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6-9-2022

LCA-assisted conception of a digestate recovery by micro-algae production

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➤ **LCA-assisted conception of a digestate recovery process by micro-algae production**

Jean-Romain Bautista Angeli, *INRAE, UR OPAALE*

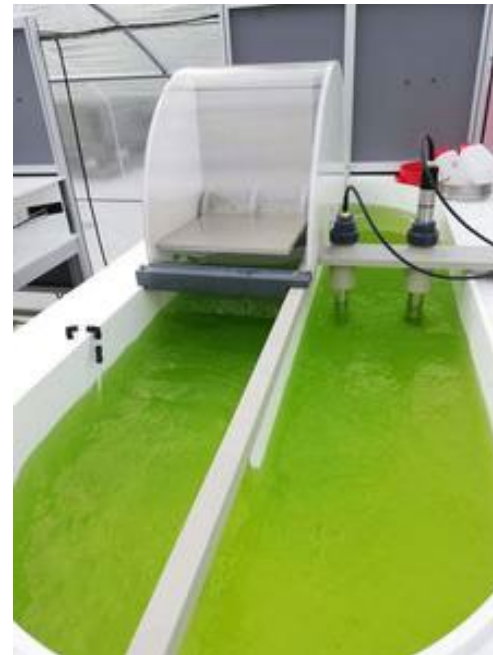
**Marilys Pradel,
*INRAE, UR TSCF***

**Fabrice Beline,
*INRAE, UR OPAALE***

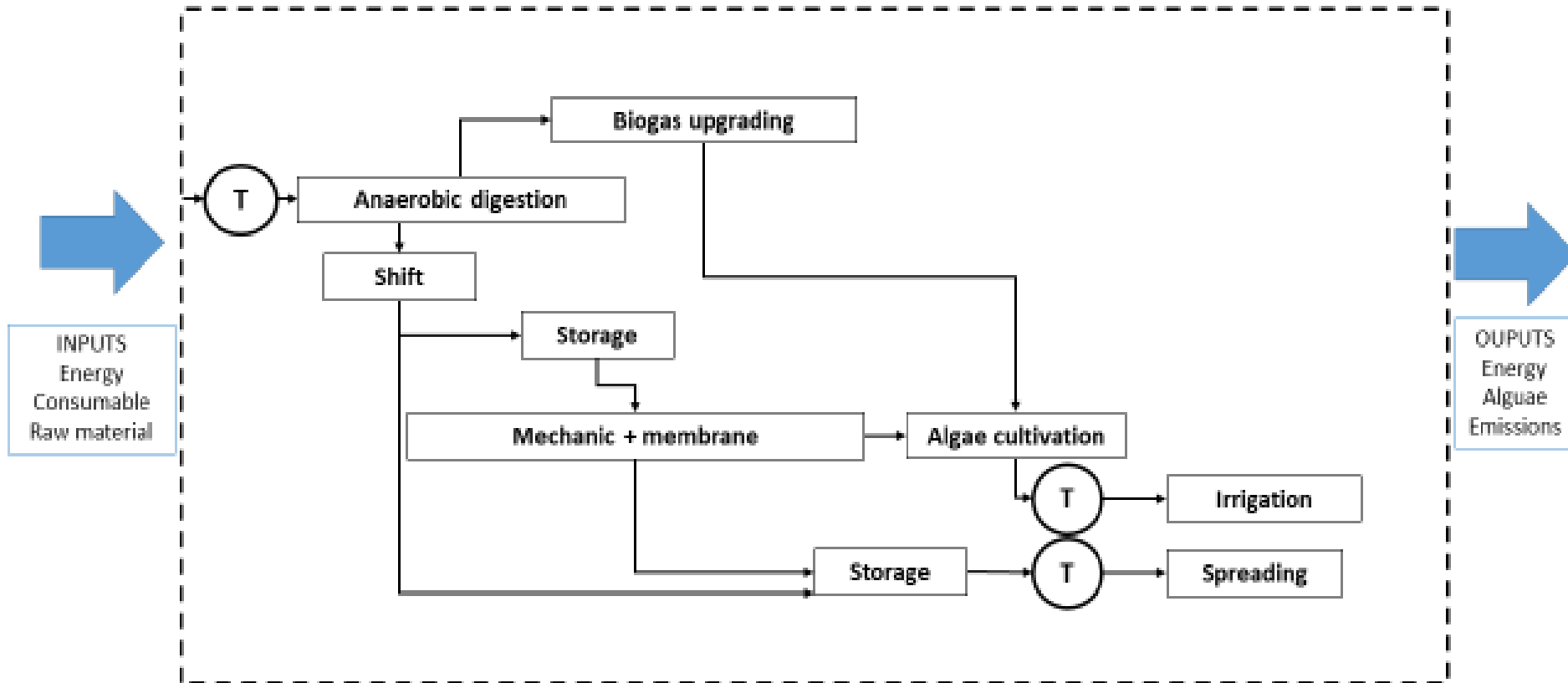
**Lynda Aissani,
*INRAE, UR OPAALE***

➤ Elements of context

- BIOMSA project, funded by ADEME until **Nov. 2023**
- Environmental biorefinery, valorization of digestate and CO₂ from anaerobic digestion by microalgae culture



➤ System A

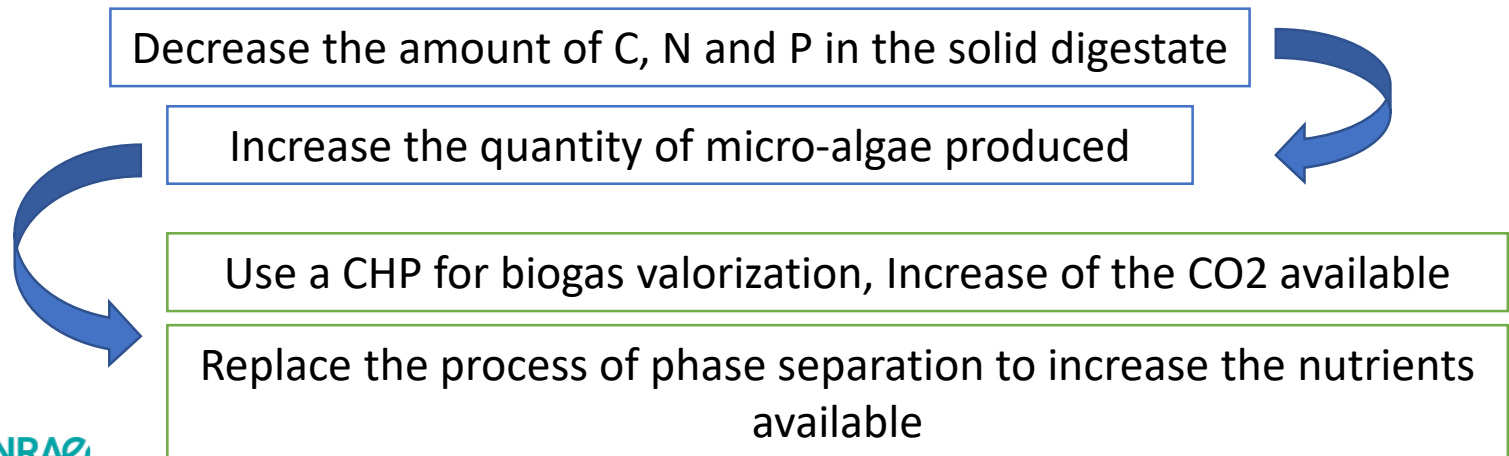


Functional unit: Treat a quantity of waste and produce algae, digestate and biomethane

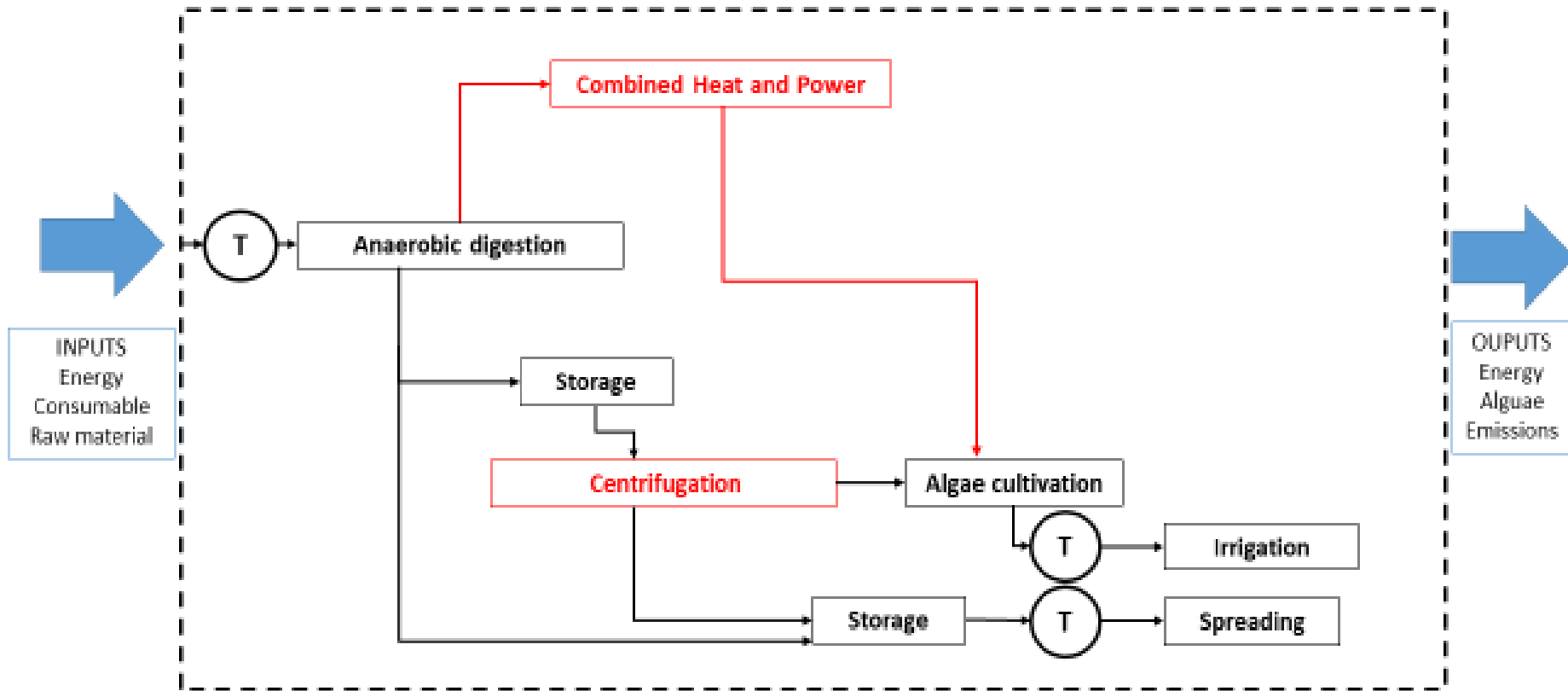
➤ First LCA results

- Hotspots

CML2001 - Aug. 2016	Spreading
Acidification Potential [kg SO2 eq.]	77%
Eutrophication Potential [kg Phosphate eq.]	78%
Freshwater Aquatic Ecotoxicity Pot. [kg DCB eq.]	84%
Global Warming Potential [kg CO2 eq.]	29%
Global Warming Potential excl biogenic carbon [kg CO2 eq.]	14%
Human Toxicity Potential [kg DCB eq.]	90%
Marine Aquatic Ecotoxicity Pot. [kg DCB eq.]	89%
Terrestrial Ecotoxicity Potential [kg DCB eq.]	16%



➤ System B



Same quantity of Inputs as System A but different quantity of Outputs



> Questioning the Systems

The first question is the FU :
Produce microalgae, biogas but **do not produce a nutrients rich digestate?**



- Then, the second question is :
How to deal with a negative form in the functional unit ?

➤ First option, not deal with it...

- Used an affirmative form Functional Unit,
« Produce X quantity of microalgae »

Substitutions and Leveling
on the System B

(based on the system with
the lowest quantity of
microalgae produced)

Economic or Energetic
Allocations

➤ UnFunctional Unit (UFU)

- Investigation in the literature

Firstly, focus on substitution, economic and energetic allocations.

Secondly, create a draft based on nutritional allocation

=> Reflection based on C, N, P contents

- The idea of an Unfunctional Unit

The really first development, to translate the avoiding effect in our system.

Highlight the concentration in recoverable C in the digestate.

Ratio, x_1 :

$$x_1 = \frac{1}{y_1 * \sum y} * \frac{1}{\sum \frac{1}{y * \sum y}}$$

y_1 = amount of recoverable C in the output 1



➤ Next step

- Results from UFU

Deploy an allocation ratio including N and P

Obtain the first results for the both systems

- Compare the results

Realize the leveling and substitutions on the System B

Focus on one allocation and apply it on System A and System B

Compare all the results and discuss around the potential differences



➤ Thank you for your attention and future discussions



> Substitution

Functional unit: Treat a quantity of waste and produce algae

- System A

1 Kg Biomethane for equivalent 1 kg natural gas

1 kg of N or P equivalent 1 kg specific fertilizers + N₂O, NH₃, NO₃ emission

- System B

10% losses, 60% heat, 40% electricity, 1 MJ electricity = 1MJ produced by FR energy mix

10% losses, 60% heat, 40% electricity, 1 MJ heat = 1MJ produced by boiler

1 kg of N or P equivalent 1 kg specific fertilizers + N₂O, NH₃, NO₃ emission

The quantity of microalgae is different in both systems



➤ Levelled System B

Functional unit: Treat a quantity of waste and produce algae

- Algae production in Syst B fixed to be similar to System A

Increased CO₂ emissions from Syst B
Increased nitrogen in liquid digestate

Comparison possible but loss of coherence/relevance for the system B

➤ Economic allocation

- Biogas / Biomethane

Biomethane 64-139€/MWh

Elec. from Biogas 150-175€/MWh

- Algae

SynCro Natura, mix of microalgae as biostimulant.

10,5% OM

13,5€ HT/L

- Digestate

No specific international market

An European value fluctuating between 3 and 10 euros / Ton



➤ Energy allocation

Higher Calorific Value, common point between the products

Algae

Digestate ?

Biogas

Waste ??





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Lot 4 : ACV
BIOMSA / JRBA