

Algotech Platform : Microalgae and Cyanobacteria to a Circular Economy



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Département du développement Technologique



Wallonie Service public de Wallonie



LE FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL
ET LA WALLONIE INVESTISSENT DANS VOTRE AVENIR



Wallonie

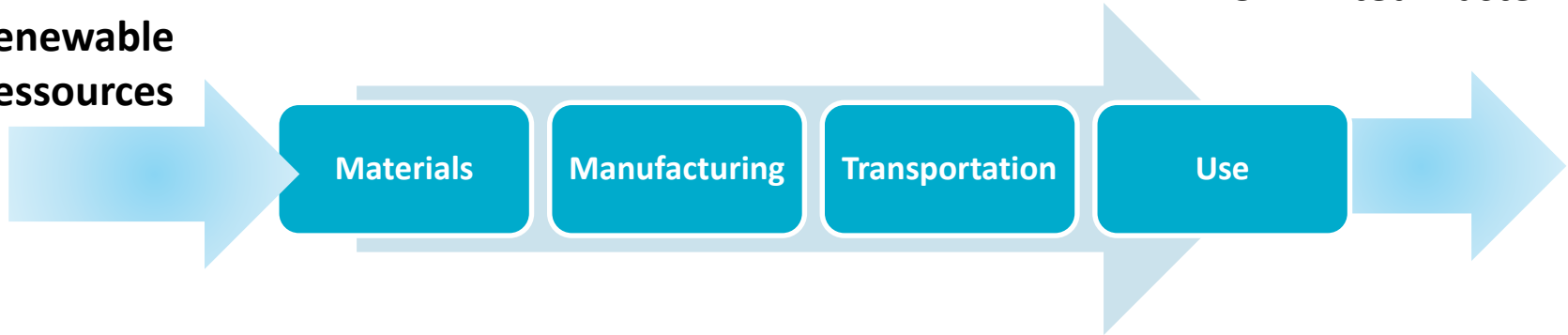
Circular economy - Definition

Conventional industrial process

« take, make, dispose »

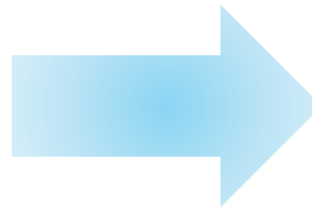
« Infinite » non-renewable resources

Unlimited waste



Circular economy :

2002 : « Cradle to Cradle » -
Michael Braungart and
William MacDonough



Sustainable principle:
Production Process including
Closed Recycling Loops based
on Ecosystem Organisation
(biomimetism)

OUTLINE OF A CIRCULAR ECONOMY

PRINCIPLE

1

Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows
 ReSOLVE levers: regenerate, virtualise, exchange



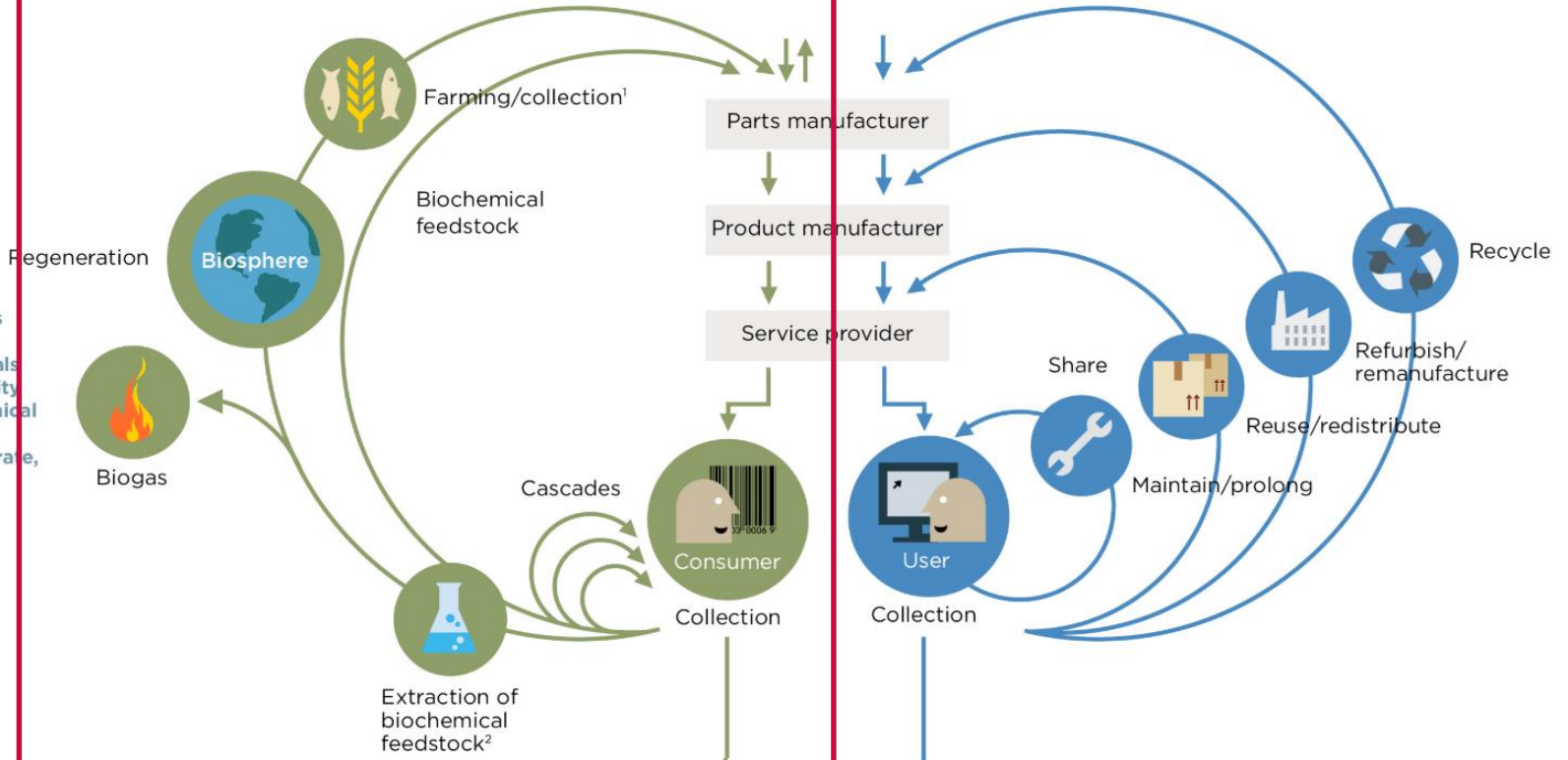
Renewables flow management

Stock management

PRINCIPLE

2

Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles
 ReSOLVE levers: regenerate, share, optimise, loop



PRINCIPLE

3

Foster system effectiveness by revealing and designing out negative externalities
 All ReSOLVE levers

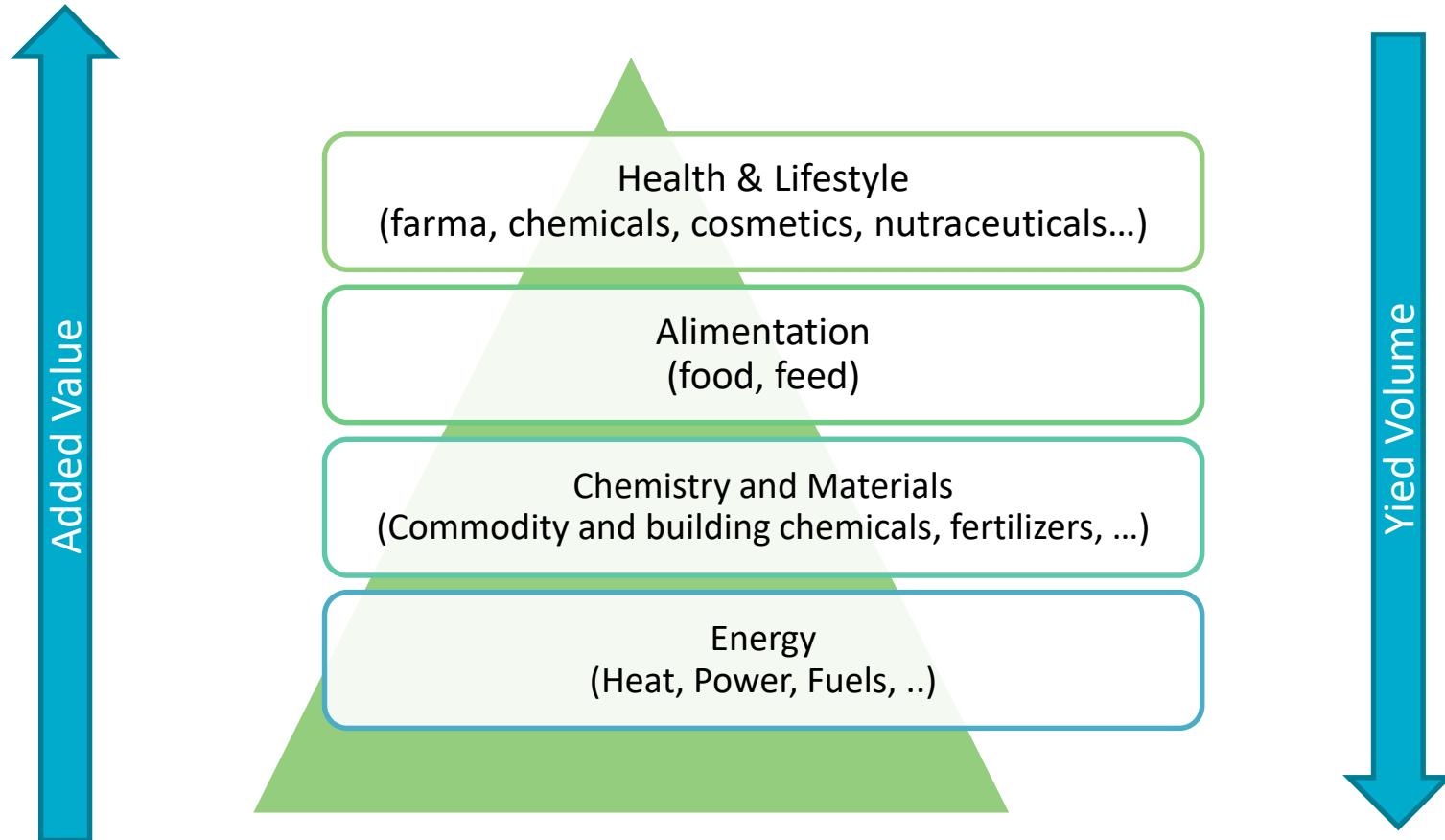
Minimise systematic leakage and negative externalities

Algotech

1. Hunting and fishing
 2. Can take both post-harvest and post-consumer waste as an input

Source: Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braungart & McDonough, Cradle to Cradle (C2C).

Value pyramid of biomass in a biorefinery concept



Industrial fields potentially covered with microalgae resources

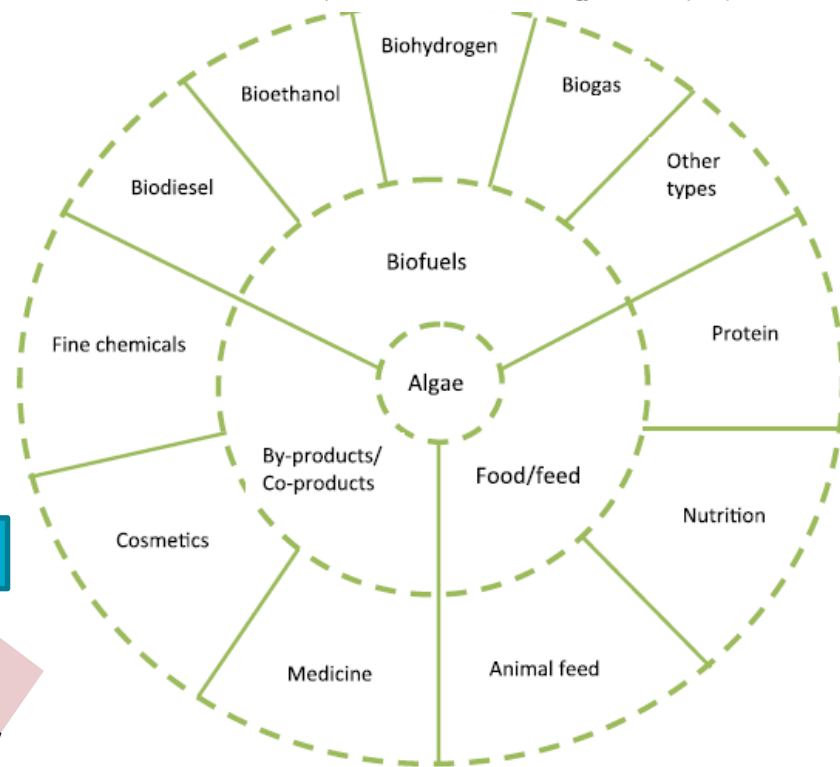
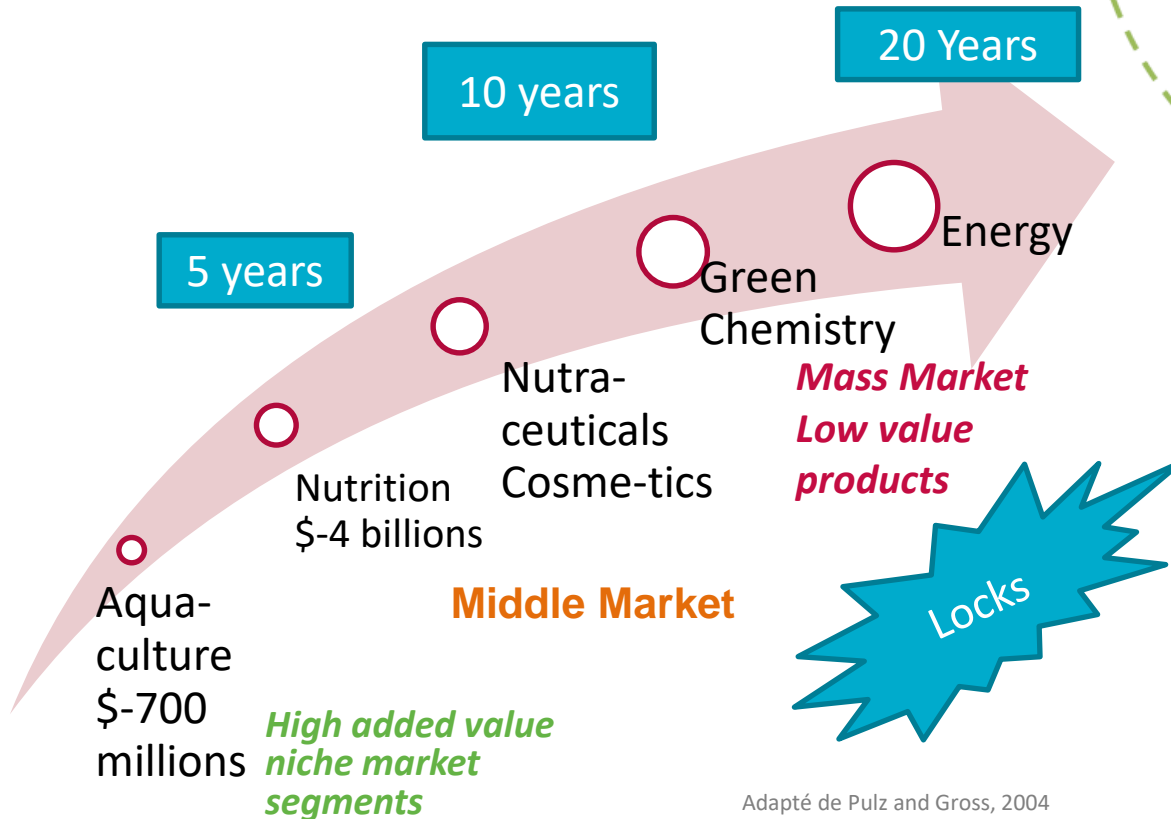


Fig. 4. Potential products from microalgae during biorefinery.



Adapté de Pulz and Gross, 2004

Value pyramid of biomass in a microalgal biorefinery concept

Phycobiliproteins
0.13 – 15 US\$/mg

Chlorophylle
 $1 \cdot 10^{-5}$ - $1 \cdot 10^{-4}$
US\$/mg

High Value Proteins
 $6.6 \cdot 10^{-6}$ US\$/mg DW

Polyunsaturated Fatty Acids
(PUFA's)
 $2.64 \cdot 10^{-6}$ US\$/mg

Carbohydrates for energy
 $1.32 \cdot 10^{-6}$ US\$/mg DW

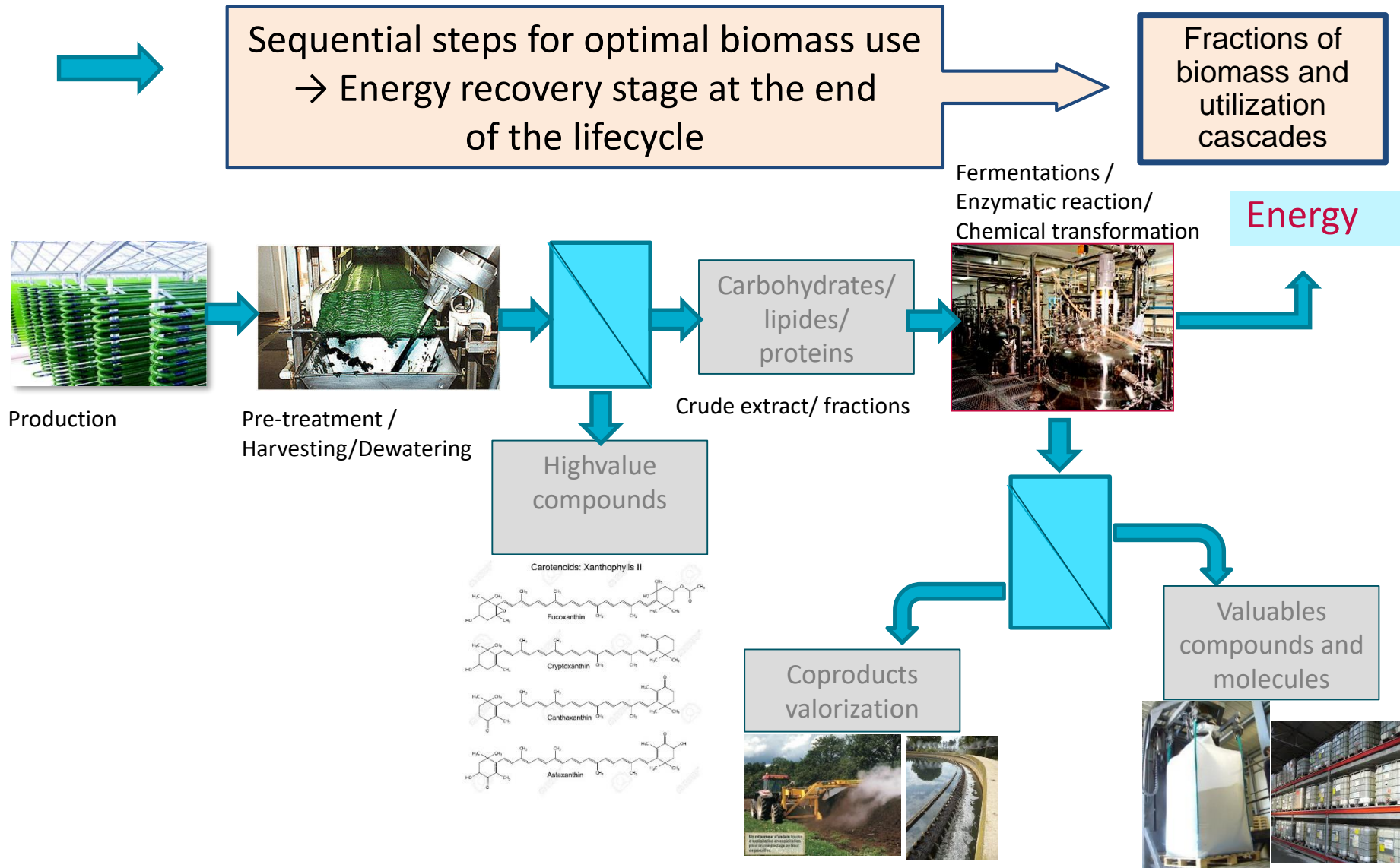
Bulk proteins
 $9.9 \cdot 10^{-7}$ US\$/mg DW

Lipids for energy
 $6.6 \cdot 10^{-7}$ US\$/mg DW

Ramirez & Olvera, 2006
Wijfels, Barbosa & Eppink, 2010

Mainstream Biorefinery with Microalgal Biomass

Cascad Principle



Microalgal Biorefinery and Circular Economy

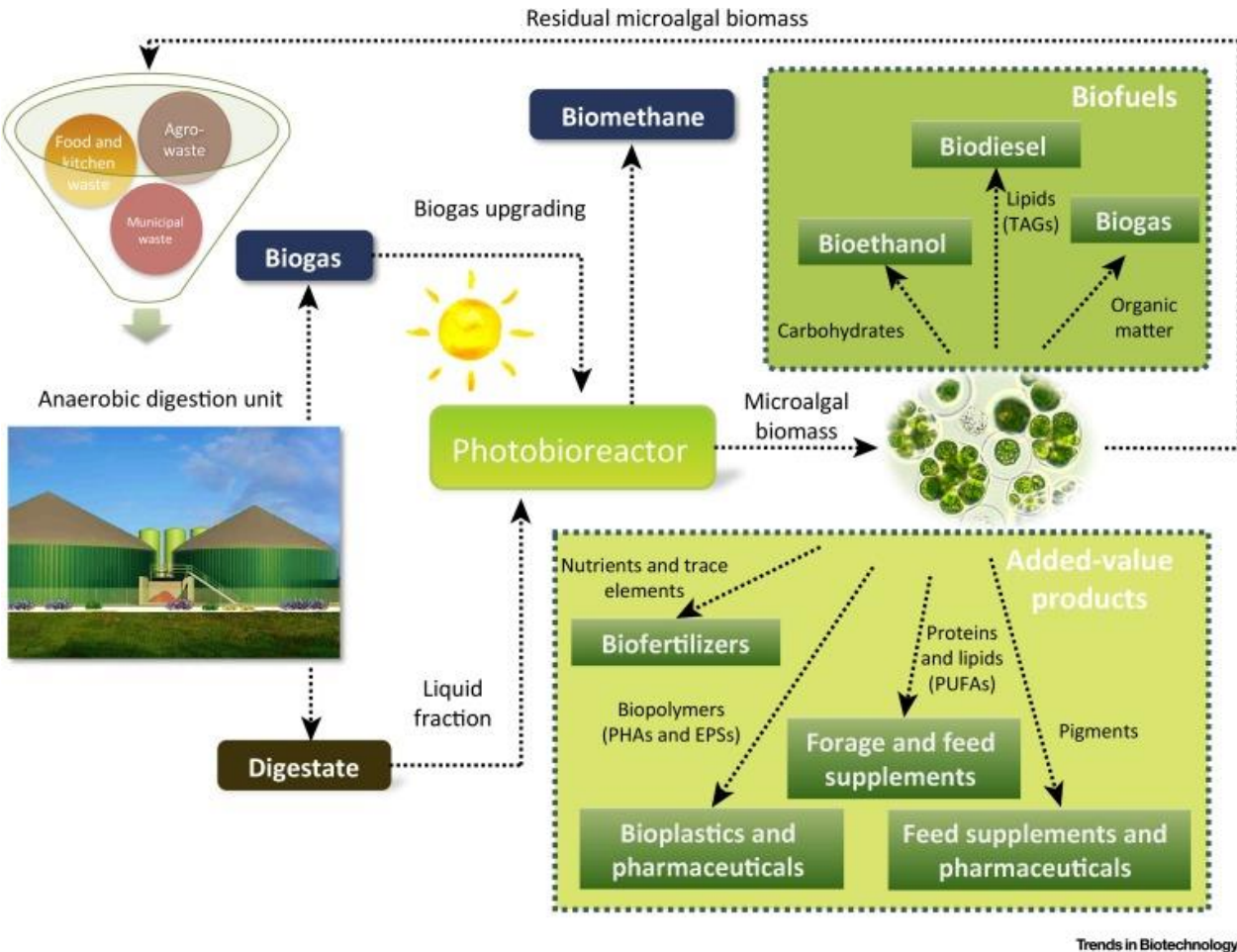
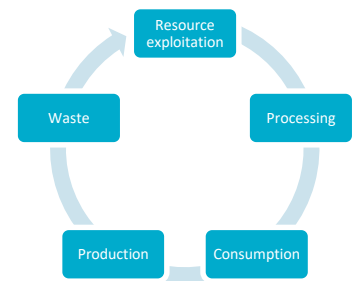
Microalgal biorefinery integrating recovery and recycling of gaseous and liquid effluents + by-products



Environmental Biorefinery

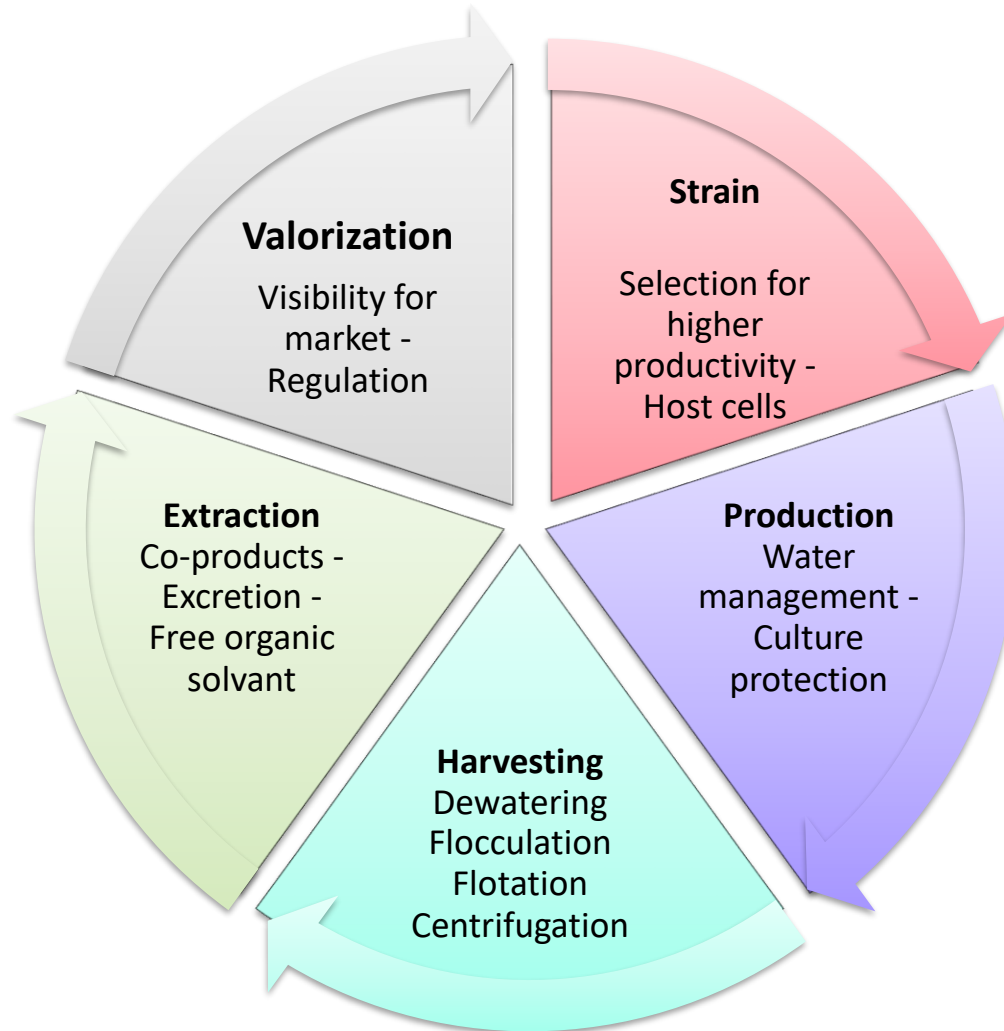


Biomass coproducts (human activities)



Trends in Biotechnology

Microalgae Biorefinery Barriers & Improvements





Chemical and Biochemical Process Engineering
 Automatic Control
 Proteomics and Microbiology
 Organic Chemistry
 Polymeric and Composite Materials

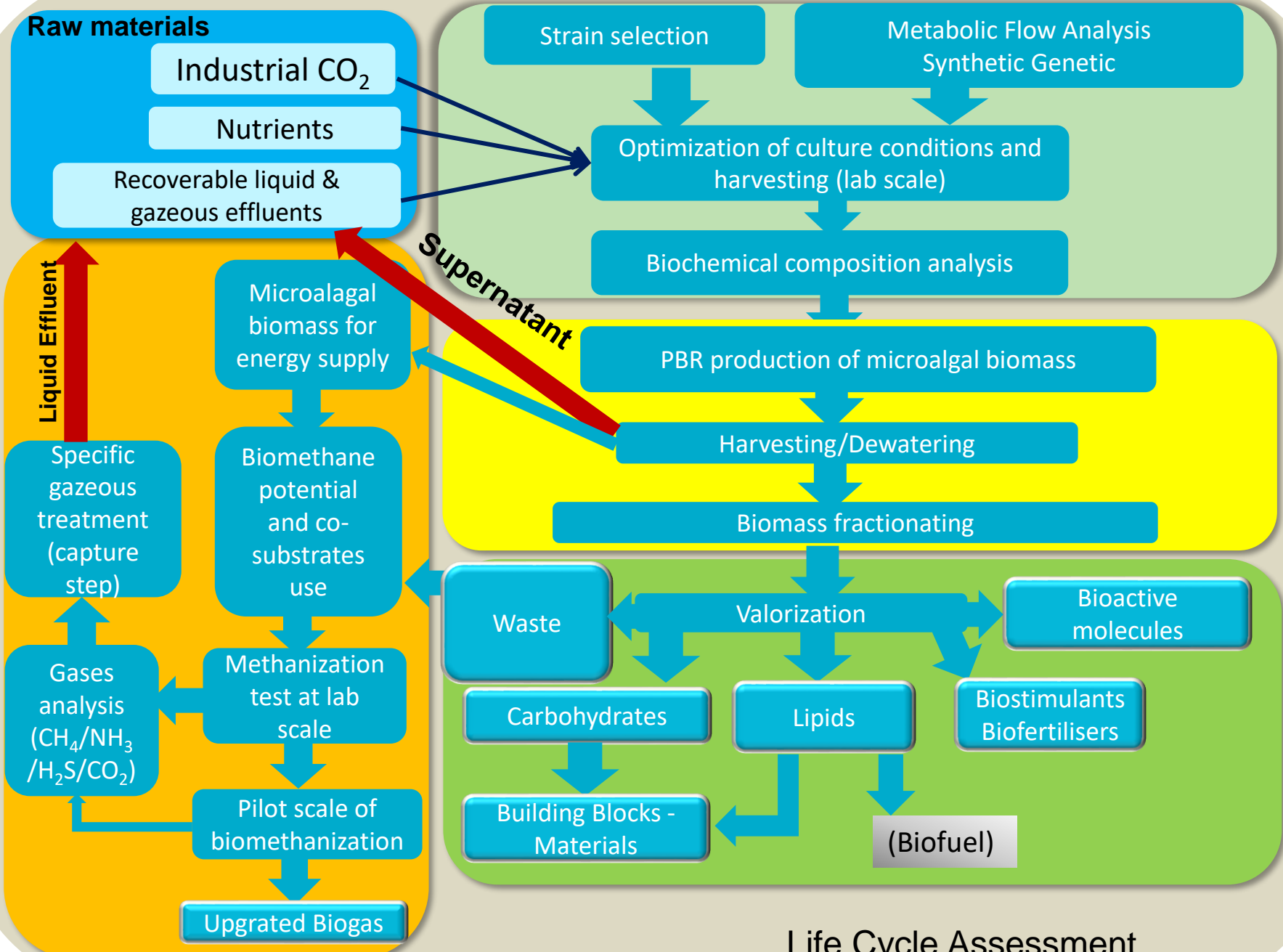


Institute of Molecular Biology and Medicine
 (Biopark Gosselies) : Molecular Cell Physiology
 & Bacterial Genetics and Physiology
 Institute for Environmental Management &
 Land-use Planning (IGEAT)

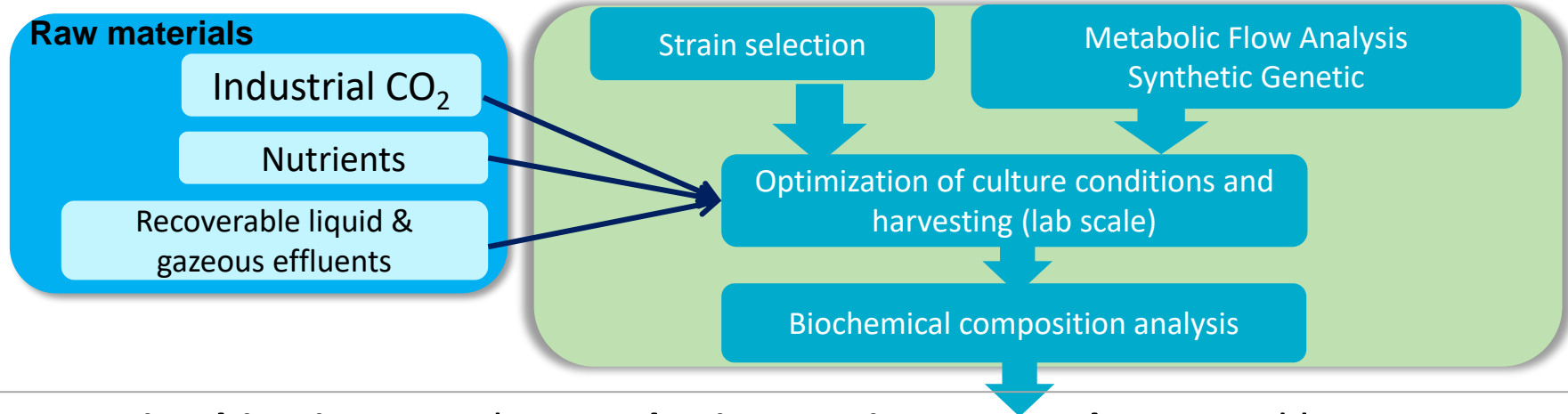
Algotech
 In the CEEEDD



EARTH & LIFE INSTITUTE
 Laboratory of Mycology



Life Cycle Assessment



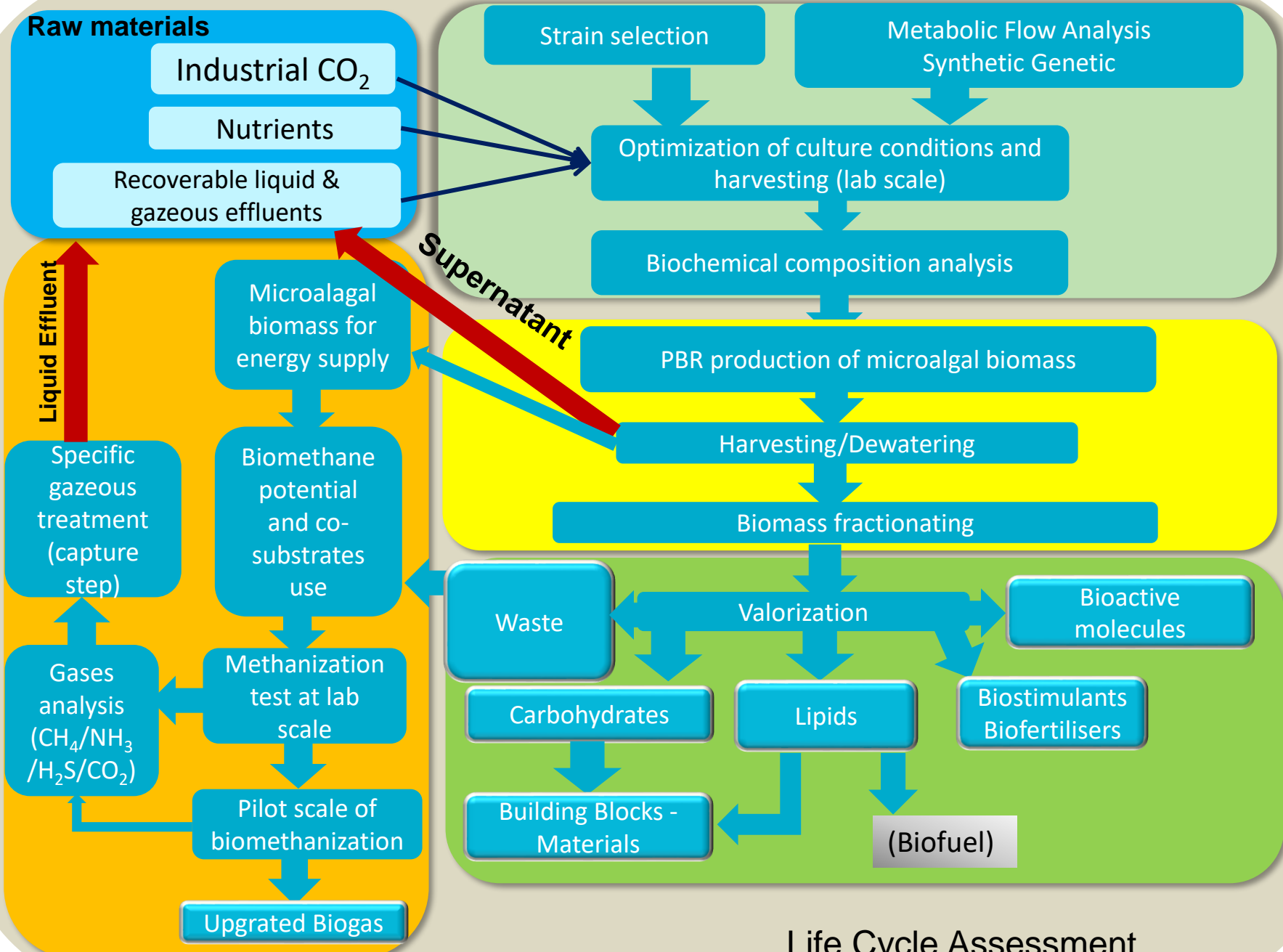
Two **main objectives** : exploit **synthetic genetics approaches** to tackle two priority problems for biotechnological production :

- **contamination** of bioreactors by other microorganisms (→**metagenomics** and **bacteriocins**)
- **excretion** of compounds (produced by yeast, bacteria) of industrial interest

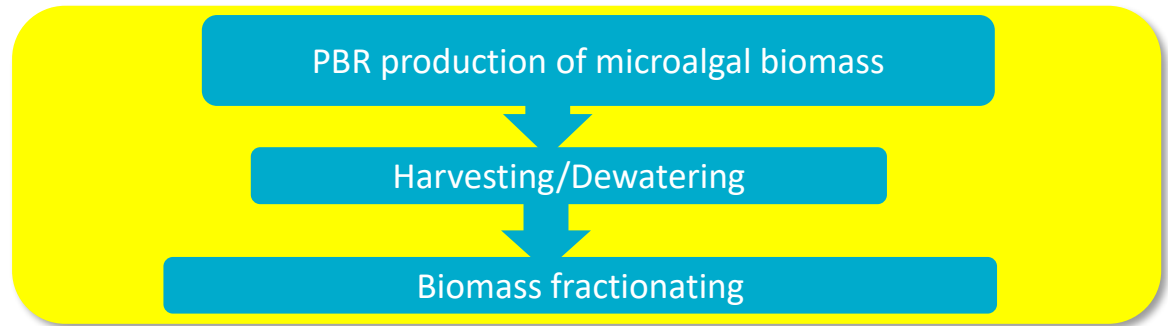
Strain selection for saccharides and lipids production, culture optimization at lab scale and biochemical composition characterization for metabolic flow analysis :

- *Cyanothece sp.* PCC 7822 (EPS)
- *Chlorella sorokiniana*, *Scenedesmus obliquus & dimorphus*, *Neochloris oleoabundans* (lipids)

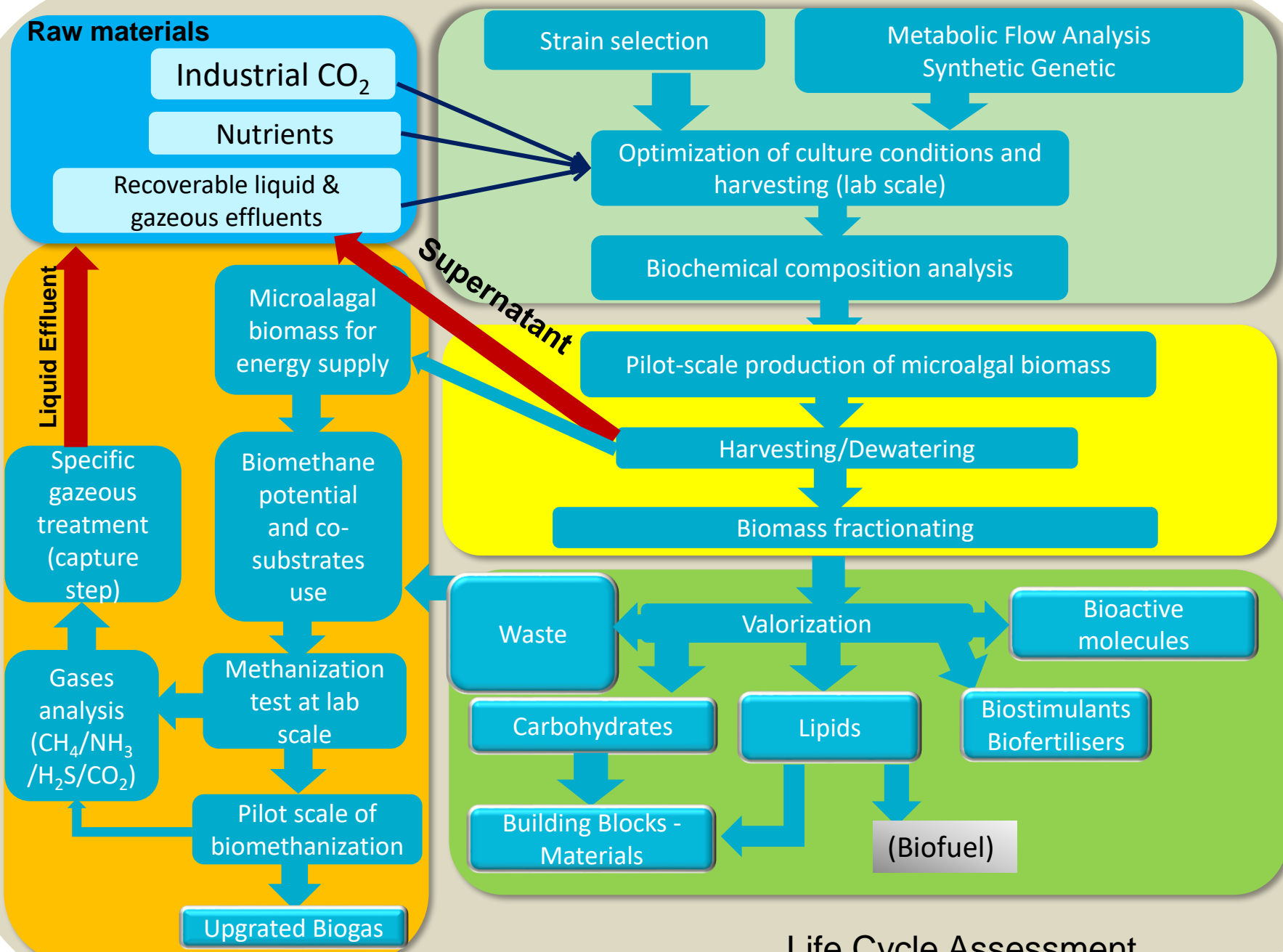




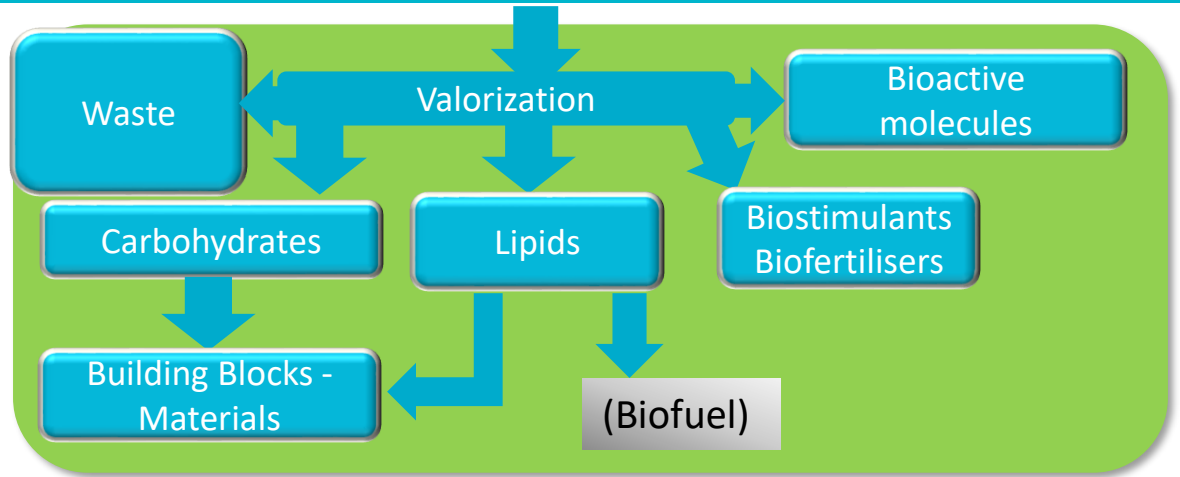
Life Cycle Assessment



- Photobioreactor design and scale up study for lipids and saccharides production at pilot scale
- Lipids extraction :
 - CO₂ supercritical vs green solvent extraction ;
 - Simultaneous extraction/transesterification
- Saccharides :
 - Extraction
 - Molecular and structural characterization



Life Cycle Assessment



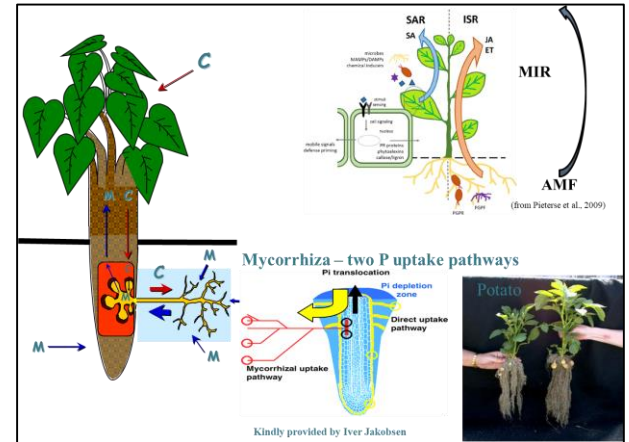
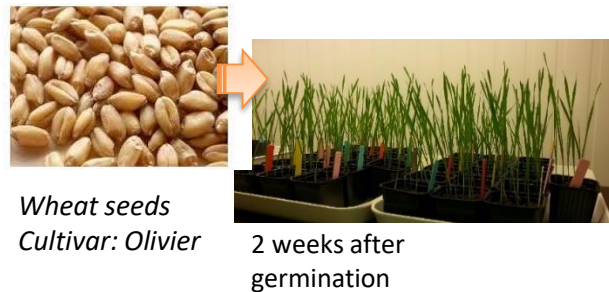
Bioprotection/Biofertilisers/Biostimulation

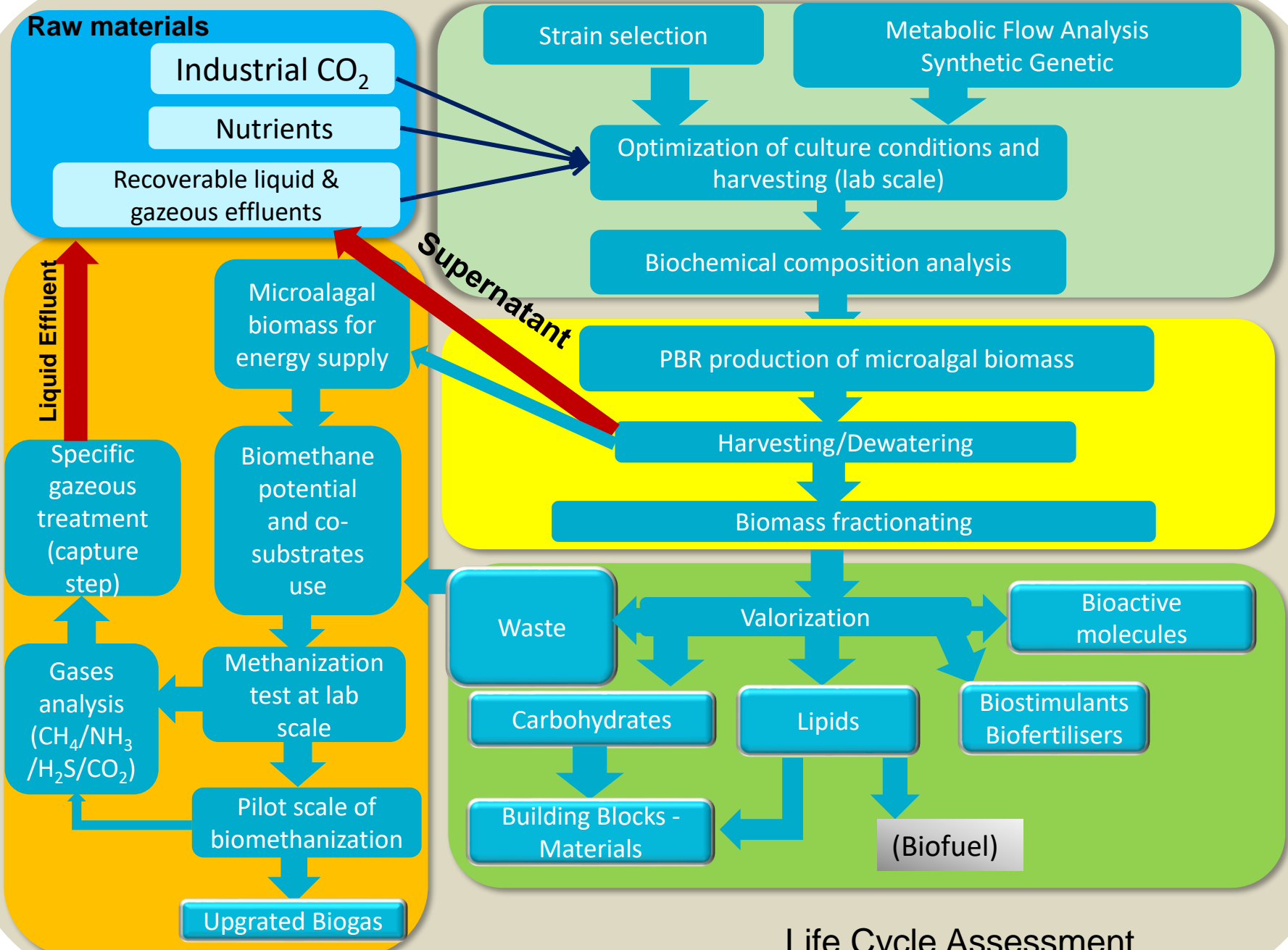
Induction of plant defense reaction application as biopesticide

Foliar spraying

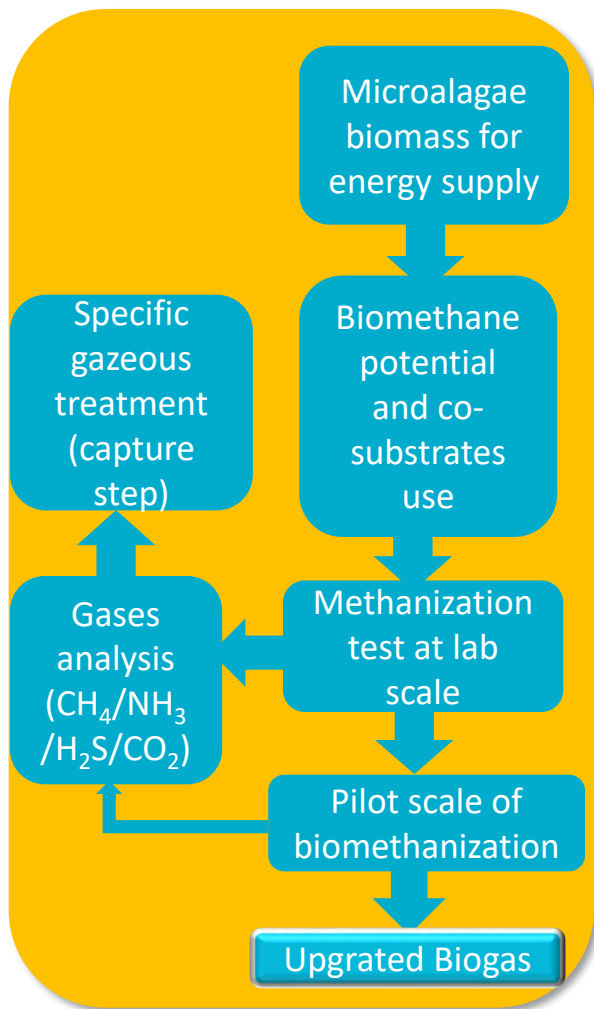
Plant cells in suspension

Seed treatment



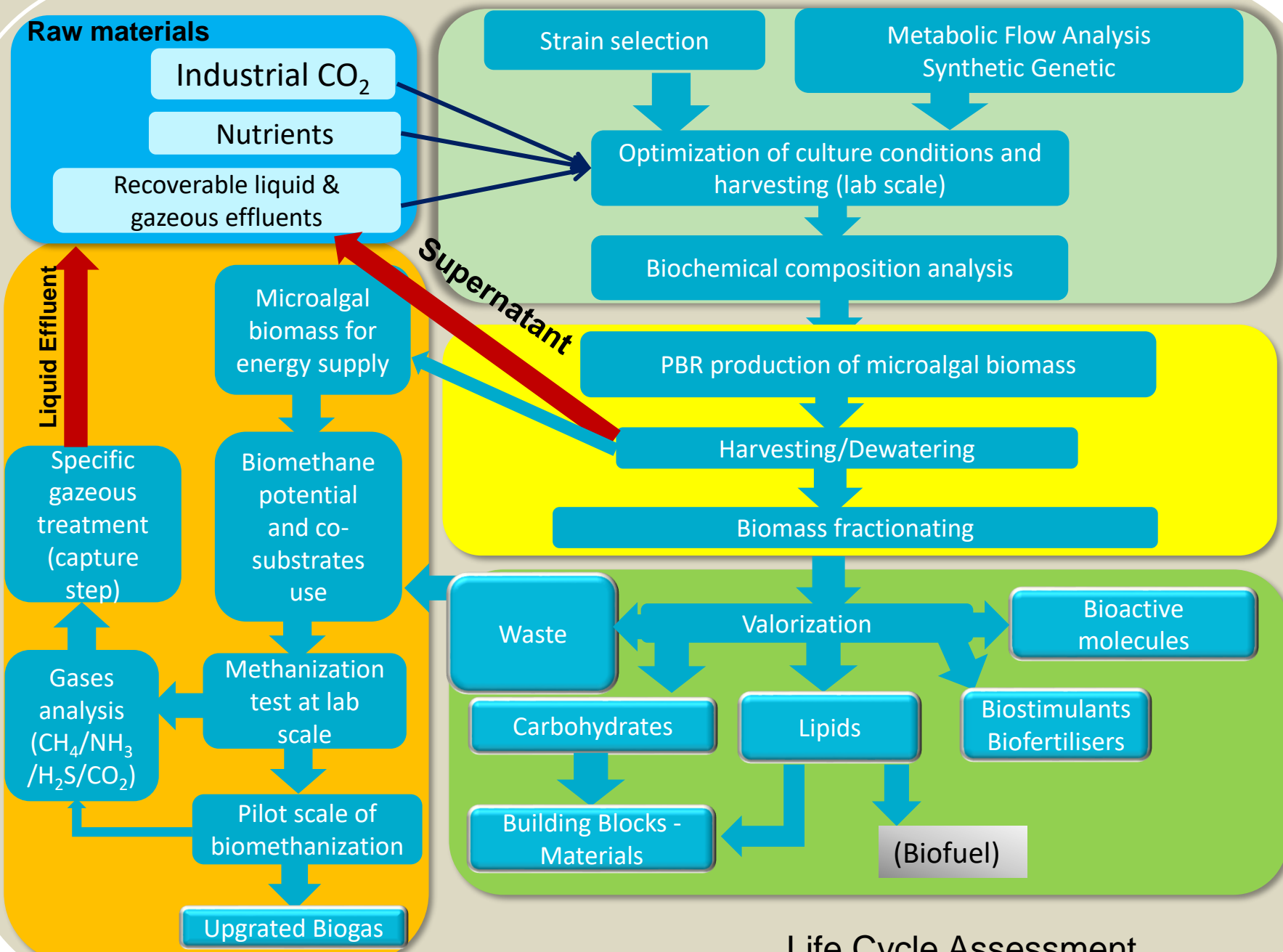


Life Cycle Assessment

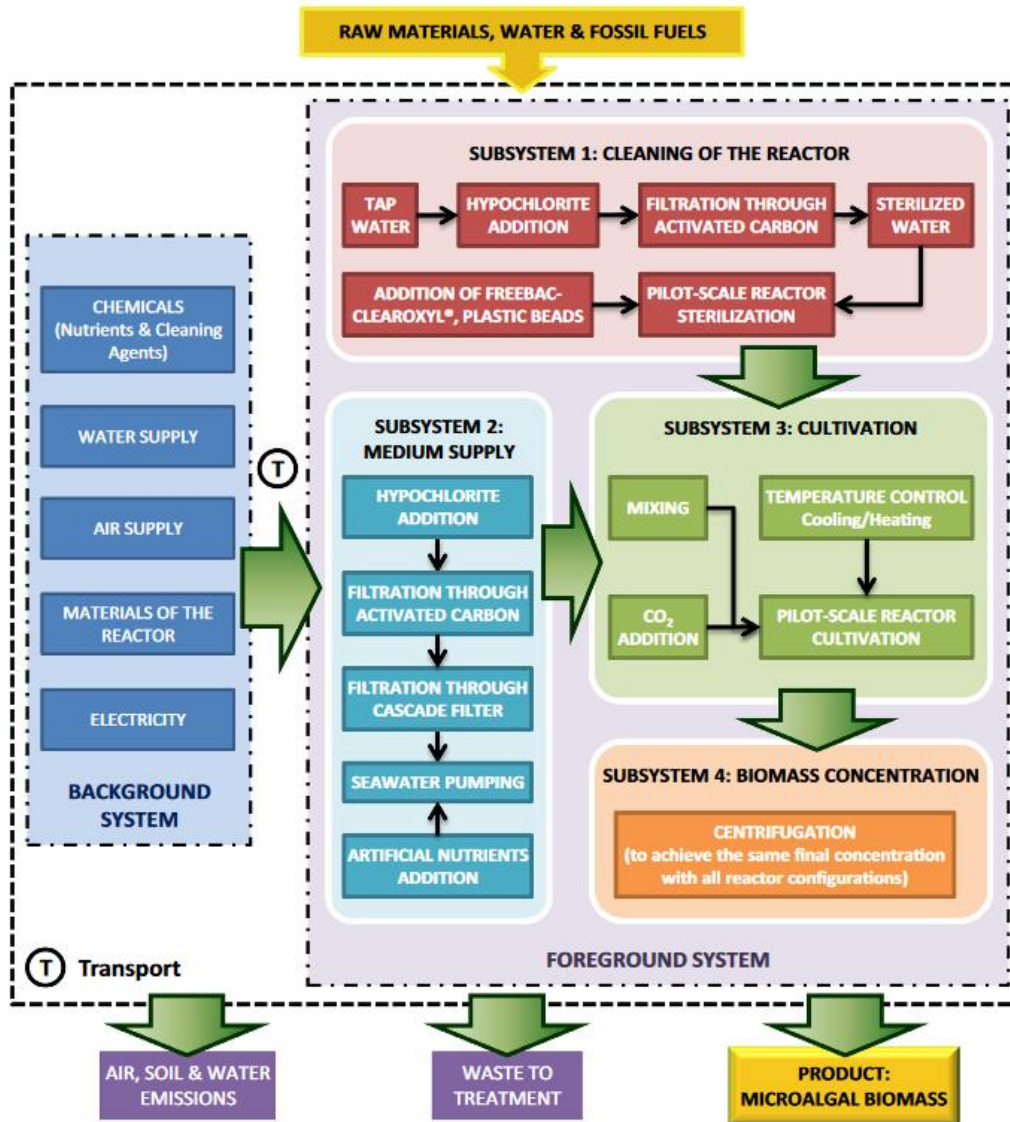


- Biomethane Potential Test with microalgal residues
- Optimal design to ammonia and sulfur inhibition impact
- Modeling and simulation
- Pilot for biogas production
- Co-methanization study with sewage and agro-industrial waste in collaboration with CEEEDD partners (Feder)





Life Cycle Assessment



Data needs:

Process inputs:

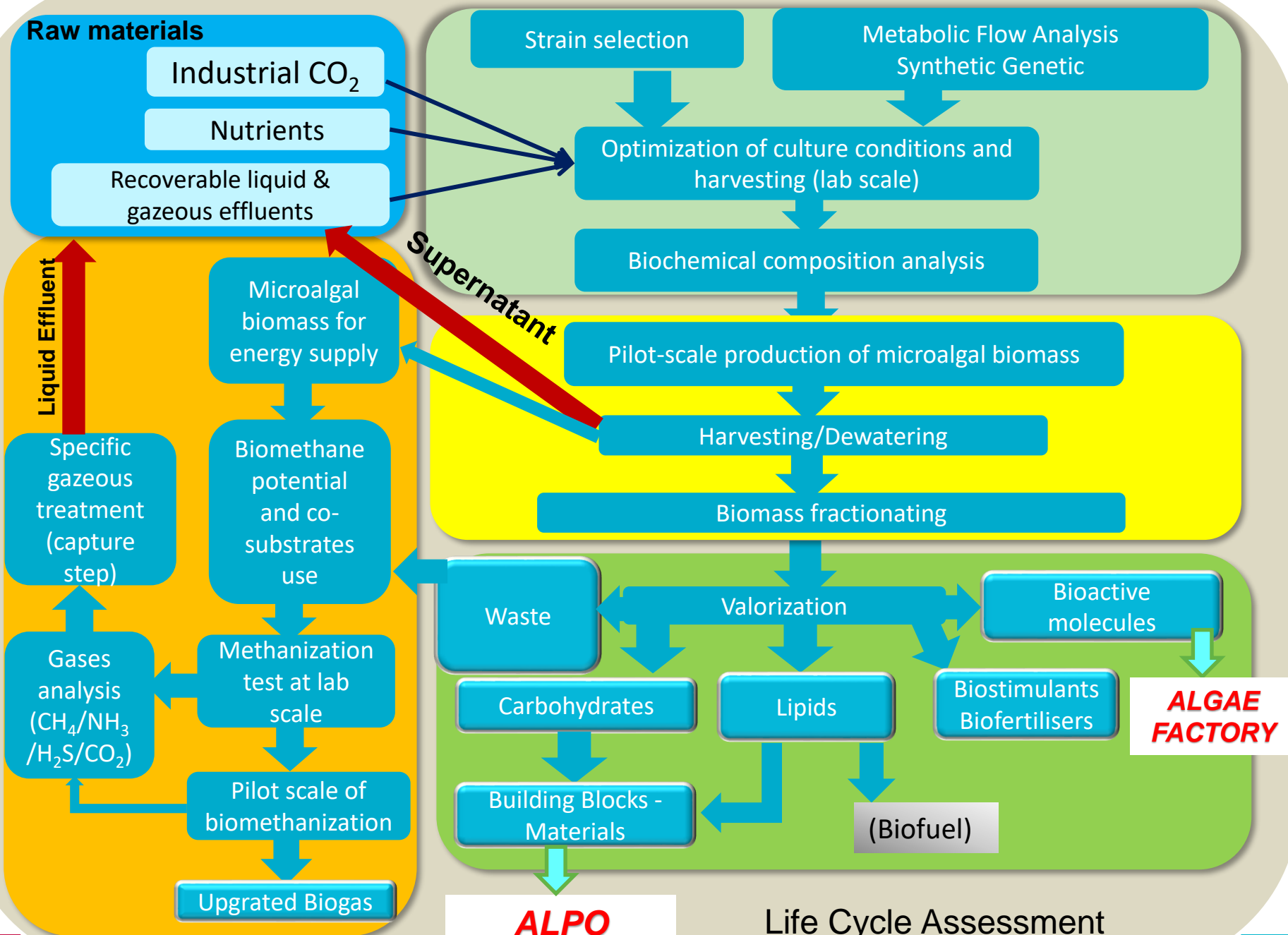
- Raw materials
- Auxiliary materials (energy, chemicals inputs, etc.)

Process outputs:

- Products, by-products, waste
- Emissions

Data sources:

- Process descriptions from process flow charts, mass balances, measurements, purchase lists, etc...
- Market studies (potential, quality, production prices...)

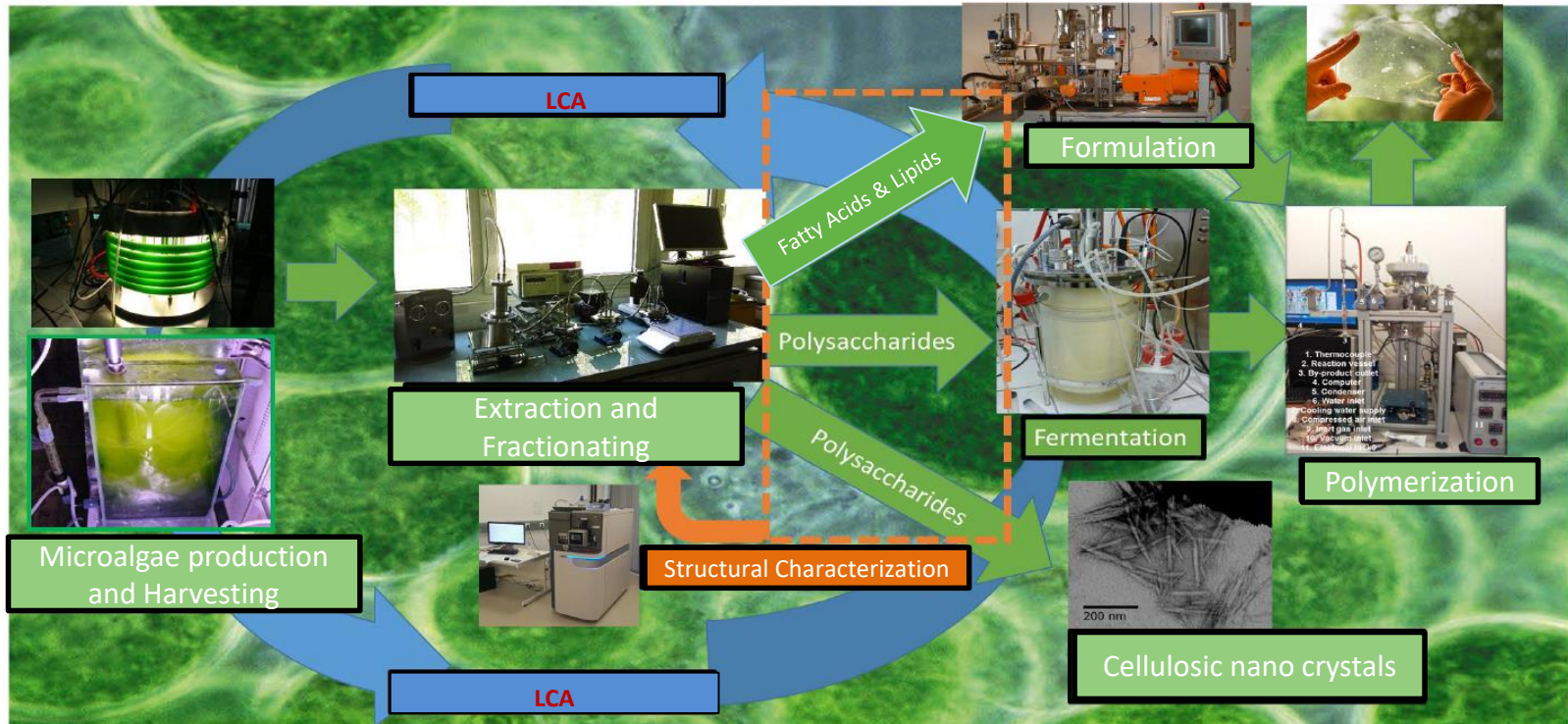


ALPO

Life Cycle Assessment

ALPO

Partnership :



AlgaeFactory

Partnership:



LE FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL
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Usinalgue

Microalgae large
scale production



Valoalgue

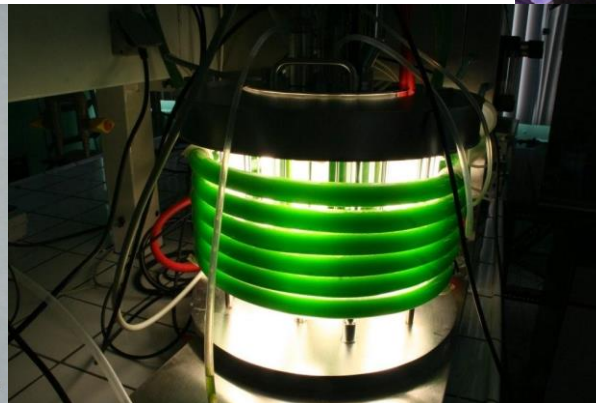
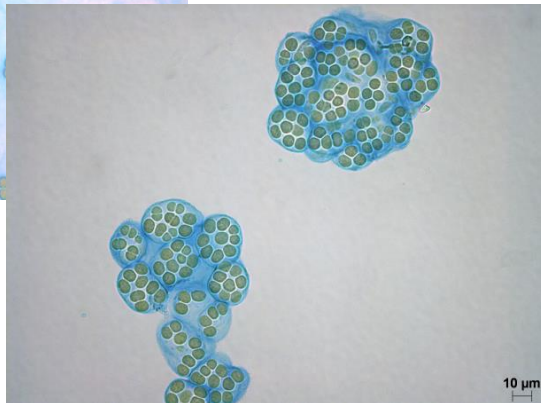
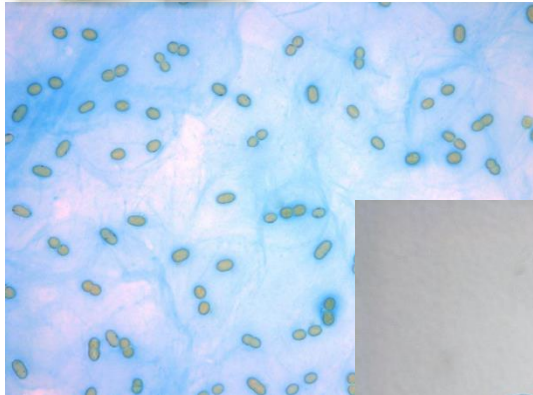
Production of
High added
value
compounds by
immobilized
microalagae

Conclusions

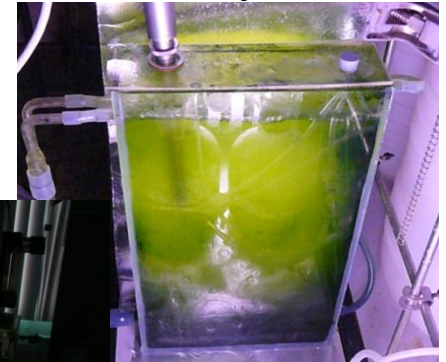
Environmental Microalgal Biorefinery

=

Real opportunity
for circular economy



Hellweg and Milà i Canals 2014



Thank for your attention

