

STEN GROUP PRESENTATION

Prof. Jo Dewulf
January 2026

GHENT UNIVERSITY

- Top 100 university
- Since 1817
- 11 faculties



BELGIUM



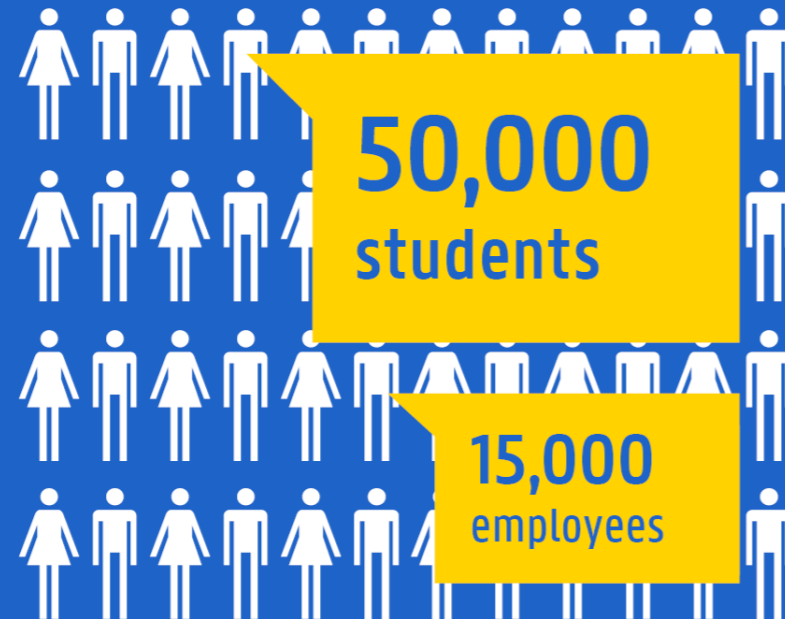
SOUTH KOREA



GHENT UNIVERSITY
GLOBAL CAMPUS

The 1st European university
in South Korea.

 **+200** programmes



68 English-taught
master's
programmes

2,250
Ghent University
students abroad



7,300
International students
at Ghent University



DARE TO THINK

Our credo: critical and
independent minds.



PLURALISM & PARTICIPATION

Open to everyone
irrespective of ideological,
political, cultural or
social background.




SUSTAINABILITY

For a future that is
ecologically, socially
and economically
sustainable, within a
local global context.

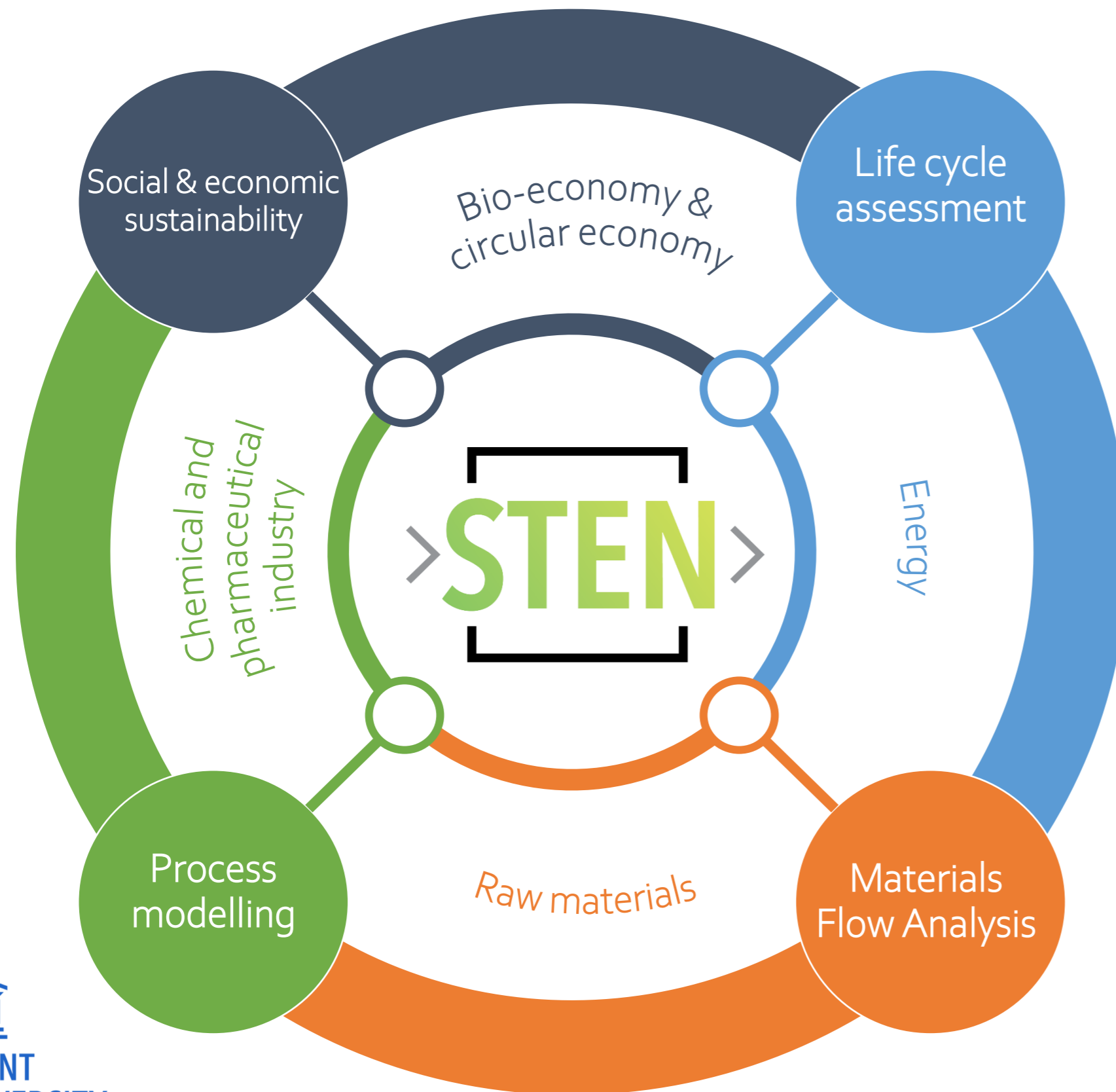
WHO ARE WE?

SUSTAINABILITY SYSTEMS ENGINEERING – STEN

- Part of the  **FACULTY OF BIOSCIENCE ENGINEERING**
- Prof. Jo Dewulf; Prof. Pieter Nachtergaele.
- About **30 Pre- and Post-doc** researchers.
- About **15 Master thesis** students.



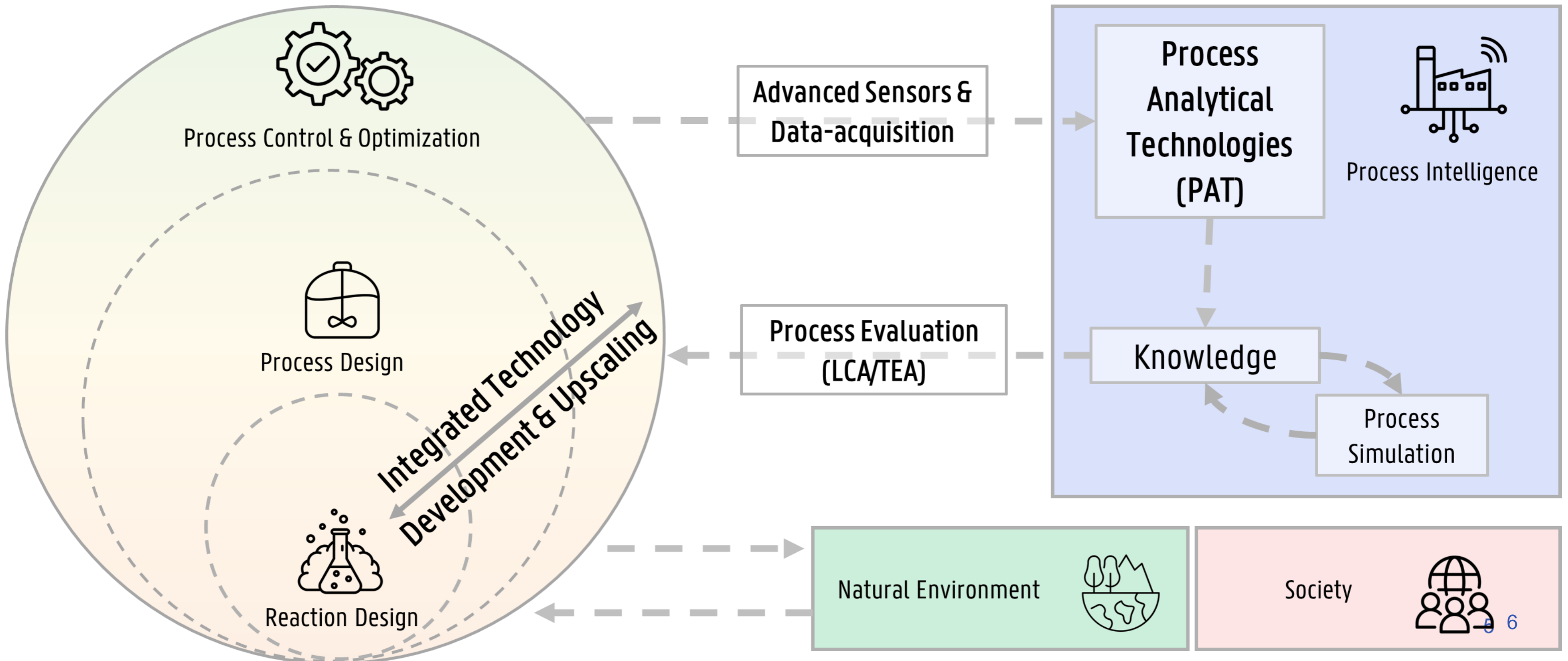
KEY FOCUS – PROF. DEWULF



Designing and evaluating production and consumption systems in a sustainability context, relying on engineering principles.

INCOMING FOCUS – PROF. NACHTERGAELE

Advanced process monitoring & optimization to support upscaling.



A BIT OF HISTORY

2003: Jo Dewulf:

Start as assistant-professor: Clean Technology.

Context: from clean-up to clean technology.

Approach: resource management:

- Based on thermodynamics.
- From process to plant to life cycle.

2025: Pieter Nachtergaele:

Assistant-professor: Process Monitoring & Optimization.

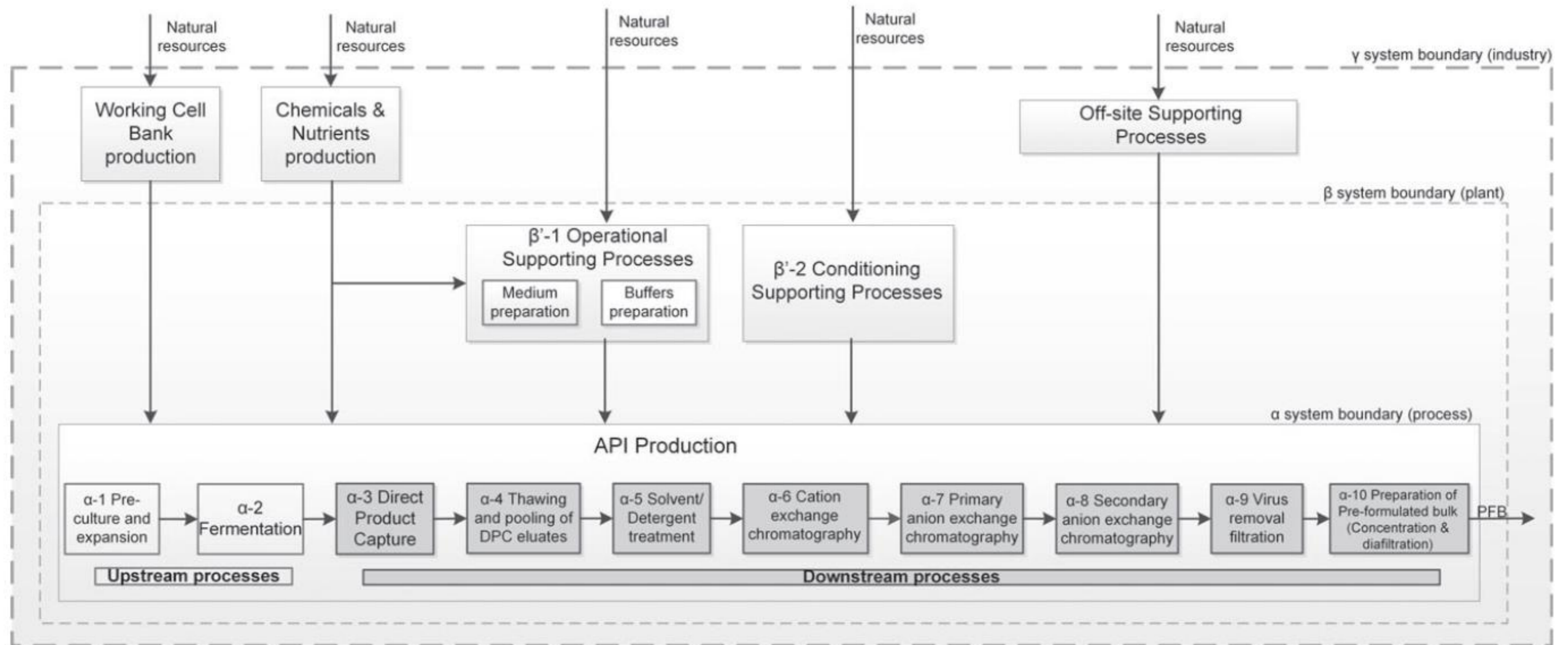
Context: circular and biobased technologies are advancing but face challenges.

Approach: digital & modelling solutions.

- Increase feedstock flexibility.
- Supporting upscaling from lab to industrial scale.

SYSTEMATIC ENGINEERING APPROACH FOR CLEANER PRODUCTION

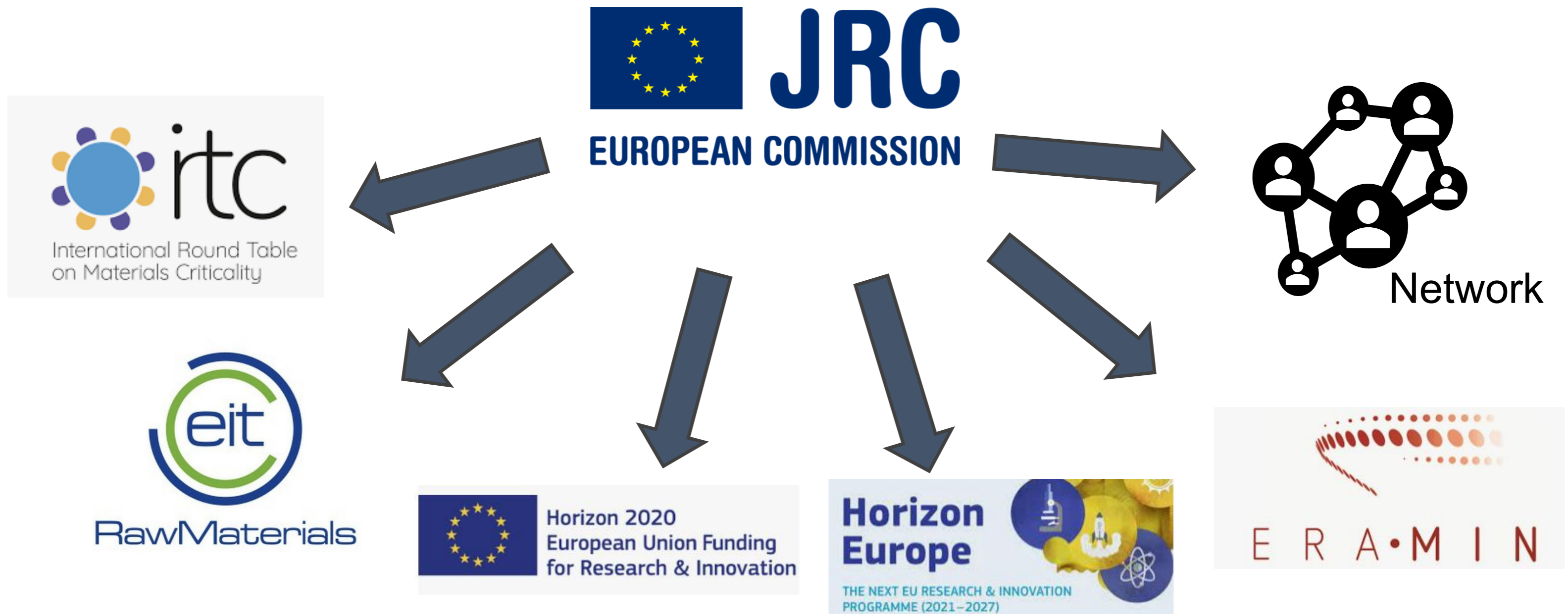
Example: biopharmaceutical production: from processes to plant to life cycle level: from α to β to γ



RESEARCH ON RAW MATERIALS

FOCUS ON RESOURCES: RAW MATERIALS

2013-2015: Work at the Joint Research Centre of the European Commission



SOME KEY PAPERS

Resource methods for LCA

Environ. Sci. Technol. 2007, 41, 8477–8483

Cumulative Exergy Extraction from the Natural Environment (CEENE): a comprehensive Life Cycle Impact Assessment method for resource accounting

J. DEWULF,^{*,†} M. E. BÖSCH,[‡]
B. DE MEESTER,[†] G. VAN DER VORST,[†]
H. VAN LANGENHOVE,[†] S. HELLWEG,[‡]
AND M. A. J. HUIJBREGTS[§]

ENVIRONMENTAL
Science & Technology

ACS AuthorChoice

Policy Analysis

pubs.acs.org/est

Rethinking the Area of Protection “Natural Resources” in Life Cycle Assessment

Jo Dewulf,^{*,†,‡} Lorenzo Benini,[†] Lucia Mancini,[†] Serenella Sala,[†] Gian Andrea Blengini,^{†,§}
Fulvio Ardente,[†] Marco Recchioni,[†] Joachim Maes,[†] Rana Pant,[†] and David Pennington[†]

Resources, Conservation & Recycling 202 (2024) 107363



ELSEVIER

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec



Full length article

Contribution to inaccessibility as resource impact method: A base for sustainable resource management along the life cycle


J. Dewulf^{a,b,*}, A. Beylot^a, D. Monfort^a, F. Lai^a, J. Santillan Saldivar^a, Stéphanie Muller^a,
F. Mathieux^c

SOME KEY PAPERS


Resource criticality

Resources Policy 53 (2017) 12–19


Contents lists available at ScienceDirect

 **Resources Policy**

journal homepage: www.elsevier.com/locate/resourpol




EU methodology for critical raw materials assessment: Policy needs and proposed solutions for incremental improvements



Gian Andrea Blengini^{a,c,*}, Philip Nuss^a, Jo Dewulf^{a,d}, Viorel Nita^a, Laura Talens Peirò^a, Beatriz Vidal-Legaz^a, Cynthia Latunussa^a, Lucia Mancini^a, Darina Blagoeva^b, David Pennington^a, Mattia Pellegrini^c, Alexis Van Maercke^c, Slavko Solar^c, Milan Grohol^c, Constantin Ciupagea^a

Resources Policy 50 (2016) 169–176

Contents lists available at ScienceDirect

 **Resources Policy**

journal homepage: www.elsevier.com/locate/resourpol



Criticality on the international scene: Quo vadis?




Jo Dewulf^{a,b,*}, Gian Andrea Blengini^{a,c}, David Pennington^a, Philip Nuss^a, Nedal T. Nassar^d

The International Journal of Life Cycle Assessment
<https://doi.org/10.1007/s11367-025-02439-6>

LIFE CYCLE SUSTAINABILITY ASSESSMENT



CriticS: a resource criticality characterization method for life cycle assessment considering stakeholders' perspectives

Isadora C. Hackenhaar¹  · Gustavo Moraga^{1,6} · Gwenny Thomassen^{1,2,3} · Sue Ellen Taelman^{1,4} · Till M. Bachmann⁵ · Jo Dewulf¹

SOME KEY PAPERS

From LCA towards LCSA

Sustainable Production and Consumption 45 (2024) 509–524



ELSEVIER

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc



Review article

A comprehensive framework covering Life Cycle Sustainability Assessment, resource circularity and criticality

Isadora C. Hackenhaar^{a,*}, Gustavo Moraga^a, Gwenny Thomassen^{a,b,c}, Sue Ellen Taelman^a, Jo Dewulf^a, Till M. Bachmann^d

Journal of Cleaner Production 467 (2024) 142978



ELSEVIER

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



A holistic framework for integrated sustainability assessment of pharmaceuticals



Renewable and Sustainable Energy Reviews 138 (2021) 110666



ELSEVIER

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: <http://www.elsevier.com/locate/rser>



The path to sustainable energy supply systems: Proposal of an integrative sustainability assessment framework

A. Buchmayr^{a,b,*}, E. Verhofstadt^b, L. Van Ootegem^b, D. Sanjuan Delmás^a, G. Thomassen^{a,c}, J. Dewulf^a



SOME KEY PAPERS

Ecosystem services

The International Journal of Life Cycle Assessment
<https://doi.org/10.1007/s11367-023-02216-3>

REGIONAL TOPICS FROM EUROPE



Integrating ecosystem services and life cycle assessment: a framework accounting for local and global (socio-)environmental impacts

Sue Ellen Taelman¹ · Laura V. De Luca Peña¹ · Nils Pr at¹ · Till M. Bachmann² · Katrien Van der Blest³ · Joachim Maes⁴ · Jo Dewulf¹

Handprint

Journal of Cleaner Production 265 (2020) 121743



Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



A framework for using the handprint concept in attributional life cycle (sustainability) assessment

R.A.F. Alvarenga^{a,*}, S. Huysveld^a, S.E. Taelman^a, S. Sfez^{a,b}, N. Pr at^a, M. Cooreman-Algoed^a, D. Sanjuan-Delm as^a, J. Dewulf^a



Applied Energy 353 (2024) 122123



Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy



Monetized (socio-)environmental handprint and footprint of an offshore windfarm in the Belgian Continental Shelf: An assessment of local, regional and global impacts

Laura Vittoria De Luca Pe a^{a,*}, Sue Ellen Taelman^a, Bilge Bas^{a,b}, Jan Staes^c, Jan Mertens^{d,e}, Julie Clavreul^f, Nils Pr at^a, Jo Dewulf^a

SOME ONGOING PROJECTS:

SUSTAINABLE AGRO/AQUA – BIO/FOOD/FEED

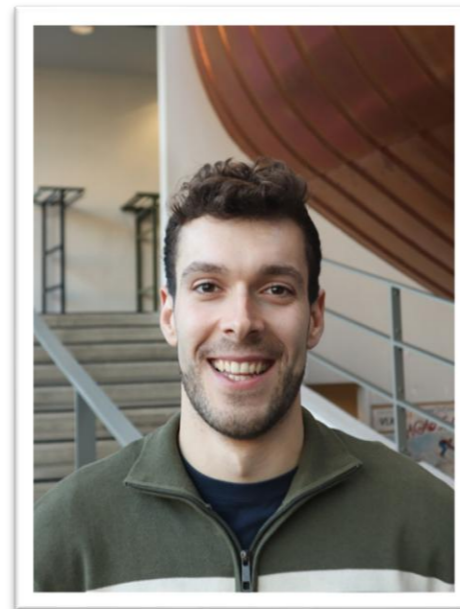
PROJECT: ESCIB (2023-2027) – PHD CRISTIAN PÉREZ

ESCIB – Developing Environmental Sustainability and Circularity Assessment Methodologies for Industrial Bio-Based Systems

Objective:

The main objective is to support the sustainability of the bio-based economy in Europe.

The aim is to develop a comprehensive, robust and fully operational methodology to assess the sustainability of bio-based systems at various technology-readiness levels (TRLs).



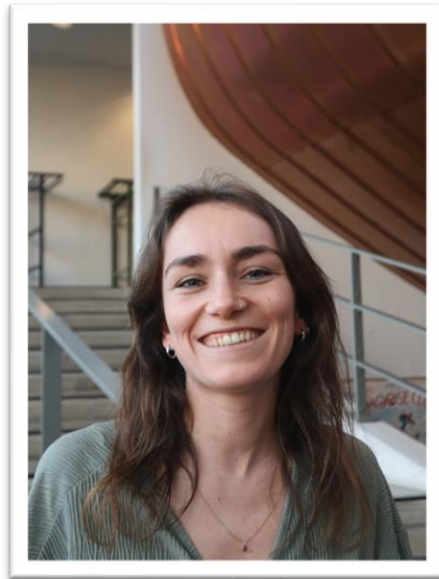
PhD of Cristian
Pérez Hernández

WP4:

CURRENT ACTIVITY:

- Critical review and selection of the most appropriate circularity assessment methods and indicators – under review
- Key elements: renewability, where closing loops, cascading ..

PROJECT: SUSFOODBEL – PHD CLAIRE DÉNOS (2023-2027)

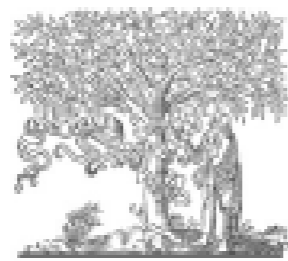


Objective:

The project aims to identify priority policies impacting on the food environment (i.e. the interface where people interact with the wider food system to acquire and consume foods) and their dietary trajectory scenarios (i.e. reducing animal protein intakes, increasing fruit and vegetable intakes, among others). All this with eventual goal to create sustainable healthy diets in Belgium.

PhD of Claire Dénos

Sustainable Production and Consumption 51 (2024) 584–598



ELSEVIER

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc



sciensano

ULB
UNIVERSITÉ
LIBRE
DE BRUXELLES

GHENT
UNIVERSITY

Contribution of ultra-processed food and animal-plant protein intake ratio to the environmental impact of Belgian diets

Claire Dénos^{a,b,c,*}, Stefanie Vandevijvere^b, Lieselot Boone^a, Margot Cooreman-Algoed^a, Michiel De Bauw^{b,d}, Wouter M.J. Achten^c, Jo Dewulf^a

<https://www.susfoodbel.be/>

PROJECT: FOODIMAR (2024-2028) – PHD IRIS ABRIGO

FOODIMAR – sustainable climate-Friendly quality fOOD Ingredients from Marine side-stReams



PhD of Iris Joy Abrigo

Objective:

FOODIMAR aims to reduce waste, enhance resource efficiency, and contribute to a resilient and environmentally friendly food system. The project envisions a future where aquatic resources are utilized to their fullest potential, creating economic opportunities while addressing environmental challenges.

Main activities:

- To evaluate the sustainability, including positive and negative environmental, economic, and social impacts, as well as the resource efficiency of the FOODIMAR proposed value chains.
- Target products: **collagen** and **glycosaminoglycans (GAGs)** from white fish and jellyfish.

PROJECT: BIOCHROMA (2024-2028) – PHD LAURA QUINECHE

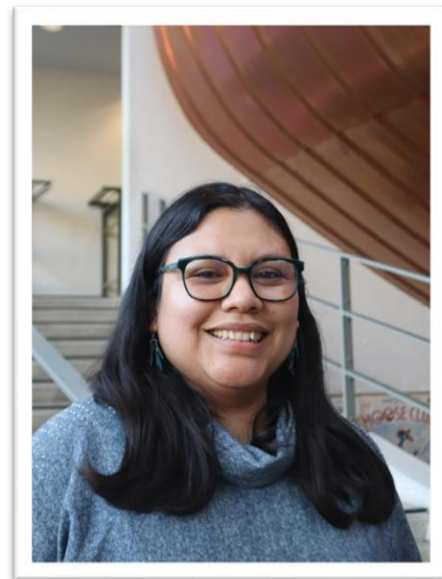
BioChroma – Exploring the functional potential of bacterial pigments for innovative food and feed applications

Objective:

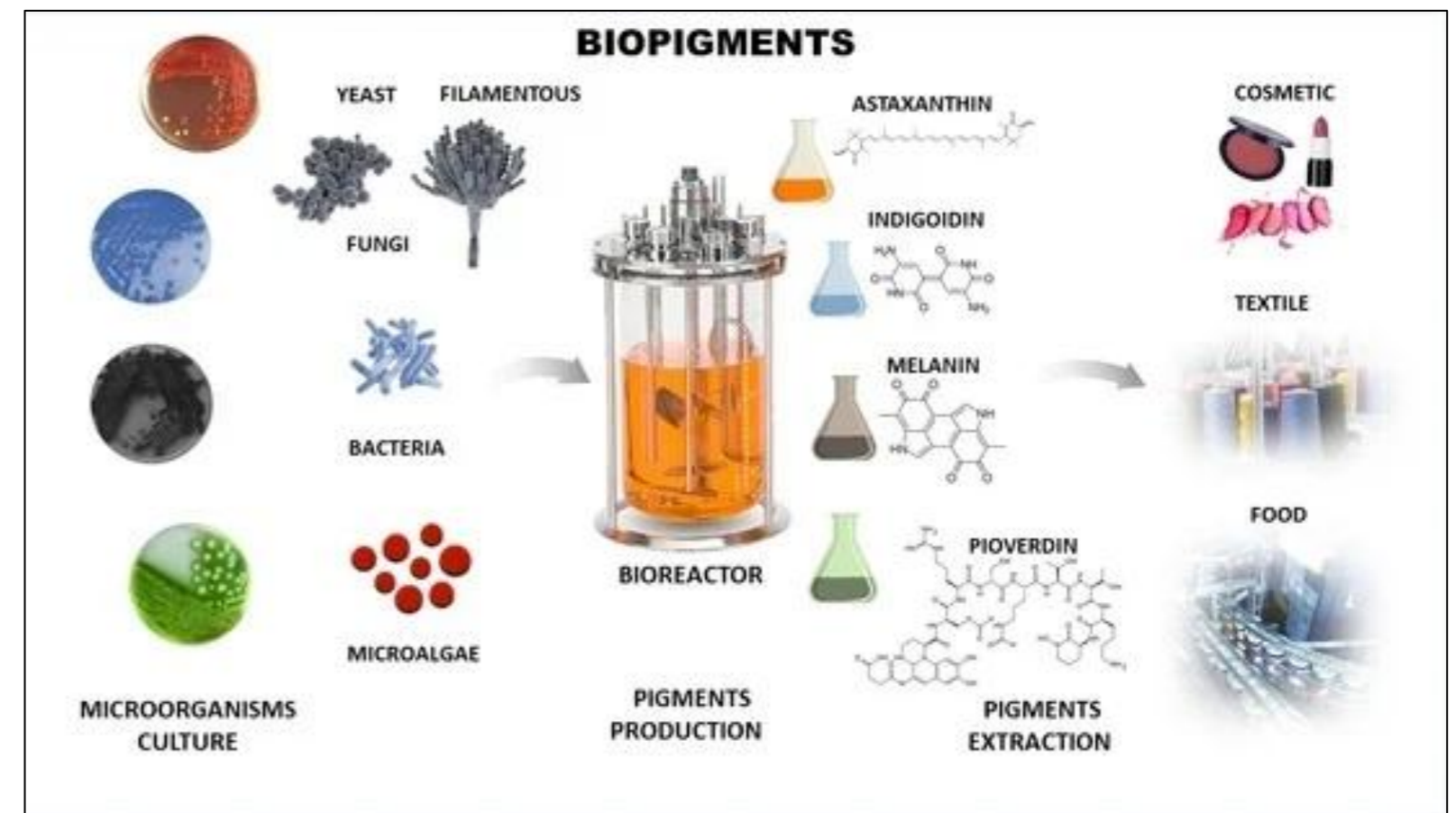
The BioChroma aims to expand the portfolio of microbial pigments for food and animal feed applications to include pigments that can meet market and consumer needs, taking into account the potential environmental benefits and drawbacks.

Main activities:

To evaluate the environmental impacts of bacterial pigments and benchmarks.



PhD of Laura Teresa Quineche Minaya



PROJECT: SUPROSEA (2024-2028) – PHD NORA SCHELTE

SUPROSEA – Sustainable Proteins from Seaweed in a Cascading Manner



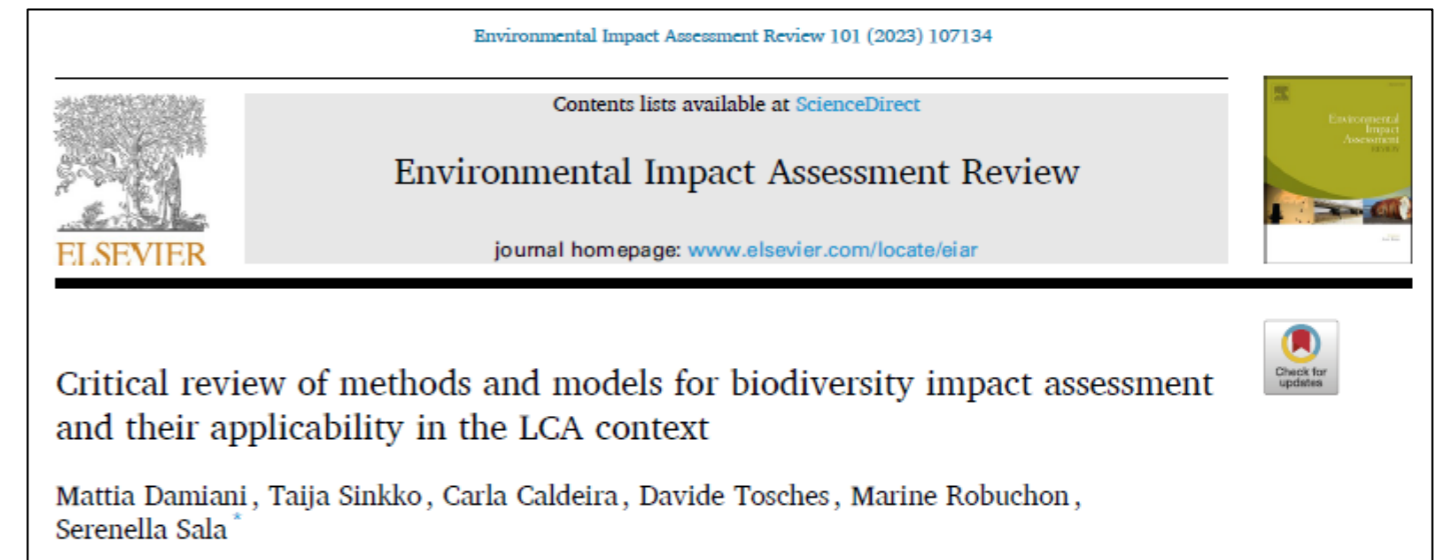
PhD of Nora Schelte

Objective:

SUPROSEA aims to assess the environmental sustainability and profitability of a novel seaweed value chain with a focus on proteins. Here, aquatic protein-rich biomass, i.e., different species of green, red, and brown seaweeds, will be considered for the extraction of proteins and other high-value compounds such as pigments for the food and feed industry.

Main activities:

- Alternative proteins.
- Prospective LCA.
- Marine biodiversity.

A screenshot of a journal article page from Environmental Impact Assessment Review. The page title is "Environmental Impact Assessment Review 101 (2023) 107134". It features the Elsevier logo and the journal title "Environmental Impact Assessment Review" with the URL "www.elsevier.com/locate/eiar". The article title is "Critical review of methods and models for biodiversity impact assessment and their applicability in the LCA context" by Mattia Damiani, Taija Sinkko, Carla Caldeira, Davide Tosches, Marine Robuchon, and Serenella Sala. There is a "Check for updates" button in the bottom right corner.

Environmental Impact Assessment Review 101 (2023) 107134

Contents lists available at ScienceDirect

Environmental Impact Assessment Review

journal homepage: www.elsevier.com/locate/eiar

Critical review of methods and models for biodiversity impact assessment and their applicability in the LCA context

Mattia Damiani, Taija Sinkko, Carla Caldeira, Davide Tosches, Marine Robuchon, Serenella Sala*



[More info](#)

Funding: FWO-Flanders

ONGOING PROJECTS:

CHEMICALS

NEED FOR NEW CHEMICAL FEEDSTOCKS:

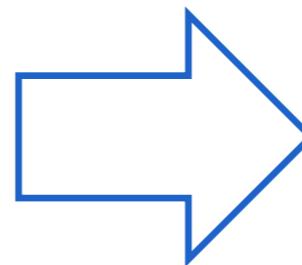
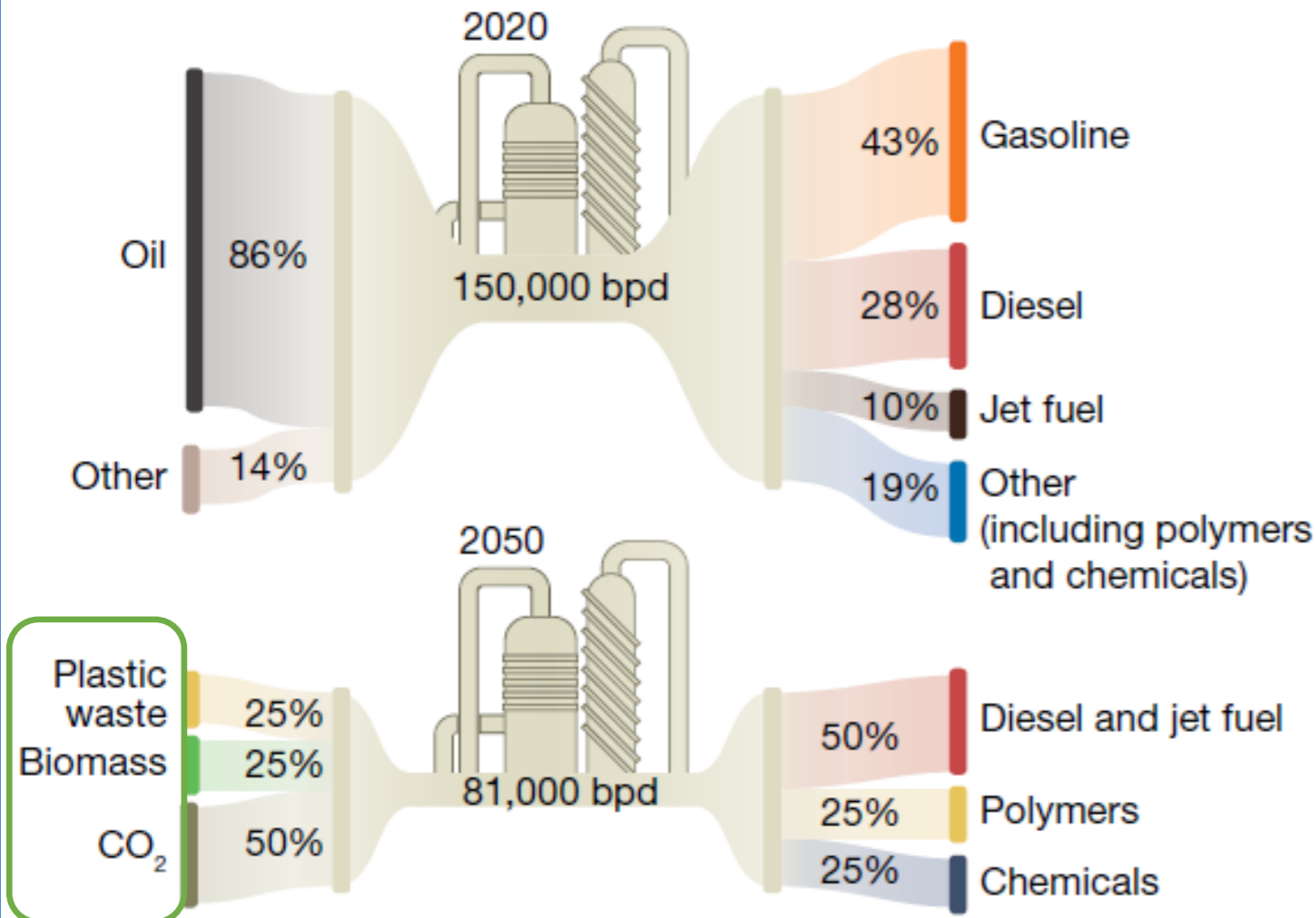
Context: search for alternatives for fossils:

- Plastic waste
- Biomass
- CO₂

Perspective

The refinery of the future

<https://doi.org/10.1038/s41586-024-07322-2> Eelco T. C. Vogt¹ & Bert M. Weckhuysen¹



EU-Horizon project: C123 Bilateral projects: Engie

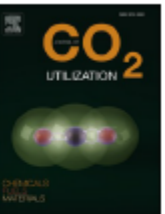
Journal of CO₂ Utilization 88 (2024) 102949

Contents lists available at ScienceDirect



Journal of CO₂ Utilization

journal homepage: www.elsevier.com/locate/jcou



CO₂ valorisation from lime production via Columbus process to produce E-methane for transport sector – A comprehensive life cycle assessment

Jordy Motte^{a,*}, Erasmo Cadena^a, Yblin Roman Escobar^a, Jim Gripekoven^b, Koen Vlaeminck^c, Friso De Clercq^d, Pierre-Olivier Cambier^d, Nathalie Van Den Bogaert^d, Brecht De Roo^d, Jan Mertens^{e,f}, Jo Dewulf^a

Journal of Cleaner Production 380 (2022) 135033

Contents lists available at ScienceDirect



Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Comparative life cycle assessment of power-to-methane pathways: Process simulation of biological and catalytic biogas methanation

Freya Goffart De Roeck^{a,*}, Astrid Buchmayr^a, Jim Gripekoven^b, Jan Mertens^{c,d}, Jo Dewulf^a



PROJECT: CAMELEON (2024-2028)

Cameleon – Electrified catalytic non-oxidative methane coupling for separated hydrogen and ethylene production



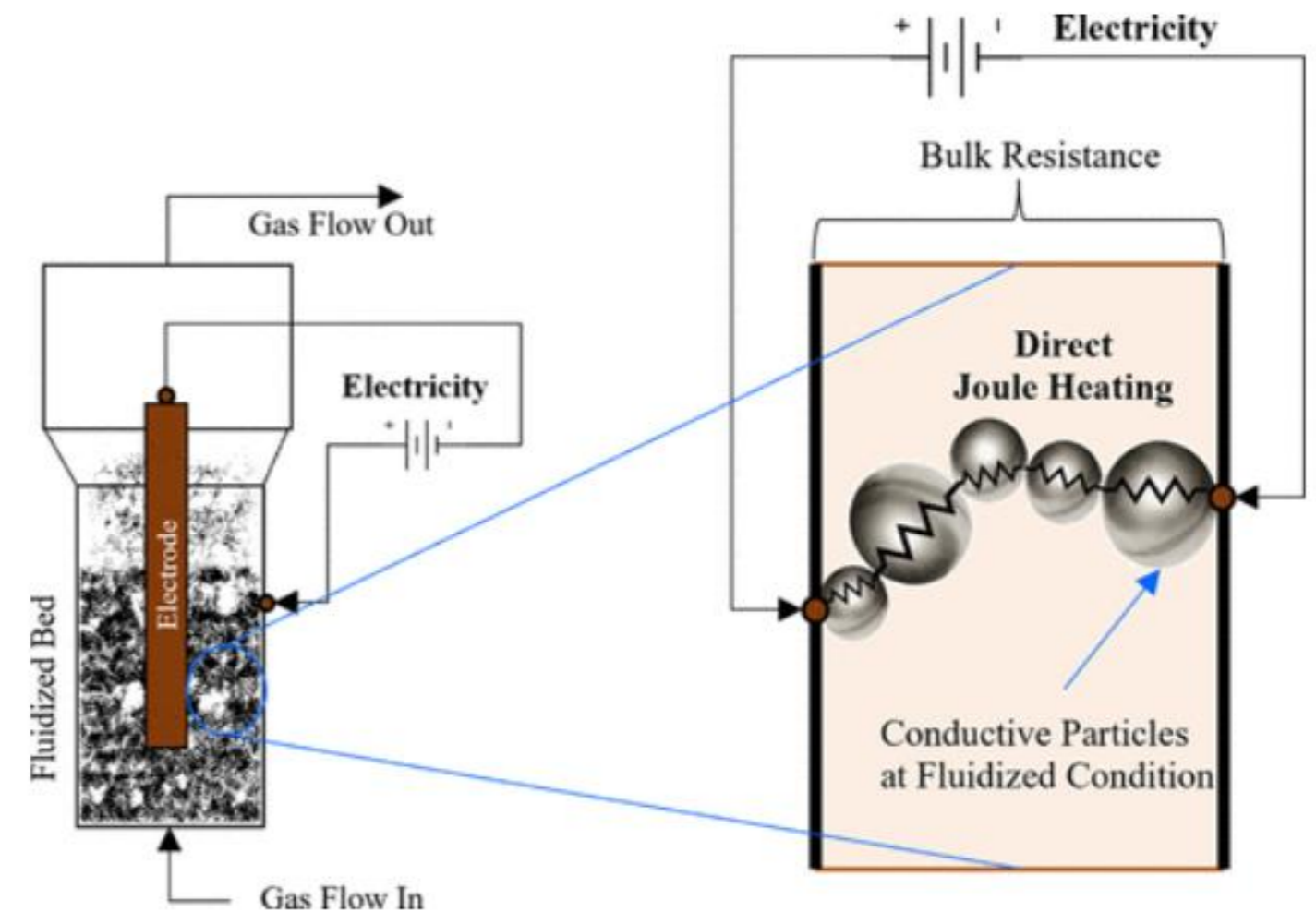
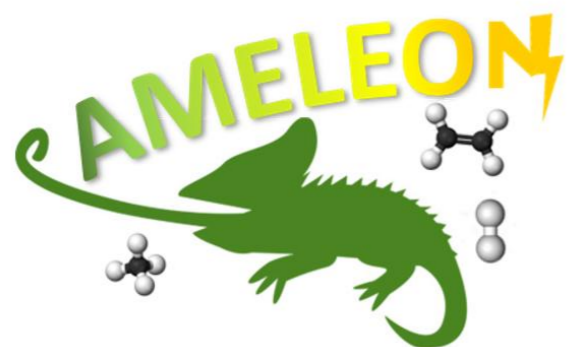
PhD of Mohammad
Lahafdoozian

Why Cameleon?

The chemical sector releases a considerable amount of CO₂ emissions and consumes large quantities of fossil resources. A transition to more sustainable chemicals production (e.g., ethylene and hydrogen) through electrification is urgently needed.

Main activities:

- Develop a model for an electrified fluidized bed reactor to produce ethylene and hydrogen using user defined functions
- Assess the environmental impacts and economic feasibility of this novel process concept



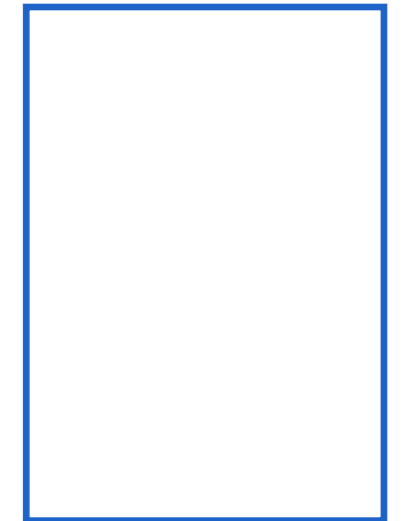
(Ahmed et al., 2024)

Funding: VLAIO (Moonshot project)

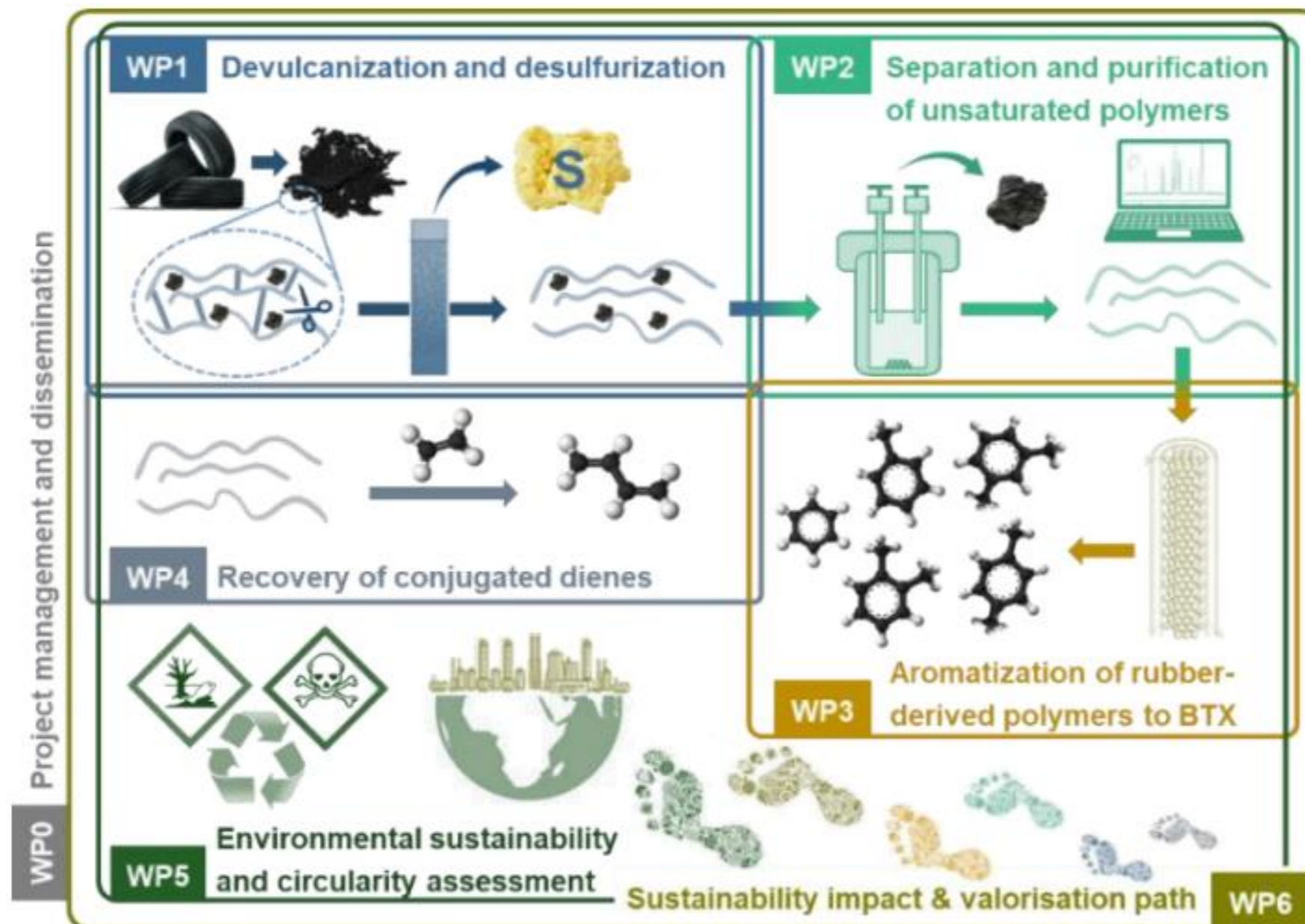
PROJECT: RUB-UP (2026-2030)

Advanced Recycling of Waste Tyres via Devulcanization and Chemical Valorization for Sustainable Material Recovery

Dr. Jordy Motte



Dr. Jordy Motte PhD student to be hired



- **Task 5.3:** Developing flow sheets and construction of mass and energy balances for waste tyre recycling at industrial scale
- **Task 5.5:** Assessing the circularity of RUB-UP value chain at industrial scale
- **Task 6.1:** Sustainability assessment based on the provided MOONSHOT tool

ONGOING PROJECTS:

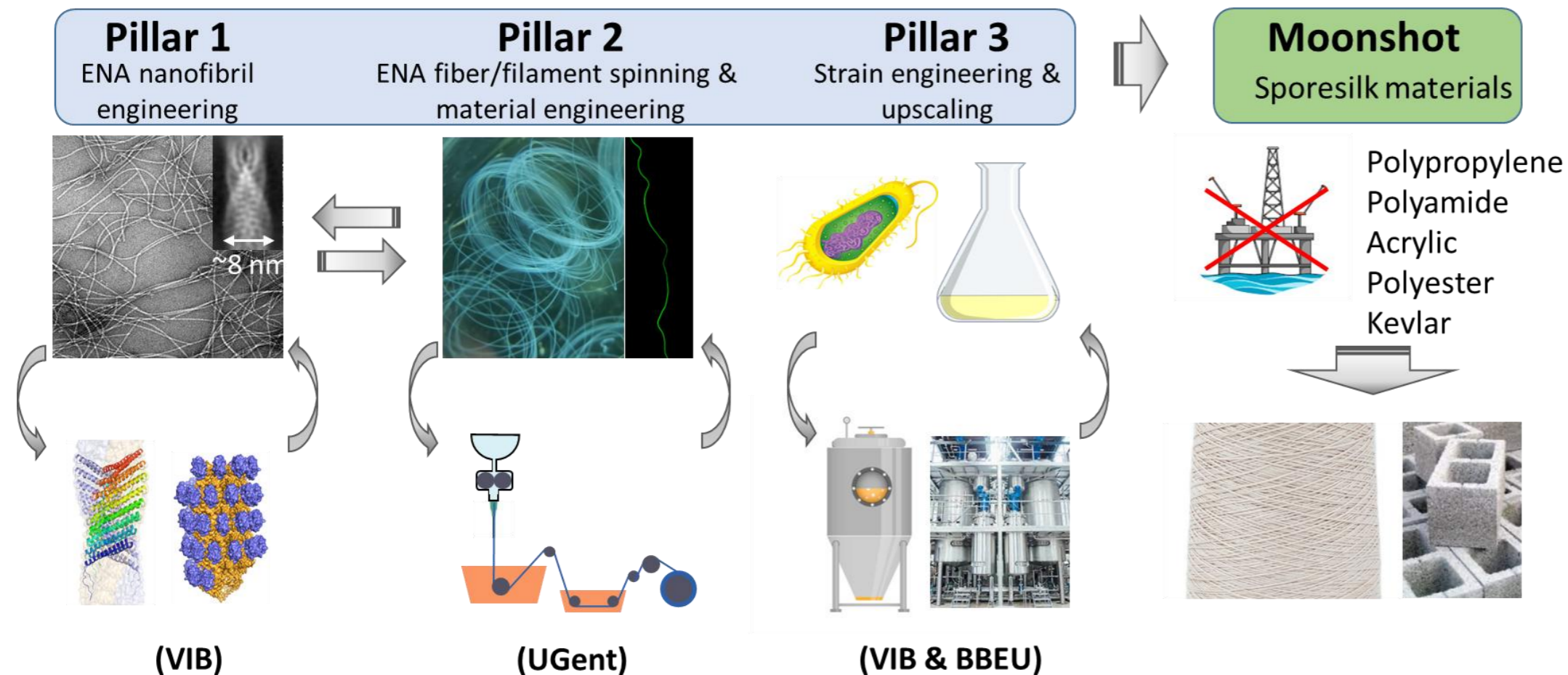
TEXTILES

FLEMISH: HIPPROFIB (2024-2028)

High Performance Protein Fiber materials:

Dr. Sophie Huysveld

Dr. Trang Thuy Nhu



- **Task 1.5:** Optimization of a circular value chain at the feedstock level
- **Task 2.5:** Assessing circular end-of-life strategies for Sporesilk materials and spinning solvents
- **Task 5.1:** Sustainability assessment based on the provided MOONSHOT tool

ONGOING PROJECTS:

PHARMA & HEALTH CARE

PROJECT: DICE (2022-2026):

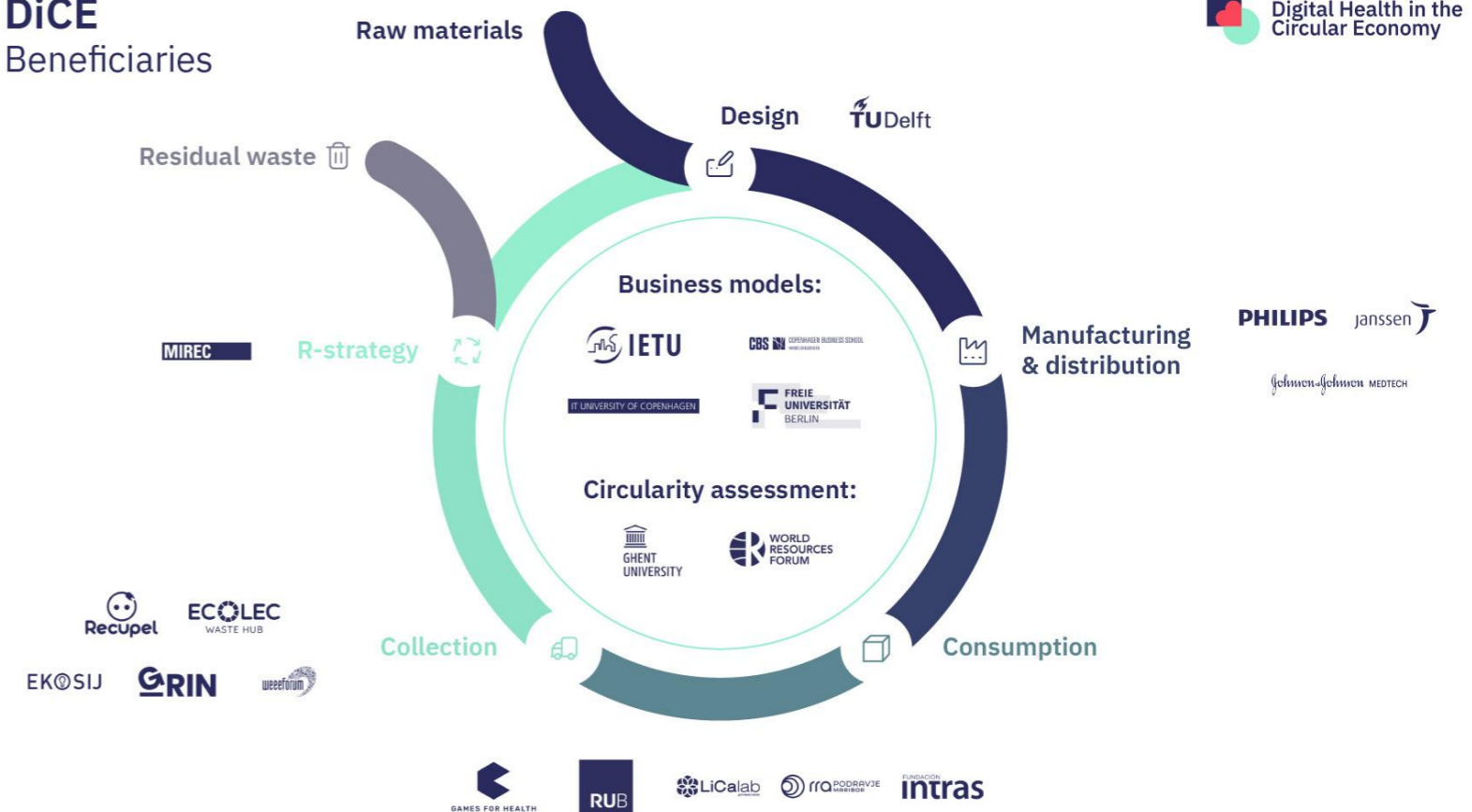


PhD of Naomi Muindi

Why DiCE?

Electronic waste (e-waste) from digital health devices is a complex and growing problem requiring a holistic solution. E-waste from healthcare products may pose biological or chemical contamination, leading to its incineration, with or without energy recovery. This means that all items are destroyed.

DiCE Beneficiaries



Main activities:

- To calculate the circularity performance for smart digital health devices.
- To calculate the economic, social and environmental impacts for each of the DICE solutions, considering the entire value chain.

Funding: EU Horizon

HORIZON PROJECT: TRANSPHARM (2022-2026)

Objective:

The aim of the project is to contribute to a more independent and competitive European pharmaceutical industry, which can ensure the timely delivery of sustainable and green therapeutics.

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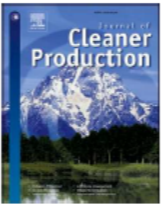
Contents lists available at ScienceDirect

Journal of Cleaner Production

ELSEVIER journal homepage: www.elsevier.com/locate/jclepro

A holistic framework for integrated sustainability assessment of pharmaceuticals

Lisa Van Wilder^{a,b,*}, Lieselot Boone^{a,1}, Ad Ragas^c, Caroline Moermond^d, Lowik Pieters^e, Aissa Rechlin^f, Rodrigo Vidaurre^f, Delphine De Smedt^{b,2}, Jo Dewulf^{a,2}



Motte et al.: Multicomponent ecotoxicity
In preparation



<https://transforming-pharma.eu/>

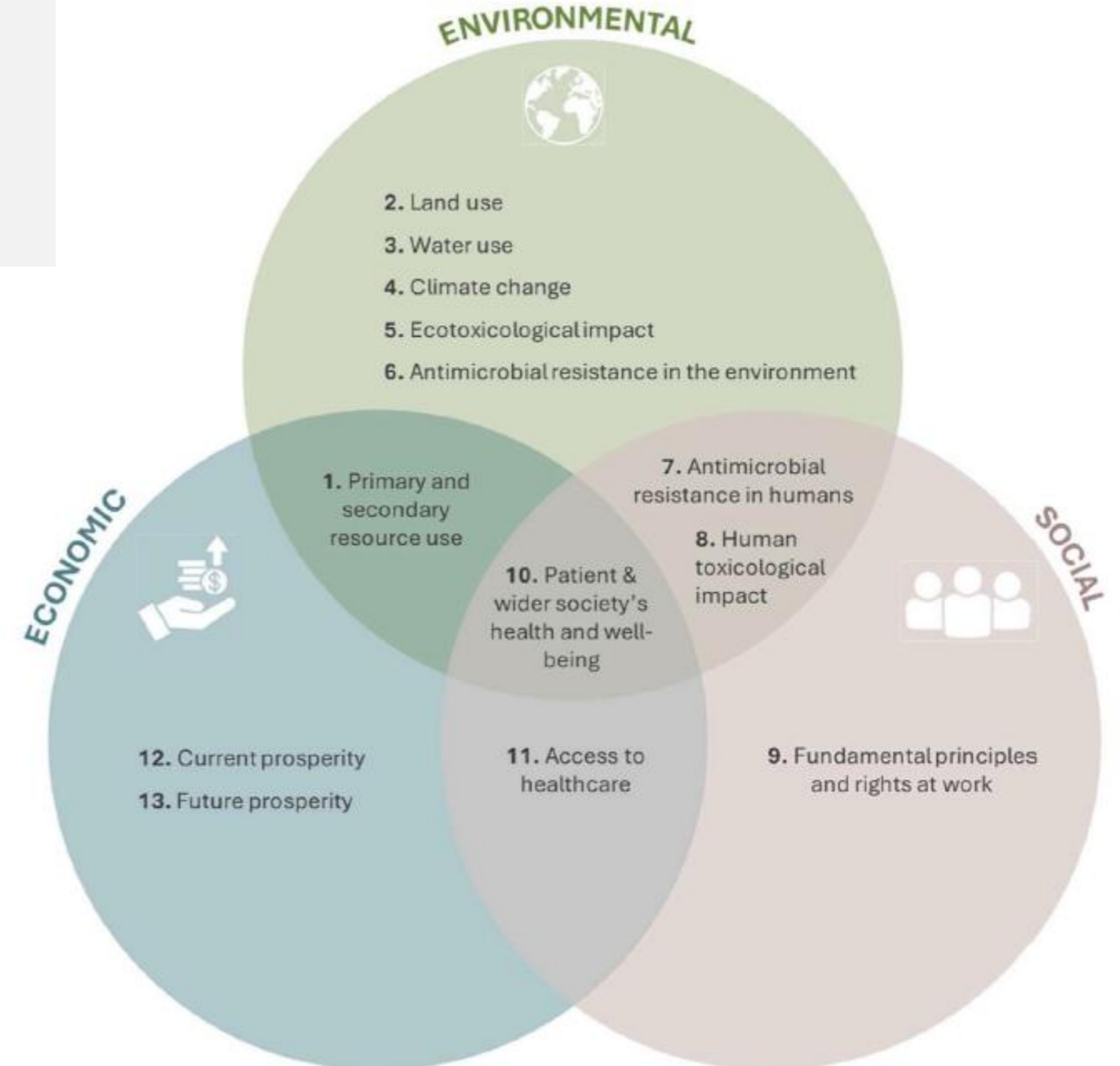


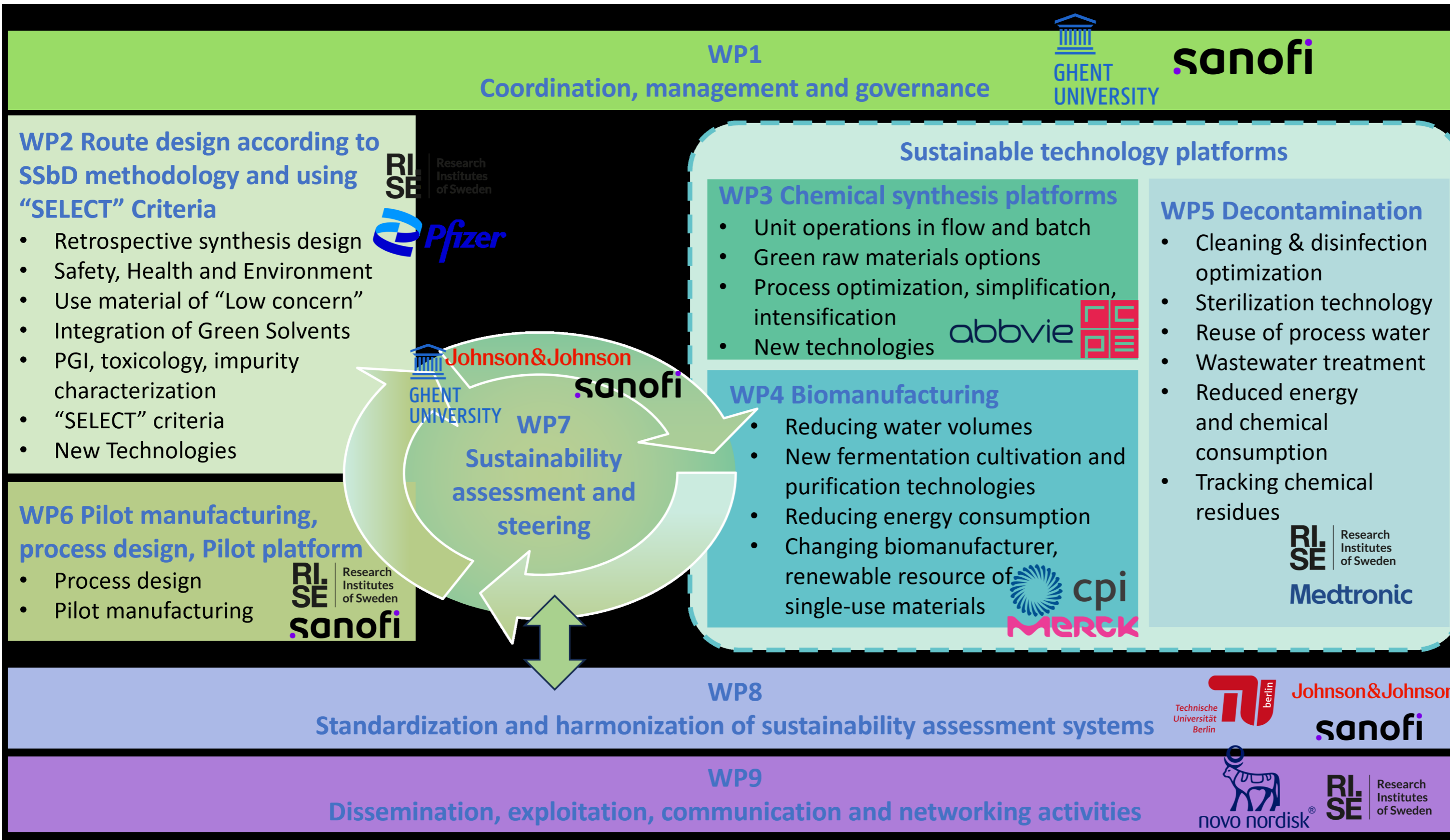
Fig. 3. Overview of the impact categories considered in the holistic framework to analyse the overall sustainability of pharmaceuticals.

PHARMECO, 45 MEURO PROJECT (2024-2030):

Main Objectives:

- To evaluate **environmental sustainability** of **innovative** (bio)manufacturing and decontamination **technologies and pharmaceuticals**, from a cradle-to-gate and eventually an end-to-end perspective.
- To evaluate **sustainability** of pharmaceuticals from an **end-to-end integrated perspective**, encompassing **environmental, economic, societal** impacts as well as **circularity** and **criticality**.
- To develop AI-driven **prediction models** for **prospective assessment** of sustainable pharmaceutical production.

PHARMECO, 45 MEURO PROJECT (2024-2030):





ONGOING PROJECTS:

RAW MATERIALS

PROJECT: DEER (2024-2028)

DEER – Demand-side measures to Enhance well-being and foster Environmental footprint Reduction

	Definition	Examples
Supply-side policies 	Policies to increase efficiency or reduce emissions from production or energy generation. Aimed at upstream producers and energy companies.	Carbon taxes applied at point of emission; subsidies for low-carbon innovation.
Demand-side policies 	Policies to encourage the adoption of climate-friendly technology or behaviours. Aimed at individuals or consumer-facing firms.	Subsidy schemes for heat-pumps; initiatives to encourage use of public transport.



PhD of Paulien Meese

Objective:

In the DEER project, the effects of demand-side measures on human well-being will be analysed from an environmental, social, economic and policy perspectives.

Products/services related to thermal comfort and mobility in the region of Flanders will be selected.

Sufficiency levels for the human needs will be defined and quantified. Applicable demand-side measures will be identified and their impact on carbon and material footprints of the selected needs will be assessed. In parallel, for the selected demand-side measures, economic and social assessments will be performed, including the analysis of consumers' willingness to adapt.

Funding: FWO-Flanders

PROJECT: RESILEX (2022-2026)

RESILEX – Resilient Enhancement for the Silicon industry Leveraging the European matrix

Objective:

RESILEX aims to improve the resilience and sustainability of silicon and other critical raw material (CRM) value chains for solar panel production in Europe. The consortium will develop technological solutions for reusing Silicon, recycling PV modules, designing new products (e.g., Si-anode for Li-ion battery) and to identify pathways to reduce the environmental impact of Solar Panel production.

Main activities:

- Environmental LCA of the innovation technologies.
- Circularity and criticality of recycling technologies.



RESEARCH AT SECTOR LEVEL: ENERGY SECTOR

PROJECT CRENMAT (2023-2027):

Critical Raw Materials for an energy company facing the energy transition



PhD of Justine Mast

Main activities:

- Analyse state-of-the-art literature around material criticality for the energy sector facing the energy transition.
- Develop a criticality framework from a clean energy technology company's point of view including:
 - Forward-looking.
 - Supply chain analysis.
- Test framework with use cases.

PROJECT: RAWCLIC (2024-2028)

RAWCLIC – future RAW materials demand, supply and sustainability in the face of CLimate Change

Objective:

RAWCLIC's main goal is to develop knowledge on the future **RM**s demand, supply and associated environmental impacts induced by the twin transition in the EU and to support fact-based industry- and policy- decision-making enabling this transition.

Support the EU in securing its access to the RMs necessary for the twin transition from primary (i.e., geological stocks) and secondary (urban mine) sources. RAWCLIC improves and expands existing models, and develops new ones, to assess and analyse the future demand, supply, and environmental effects associated with this transition.



PHD subject:

Future demand of raw materials for the energy transition and digitization in 2030, 2050, 2070.

OFF SHORE PROJECTS: COMPASS, DECOMPASS, ORESA

COMPASS - Comprehensive Offshore Management Platform for Assessing SuSustainability

Create an open, decision-support modular platform.
Holistically evaluating impacts across all scales and life phases of existing and future OWFs - integrating digital twins, environmental/social/economic assessments.

DECOMPASS – Decommissioning Compass for Offshore Wind)

Develop a decision-support “compass” for offshore wind decommissioning in Belgian North Sea covering removal techniques, logistics, LCA/circularity, ecological impacts.

ORESAS – Offshore Renewable Energy Sustainability Alliance

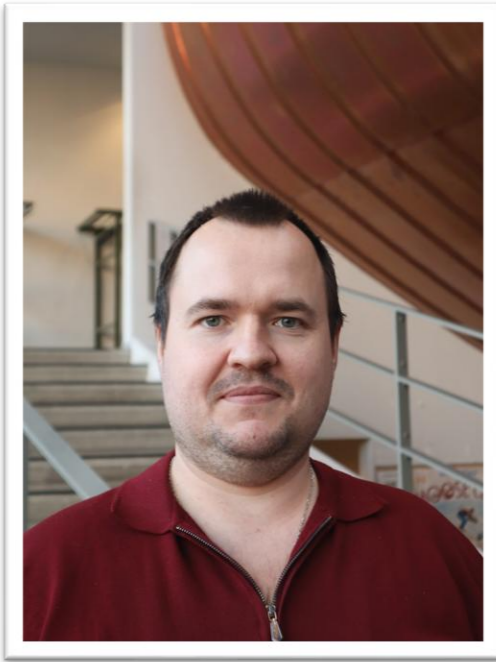
Build and pilot an offshore-sustainability accelerator for 25 SMEs across overarching themes (LCA & Circularity; Profitability; Nature-inclusive Design; Policy)



Funding: EU Horizon and INTERREG



RESEARCH PROJECT: HEAT PUMPS (2024-2028)



PhD of Valeriy Matveev

Towards Circular Design and Business Models for Sustainability of the next generation heat pumps

Mapping current material flows and level of circularity of HP:

- Component and material level
- Coverage upstream of manufacturing, manufacturing at Daikin, use (e.g. repair), and EoL.

Identification and design of innovative scenarios for new circular business strategies:

- Various potential R-strategies at the product, component and material level.
- Quantification in terms of the related MFAs, with prospective sustainability assessment.
- Proposal for decision support guidance on circular design for sustainability of the next generation HP.

EDUCATION AND TRAININGS

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Bachelor level:

[Process Engineering](#)

[Sustainable Development in Production and Consumption Systems](#)

[Smart Sensors](#)

[Process control](#)

Master level:

[Process Engineering 2](#)

[Environmental Impact Assessment \(EIA\)](#)

[Concepts for Sustainable Systems Engineering](#)

[Sustainability Assessment](#)

[Sustainable Systems Engineering](#)

[Integral Process Design](#)

Postgraduate level:

[UGain Environmental coordinator A](#) > Module Environmental Technology

On demand / tailor-made trainings

<https://cespe.be/2024/11/21/sten/> (e.g., LCA):

ITP training:

International Training Programme; environmental LCA training to Global South institutions.



Prof. Dr. ir. Jo Dewulf

Sustainable Systems Engineering Group

DEPARTMENT OF GREEN CHEMISTRY AND TECHNOLOGY

JO DEWULF

E jo.dewulf@ugent.be

T +32 9 264 59 49

PIETER NACHTERGAELE

E Pieter.Nachtergaele@ugent.be

T +32 56 29 26 00

www.ugent.be