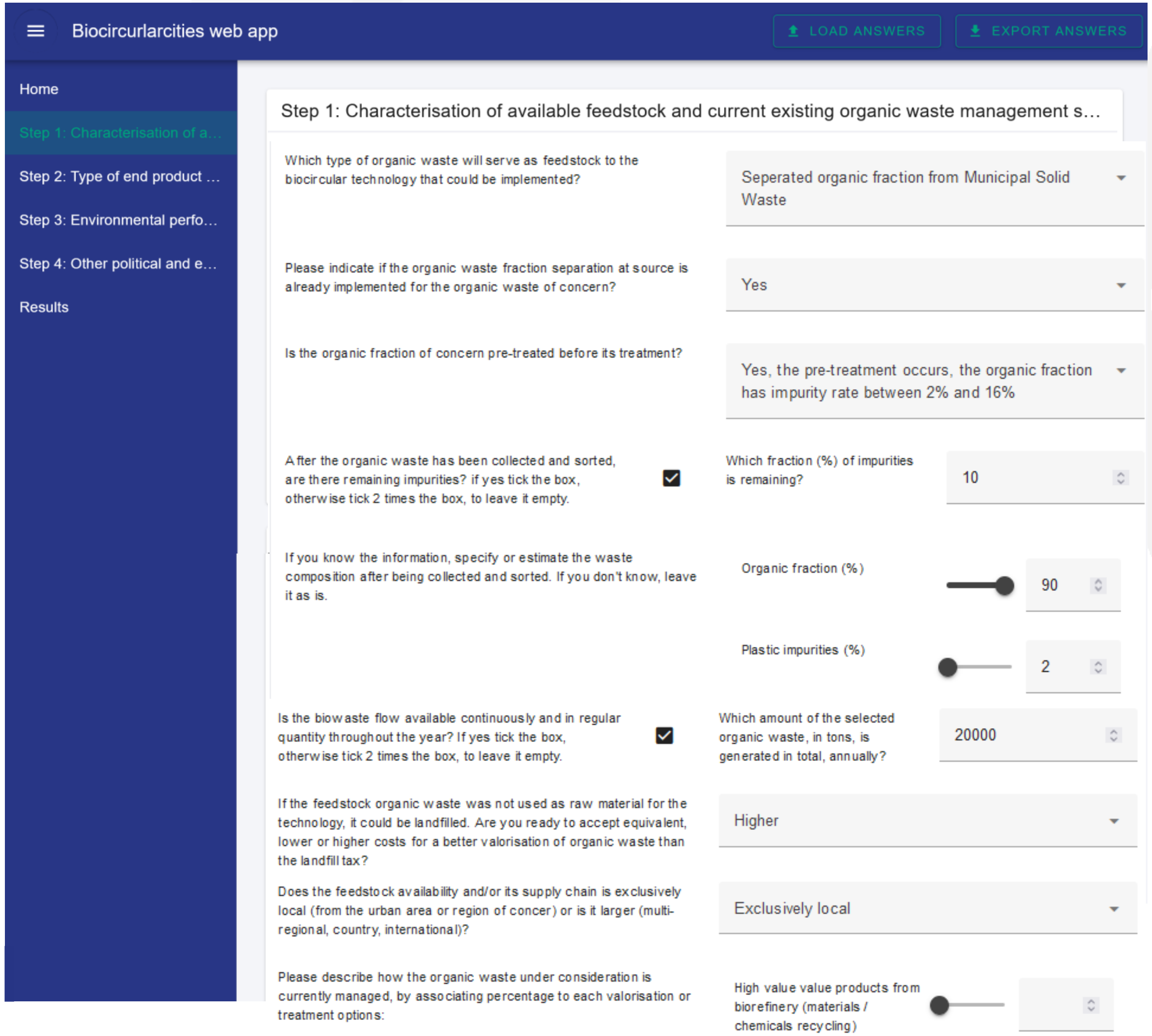
RESULTS: Technology ranking



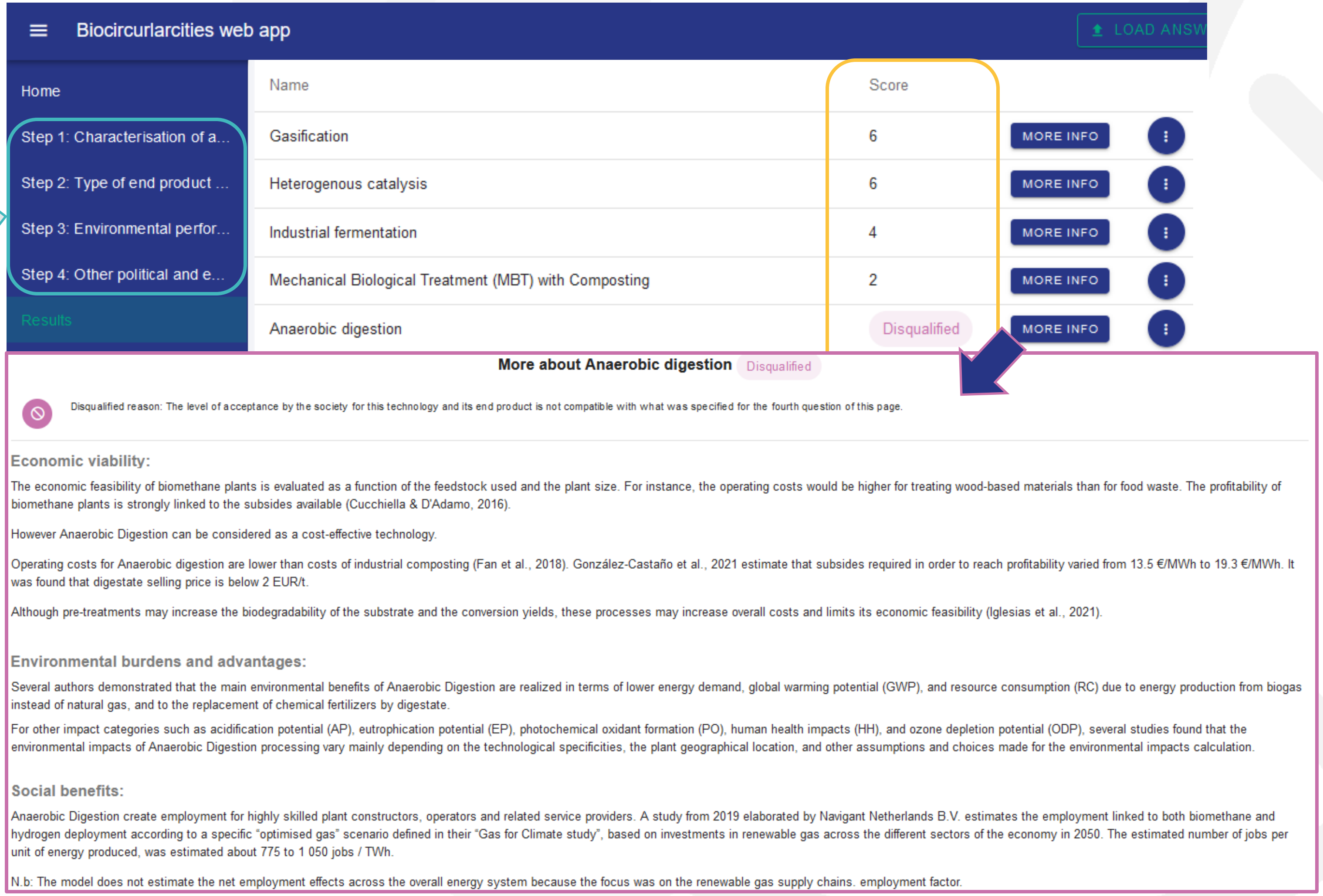
BCC webtool: database and results

BACKGROUND DATABASE for technology selection

- Valorisarion technologies portfolio
- Significant technical parameters
- Associated EU policy framework
- Significant environmental & economic parameters
- Data for sustainability comparisons

RESULTS: Ranking of the 14 integrated technologies, depending on the:

- Type, quantity and quality of feedstock
- Specification of environmental performances
- Available political and economic incentives
- Job creation potential
- The possibility to recycle/recover/reuse a product (end-of-life stage) etc.



Why and how to unlock a local and circular bioeconomy – Barriers and solutions

Icon: Freepik