Webinar

BIo-Impact

2 Years of Innovation in Biomethane Production with SEMPRE-BIO

SEMPRE-BIO

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Webinar
BIo-Impact

Schedule

- SEMPRE-BIO Project and Objectives overview
- Three Case Study Presentations
- Insights into CO2 valorization techniques
- Q&A session with our expert panel

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Webinar
BIo-Impact

SEMPRE-BIO Presentation

with

Alejandra Cordova

Project Manager | Sustainability Certifications

CETAQUA
CENTRO TECNOLÓGICO DEL AGUA

SEMPRE-BIO

SEMPRE-BIO at glance

Goals

- Demonstrate novel and cost-effective biomethane production solutions and pathways.
- Increase the market up-take of biomethane related technologies.
- Support circular economy.
- Reduce dependence on fossil fuels.

Numbers

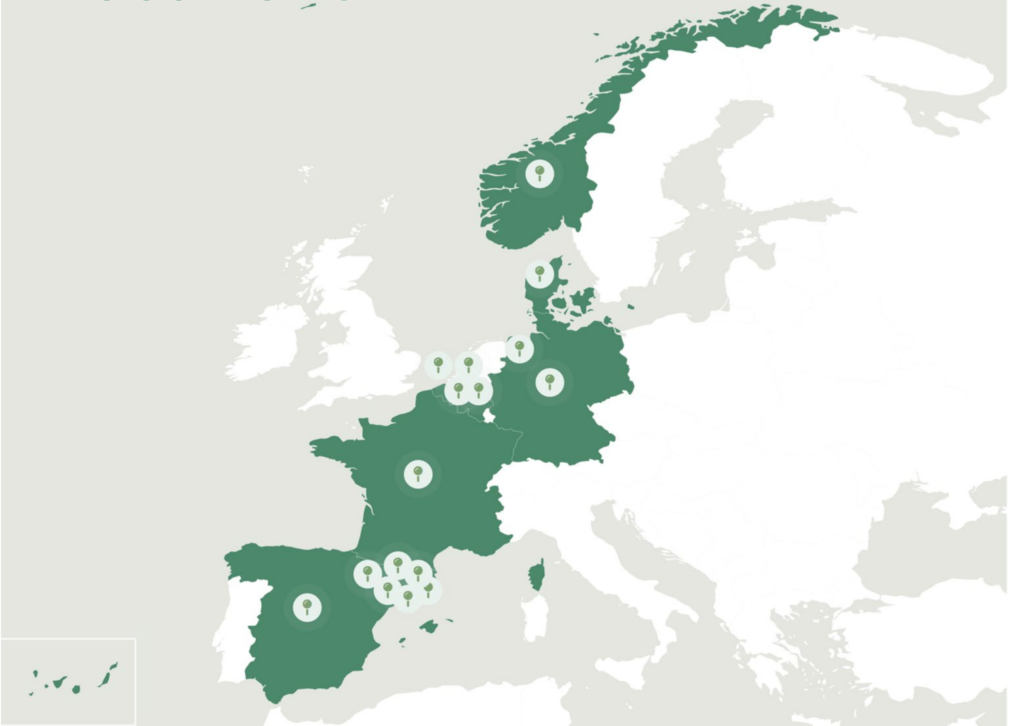
42 Months

17 Partners

7 Countries

9.9M Funding

Locations



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CETAQUA CENTRO TECNOLÓGICO DEL AGUA · Aigües de Barcelona · SINTEF · ProPuls · DBFZ · TMB · terrawatt · Naturgy · Innolab · CRYO inox · Beta Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària · UNIVERSITEIT GENT · inveniam · NV De Zwanebloem · Biogas-E platform voor anaerobe vergisting · DTU · BIOTHANE by VEOLIA

Research organizations	CETAQUA Centro Tecnológico del Agua; DBFZ; SINTEF; Innolab
Industry	Aigües de Barcelona; CRYO inox; ProPuls; terrawatt; BIOTHANE by VEOLIA Water Technologies
Academia	DTU; Universiteit Gent; Beta Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària
End-users	TMB; Naturgy
Consulting agency	inveniam
Stakeholder's engager	Biogas-E platform voor anaerobe vergisting
Farmers	NV De Zwanebloem

17 Partners

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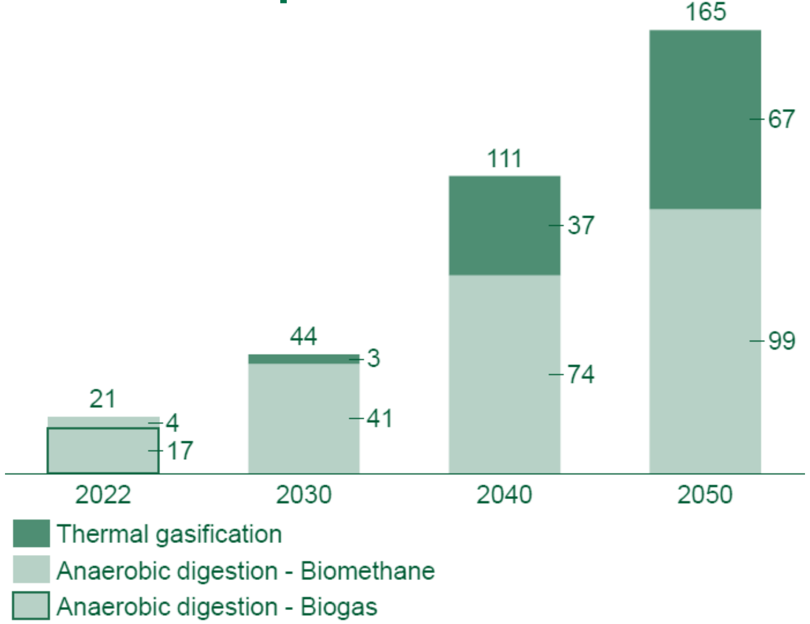
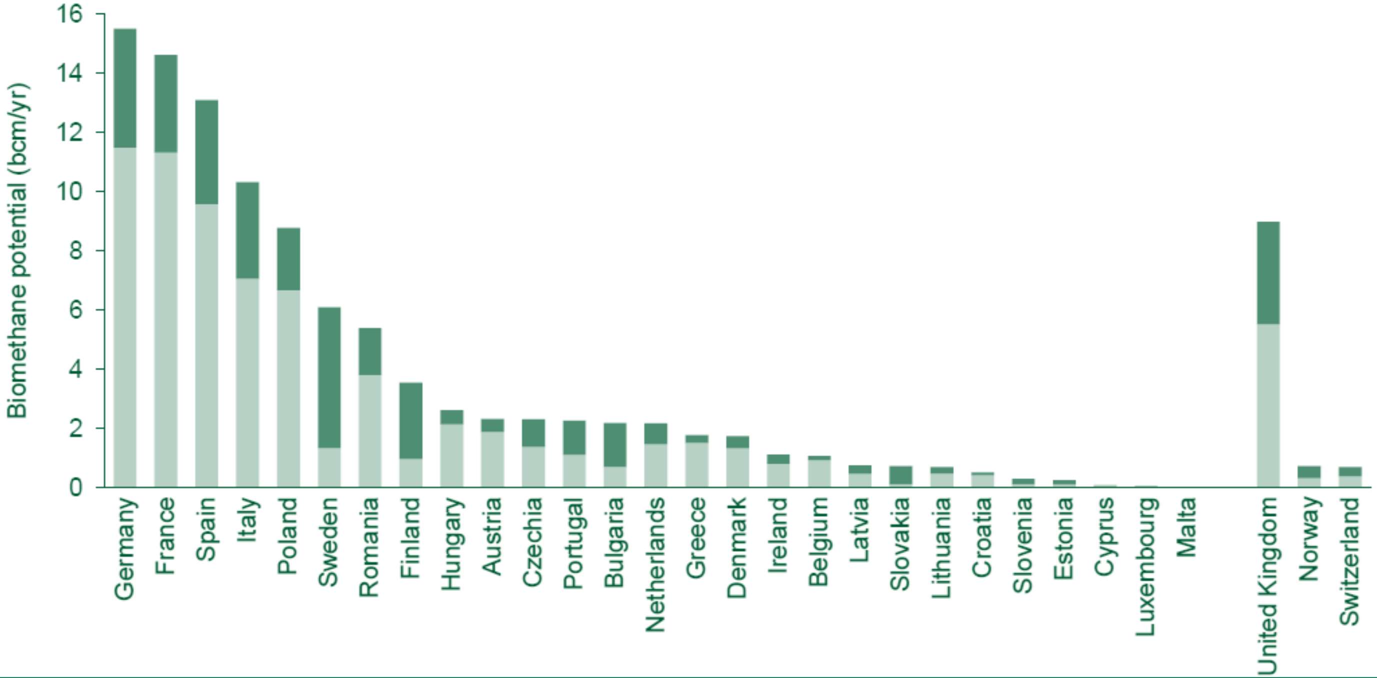
Projected Biomethane Production Potential in Europe (2022-2050)

Potential to scale-up biomethane production



Biomethane potential of 111 bcm/yr in Europe in 2040



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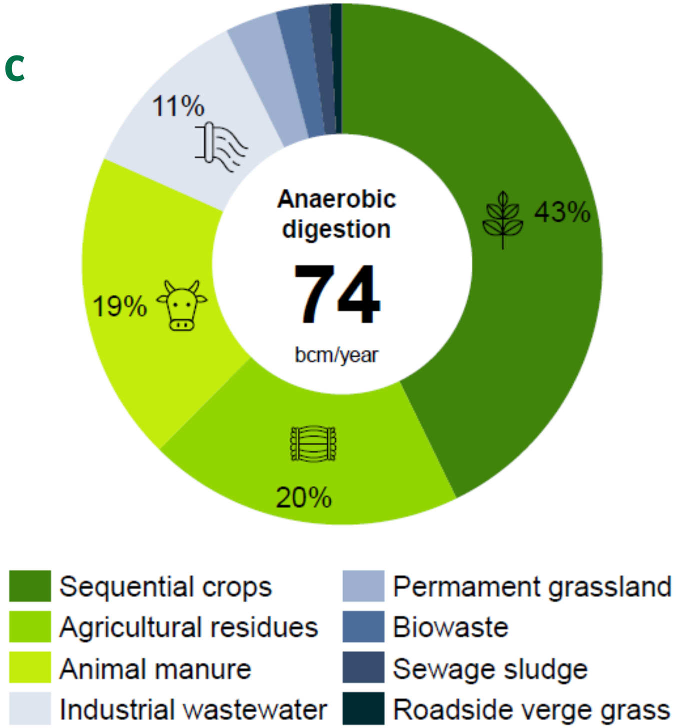
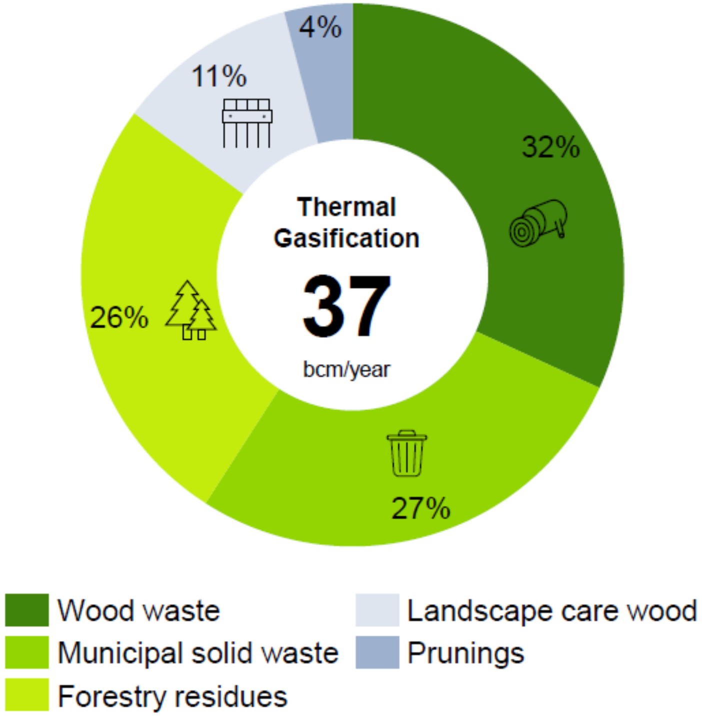
Source: "Biogases Towards 2040 and Beyond" (Guidehouse, EBA)

2040 Feedstock and technology selection

2040 Anaerobic digestion feedstock



2040 Thermal gasification feedstock



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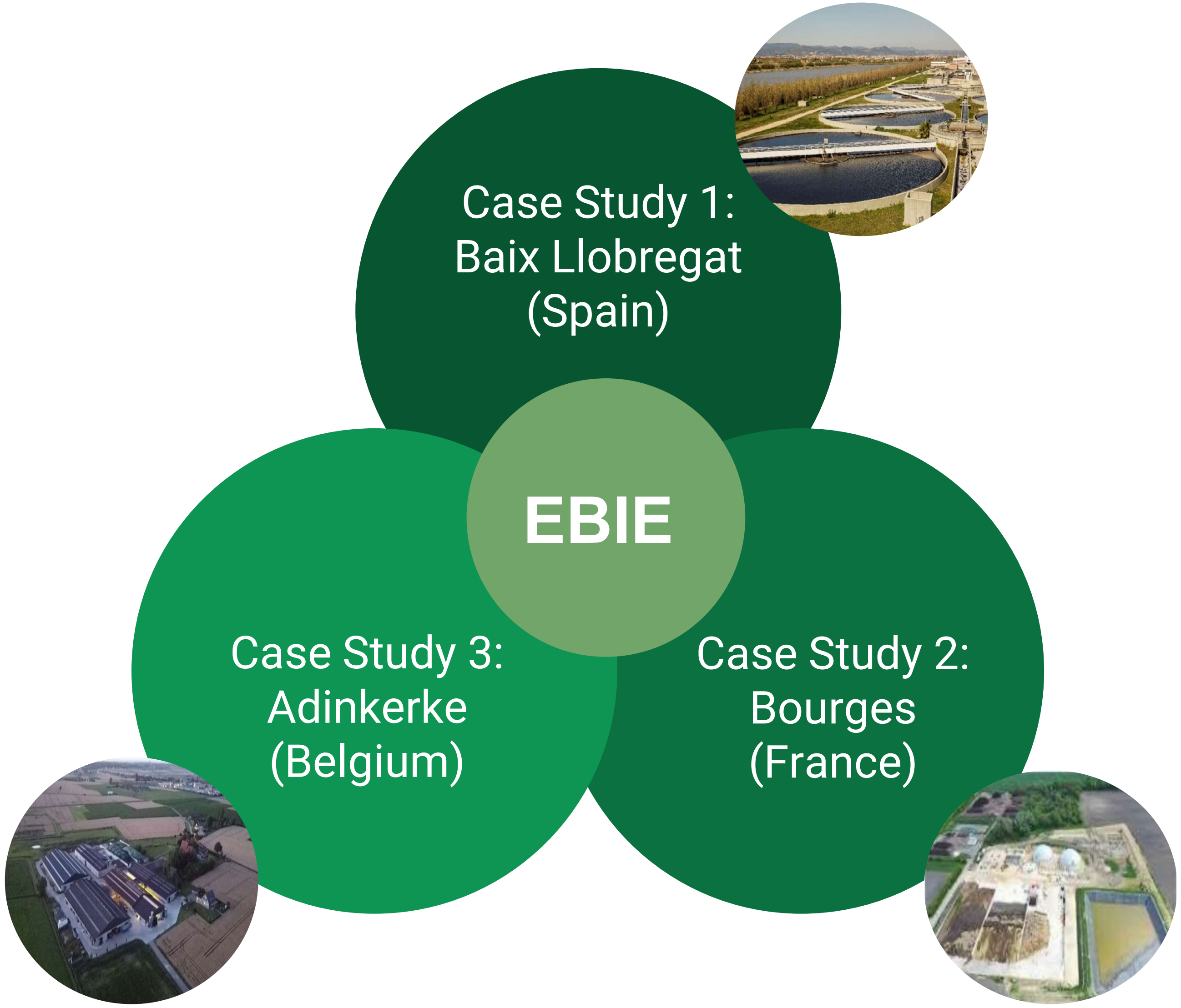
Source: "Biogases Towards 2040 and Beyond" (Guidehouse, EBA)



European Biomethane Innovation Ecosystem

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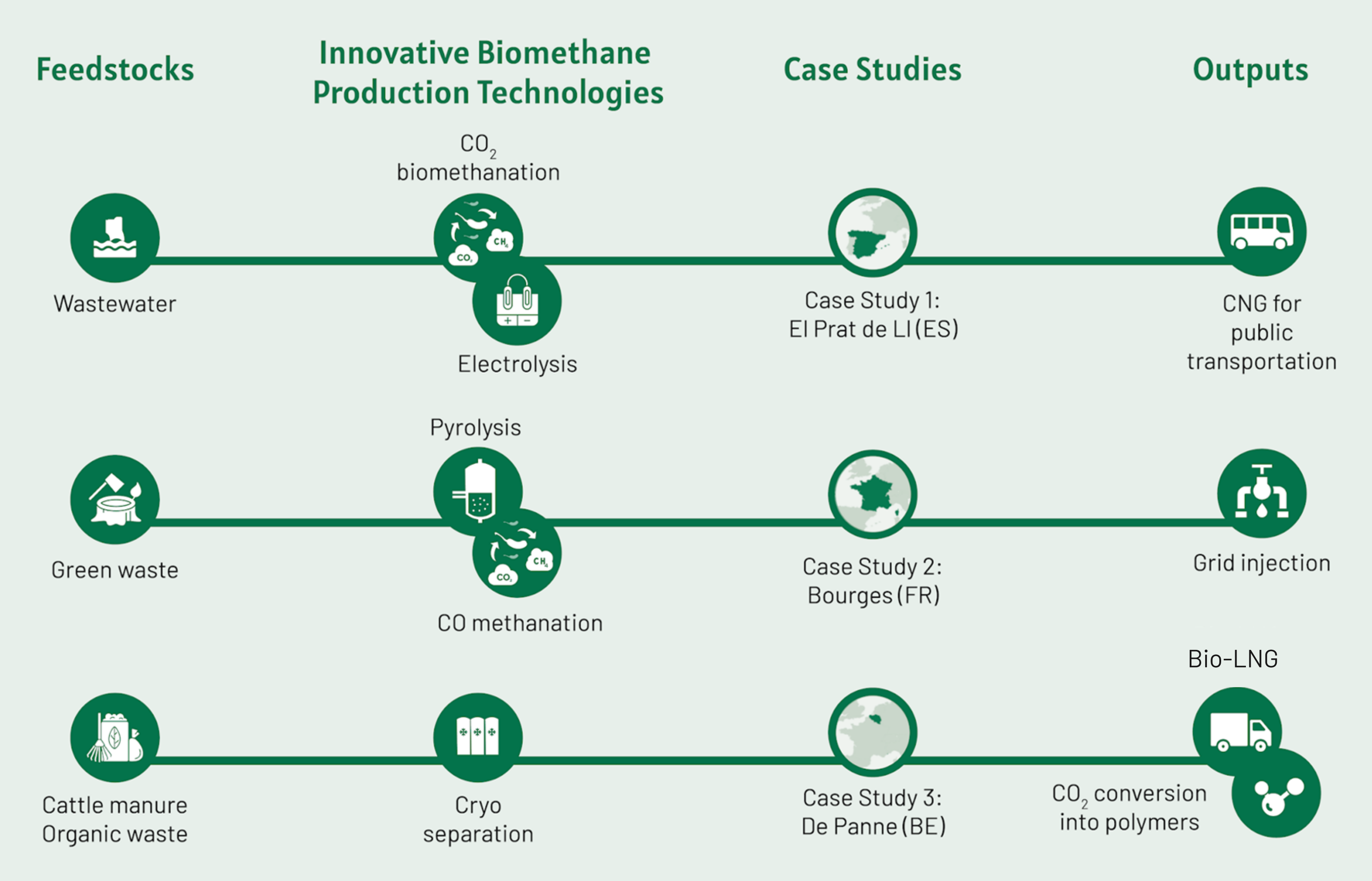
Case Studies



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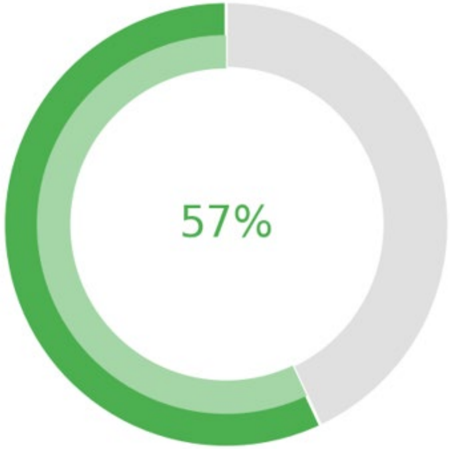
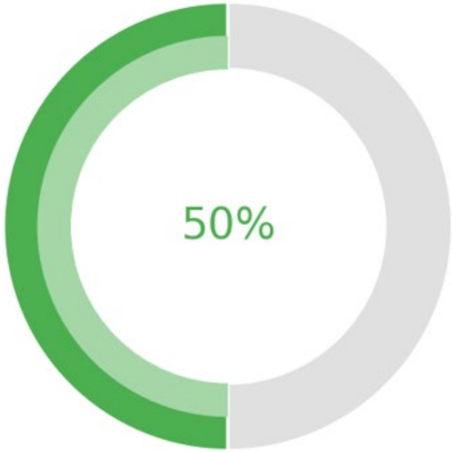
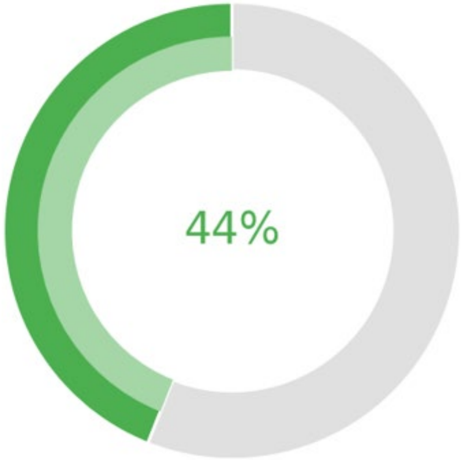
SEMPRE-BIO Progress Overview



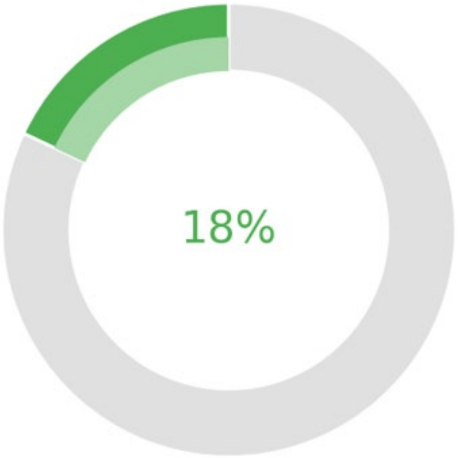
Time



Milestones



Deliverables



Tasks

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Expected outcomes

01 Increase the cost-effectiveness of conversion in biomethane production.

02 Diversify conversion technologies for biomethane.

03 Contribute to the acceptance of biomethane technologies in the gas market.

04 Contribute to the demonstration on a semi-industrial scale of new conversion technologies to produce biomethane from wastewater, wood biomass and manure.

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Expected impacts

- Biomethane as a substitute for imported LNG.
- Biomethane as a fuel substitute in transportation.
- Reduction of CO_2 by 213 million tons/year by 2050.
- Diversify energy sources and new routes.
- Reduce the need for strategic reserves.
- Smaller extension of critical infrastructure to protect.

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Case Study I

with

David Checa Sánchez

Doctoral Researcher

CETAQUA
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Case Study I: Baix Llobregat (Spain)

Feedstock	Technology	Site	Final use of biomethane
Wastewater	CO_2 biomethanation; Electrolysis	Case Study 1: El Prat de Ll (ES)	CNG for public transportation

Aigües de Barcelona · CETAQUA CENTRO TECNOLÓGICO DEL AGUA · ProPuls · DTU · SINTEF · TMB

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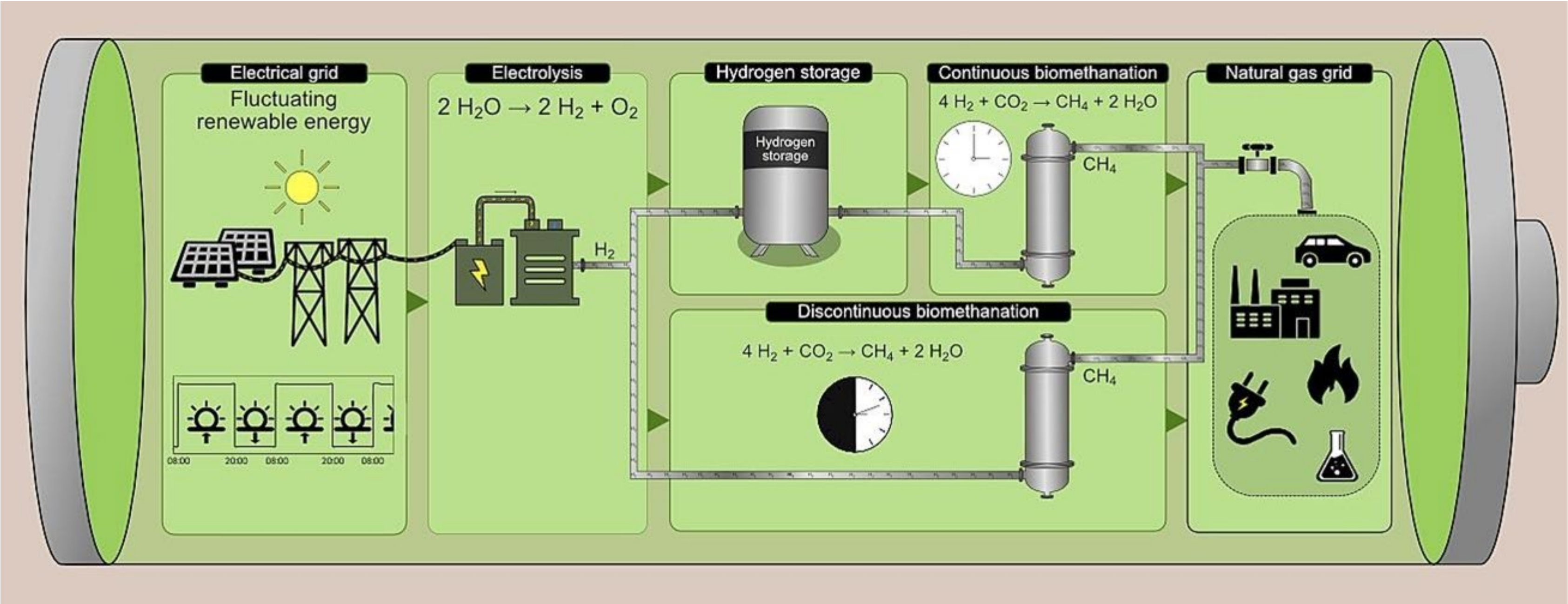
Power-to-gas



[1] Sieborg, M. U., Engelbrecht, N., Ottosen, L. D. M., & Kofoed, M. V. W. (2024). Sunshine-to-fuel: Demonstration of coupled photovoltaic-driven biomethanation operation, process, and techno-economical evaluation. *Energy Conversion and Management*, *299*, 117767. https://doi.org/10.1016/j.enconman.2023.117767

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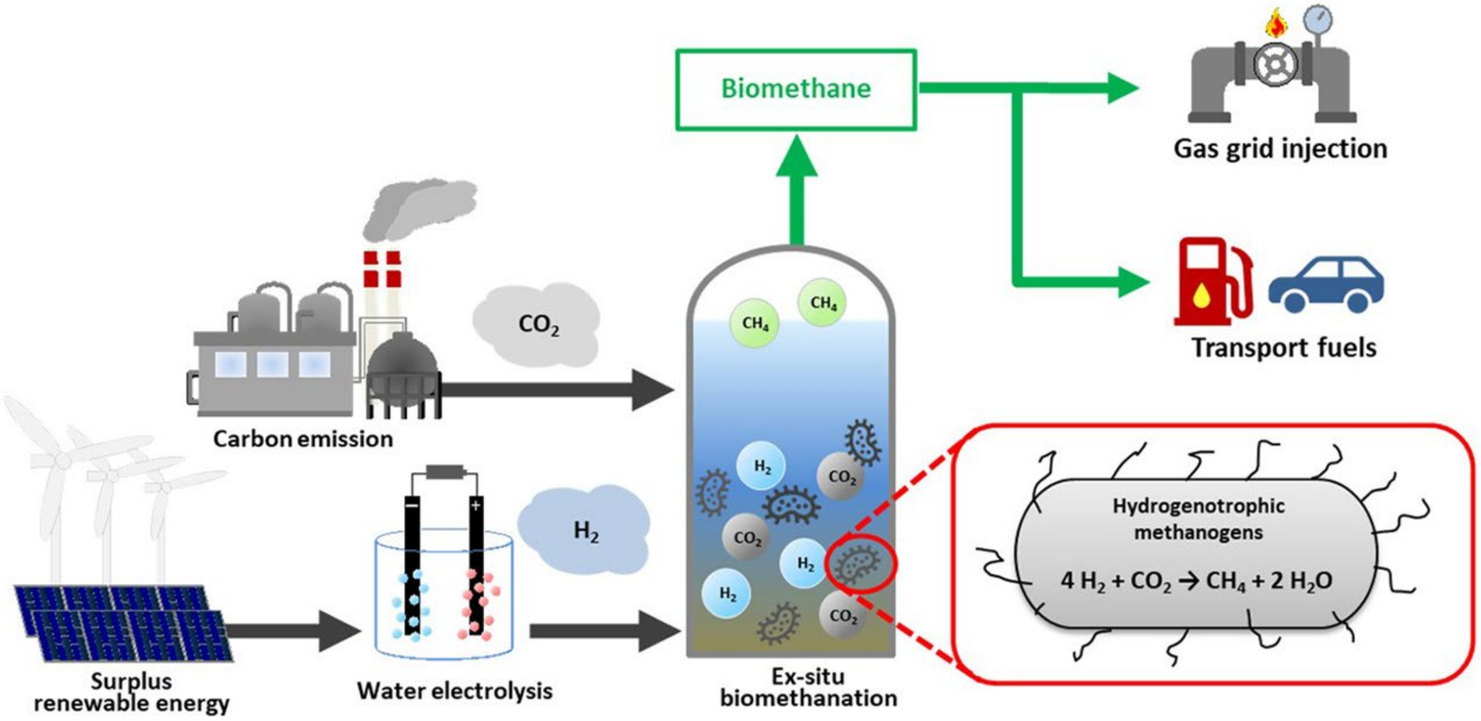
Power-to-gas



[2] Thapa, A., Jo, H., Han, U., & Cho, S. K. (2023). Ex-situ biomethanation for CO2 valorization: State of the art, recent advances, challenges, and future prospective. Biotechnology Advances, 68, 108218. https://doi.org/10.1016/J.BIOTECHADV.2023.108218

Power-to-Gas concept

Anaerobic digestion

- From WWTP
- Biogas + digestate
- ~65% CH_4

Renewable energy surplus

- Non storable
- Volatile

PEMEL

$$2\,H_2O \rightarrow 2\,H_2 + O_2$$

- Regenerated water
- Heat

Biomethanation

$$CO_2 + 4\,H_2 \rightarrow CH_4 + 2\,H_2O$$

- Different reactor configurations
- Exothermic
- Hydrogenotrophic archaea

Biomethane

- LNG, CNG, grid injection
- >95% CH4

Bus station

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Technology design

- **Trickling bed reactor (TBR)**
  - 3 phases
  - Maximum mass transfer
- **To treat up to 15.1 Nm^3/h of biogas**
  - Progressive adaptation of the biofilm
- **Biomethane to comply with norm**
  - Remove impurities (H_2S, siloxanes, VOCs)
  - Correct dew point
- **Liquid recirculation**
  - pH and nutrient concentration control
  - Temperature control
- **Packing material**
  - HDPE pall rings
- **Reactor pressure range**
  - 3-8 barg
- **Thermophilic temperature**
  - 55℃

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Construction advancements

- Detailed engineering is taking place
- PEMEL construction ongoing
- To begin operation in February

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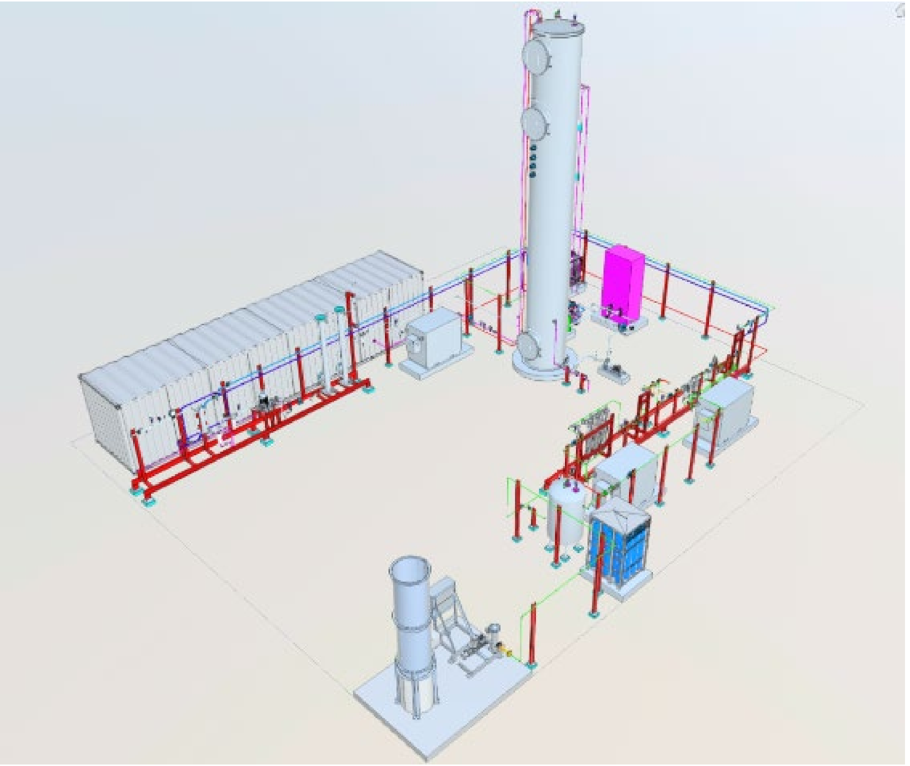
Construction advancements



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Case Study 2

with

Arthur Lacaine

Growth and Strategy

terrawatt

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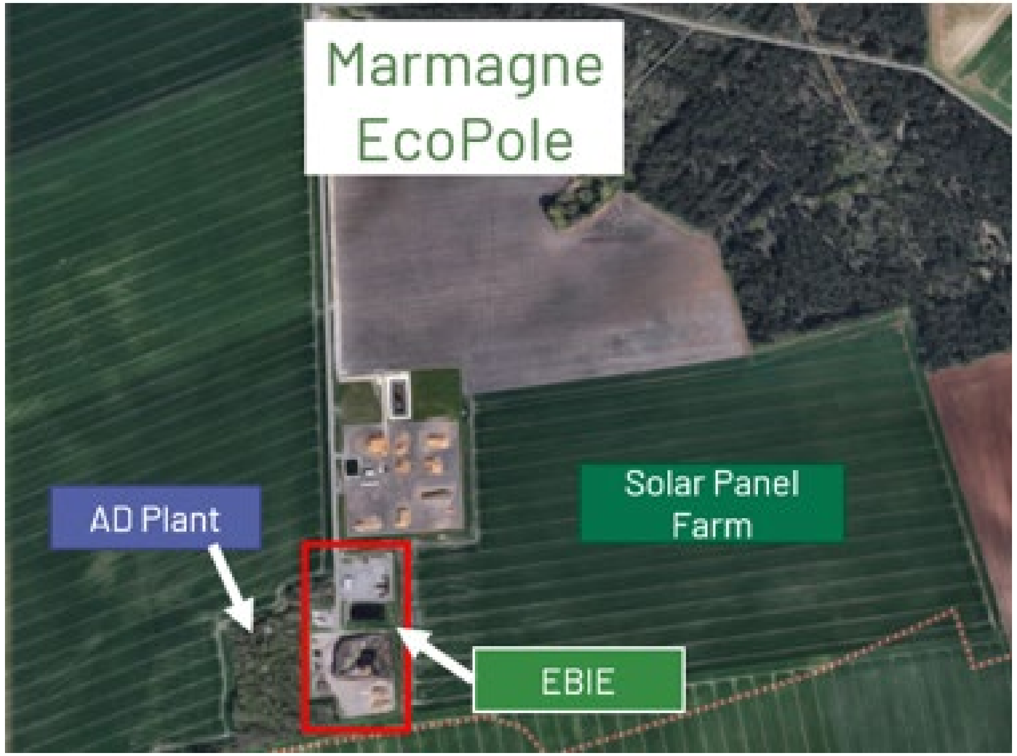
General Description

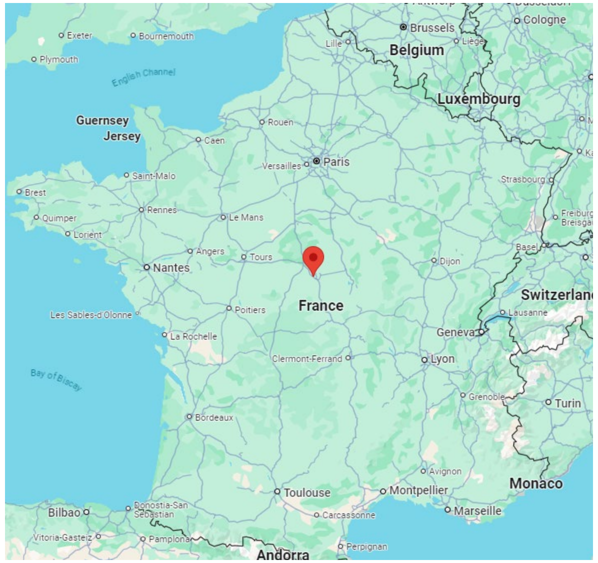
Location



Located at Marmagne near Bourges, at the center of France

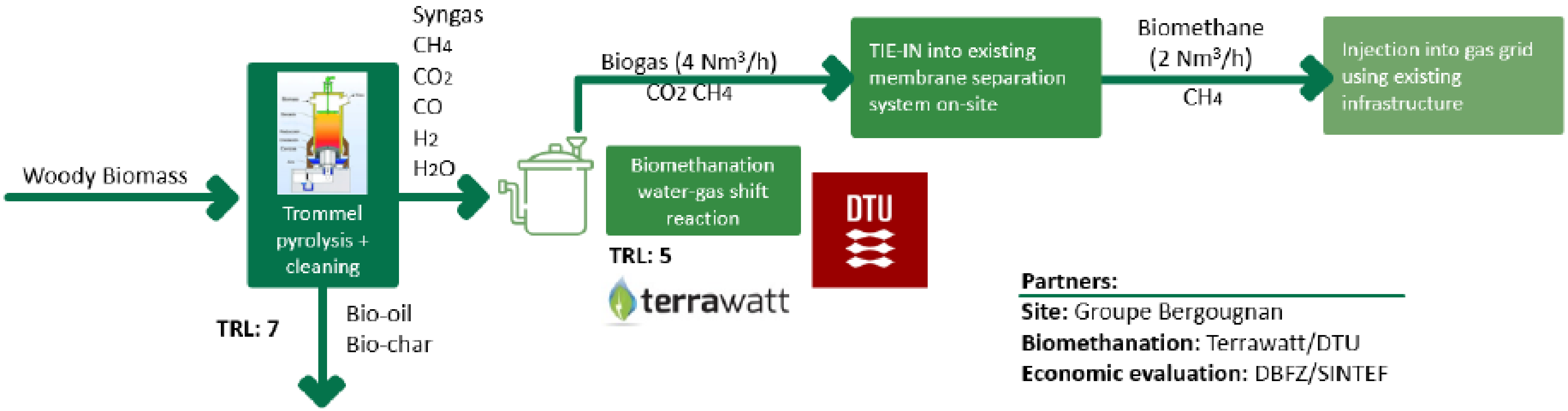
Surrounded by:

- Anaerobic Digestion plant
- Solar Panel farm
- Cereal Crops
- Green Waste Storage
- Composting Area
- Gas Grid Injection Point



General Description

Process Description



Partners:

Site: Groupe Bergougnan

Biomethanation: Terrawatt/DTU

Economic evaluation: DBFZ/SINTEF

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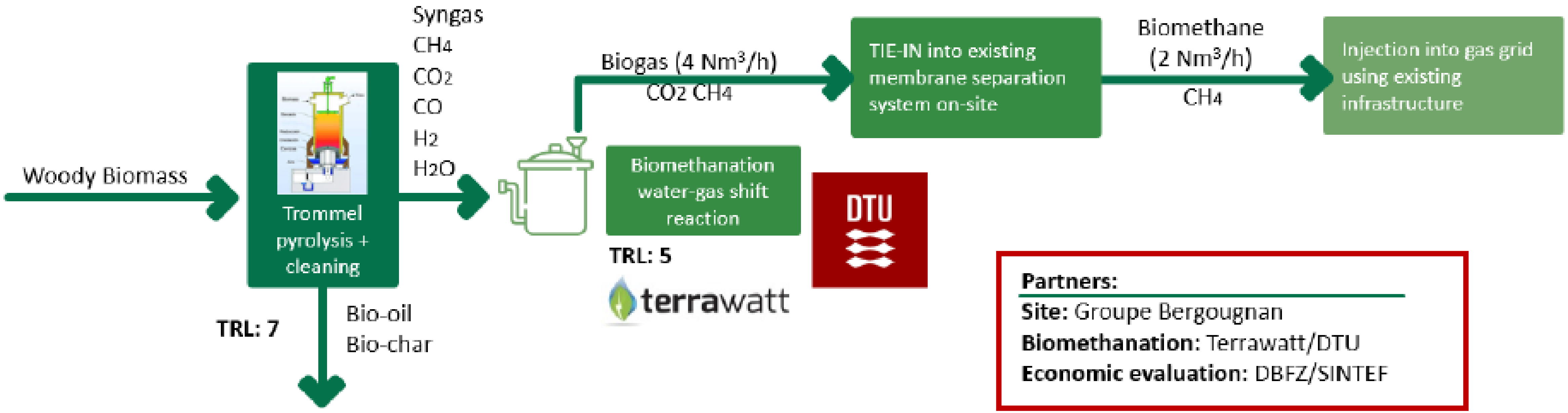
General Description

Process Description



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General Description

Technological Partners:

Technical University of Denmark
Laboratory Optimization of the Biological Methanation process

French start-up developping pyrolysis and biological methanation process
In charge of developping the coupling process and the demonstration plant in Marmagne

Economic Developpement Partners:

Norvegian Foundation for scientific and industrial reasearch
Business models assays and Full Scale modelling

German Biomass Research Center
Full Scale simulation of technological potential
Study of the use of biomass for energy at EU scale

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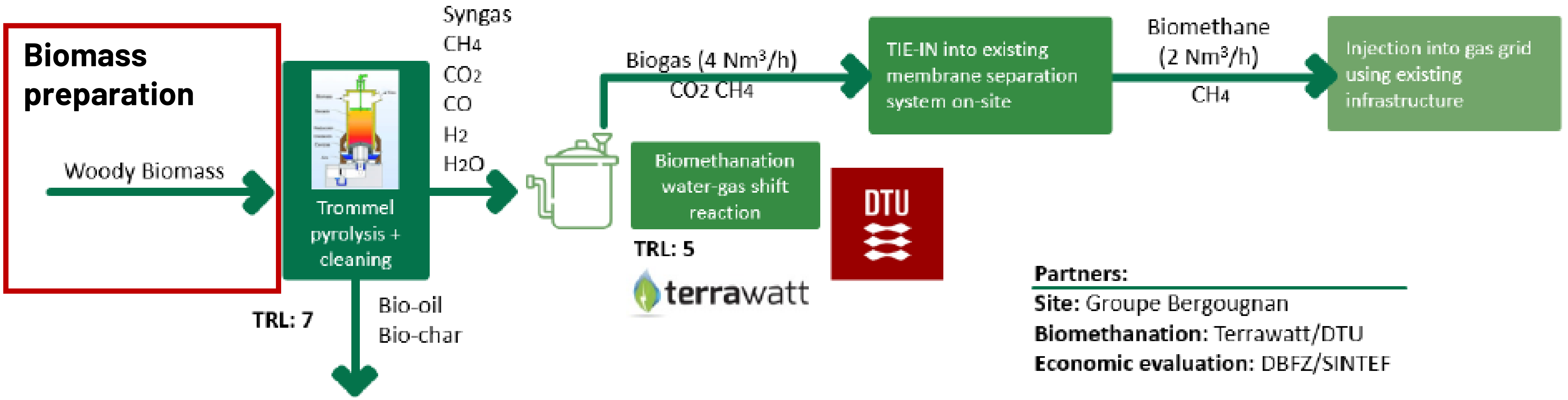
General Description

Process Description



Partners:
Site: Groupe Bergougnan
Biomethanation: Terrawatt/DTU
Economic evaluation: DBFZ/SINTEF

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Biomass used in the process

Green Waste residues from Marmagne after composting

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Biomass used in the process

Biomass need to be shredded before being used in the pyrolysis process

50mm particles
Rocks/metals separation
On site shredding with a project partner

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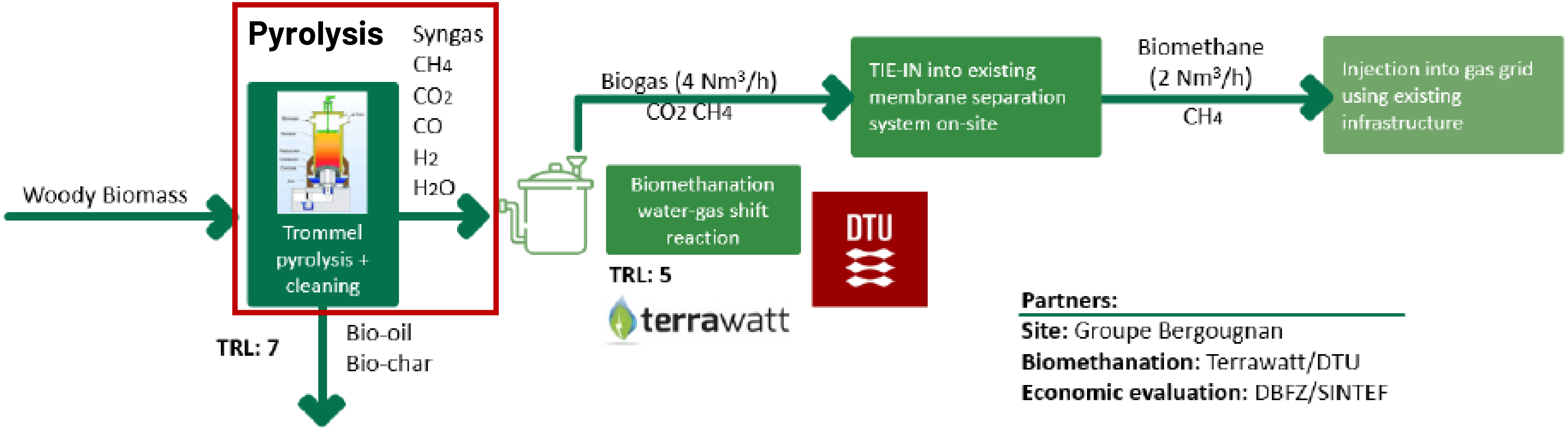
General Description

Process Description



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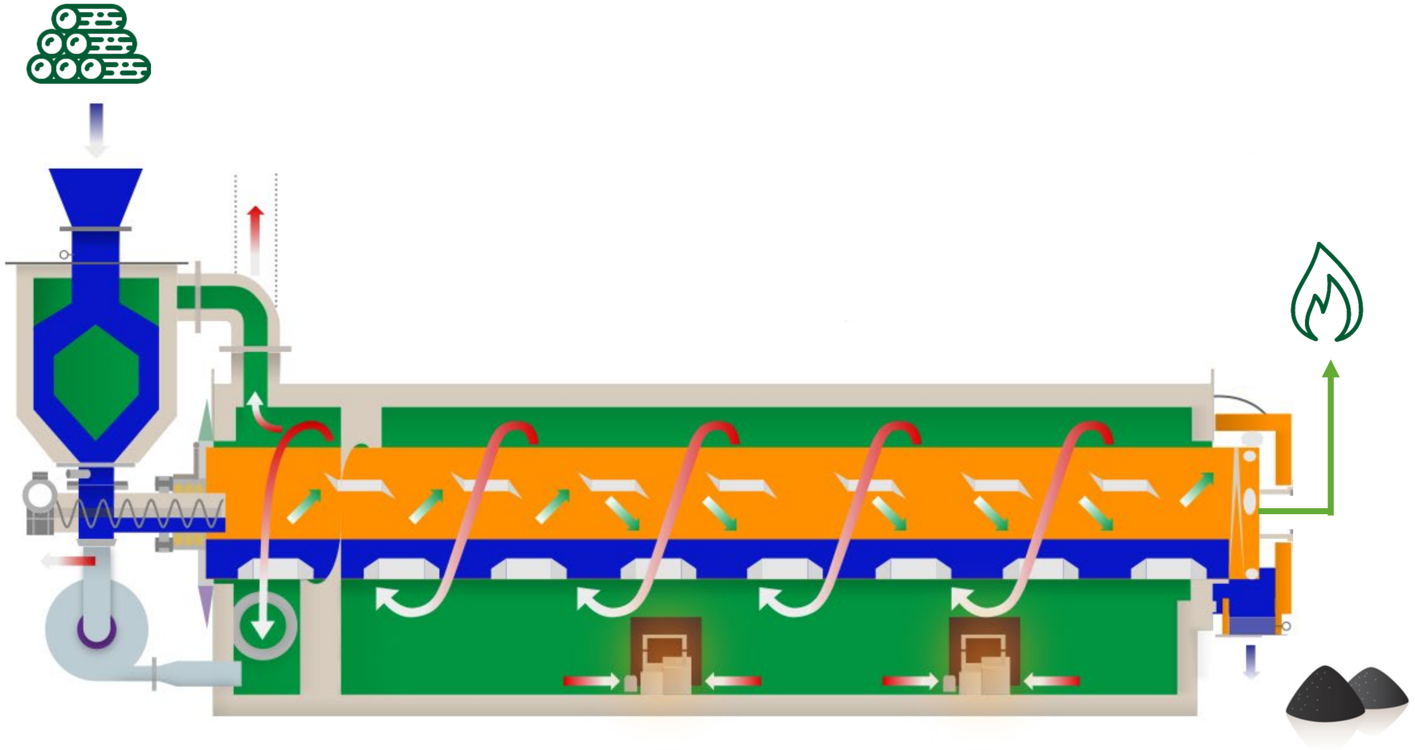
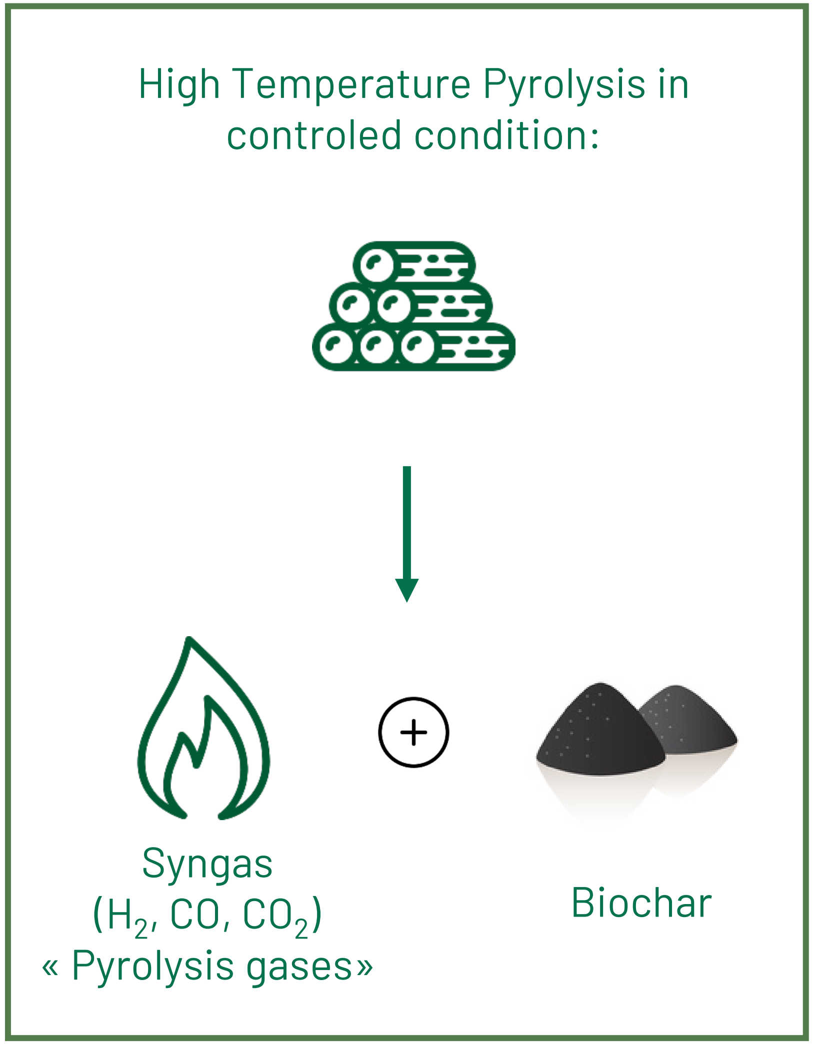
Pyrolysis Process

HIGH TEMPERATURE PYROLYSIS





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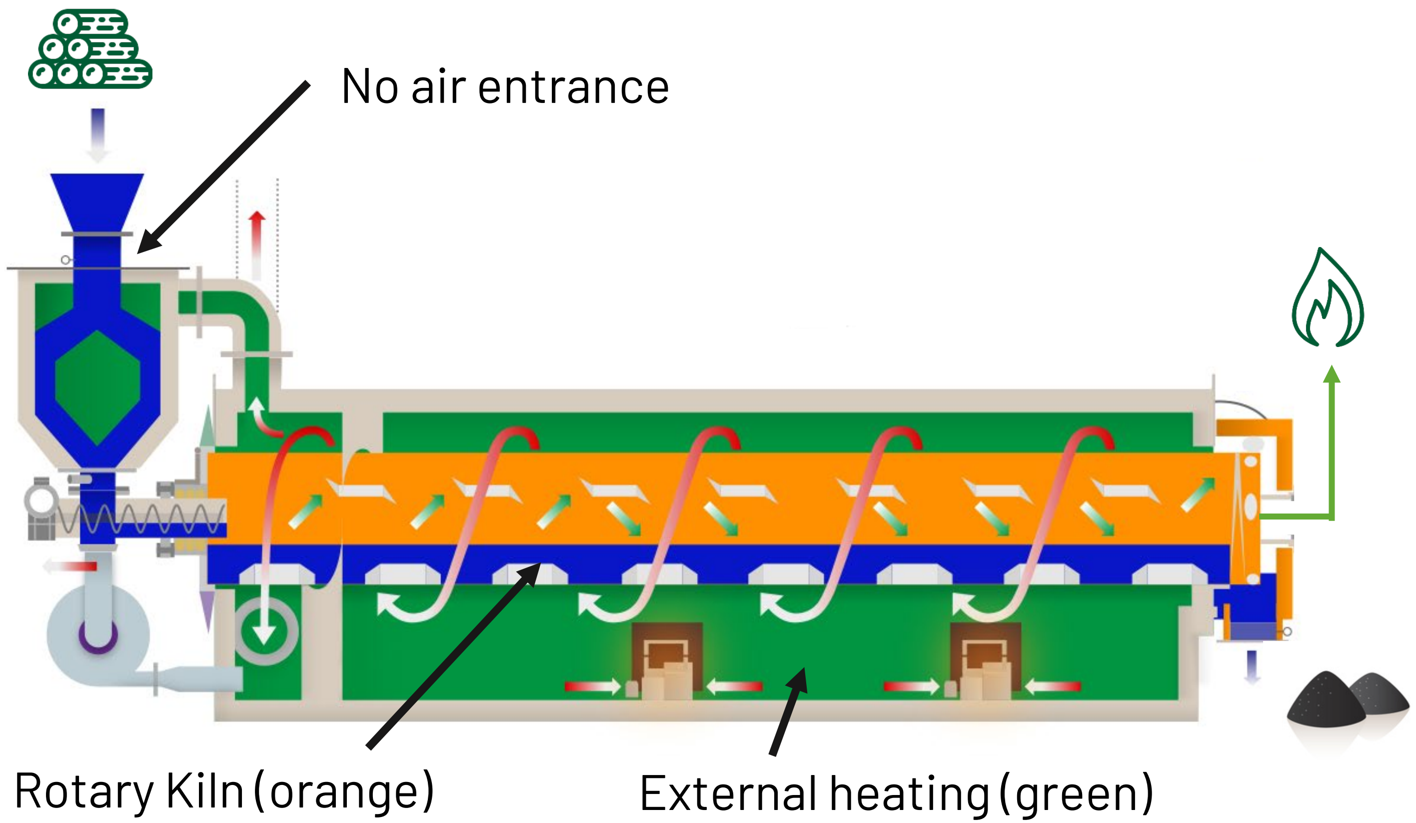
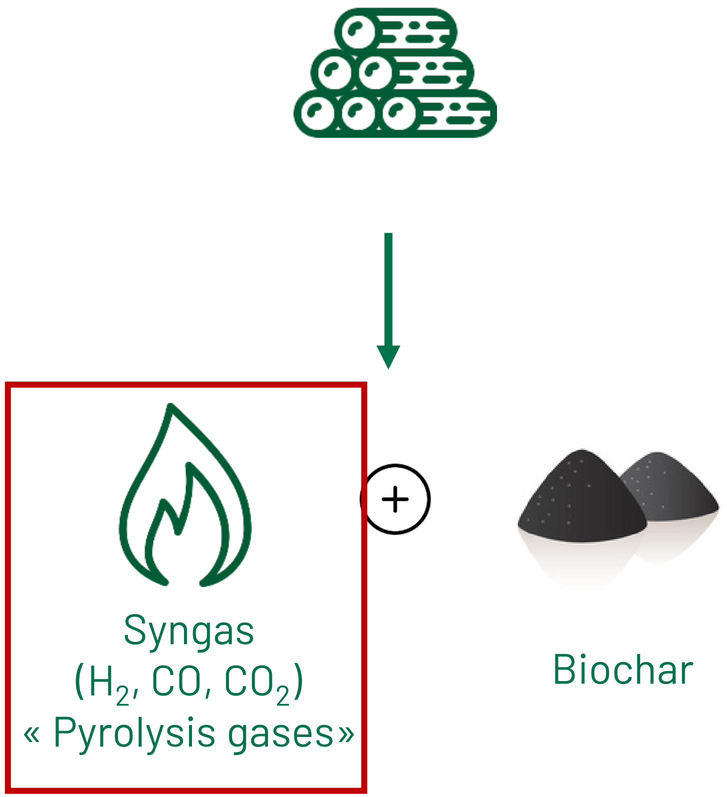
Pyrolysis Process

HIGH TEMPERATURE PYROLYSIS



High Temperature Pyrolysis in controled condition:



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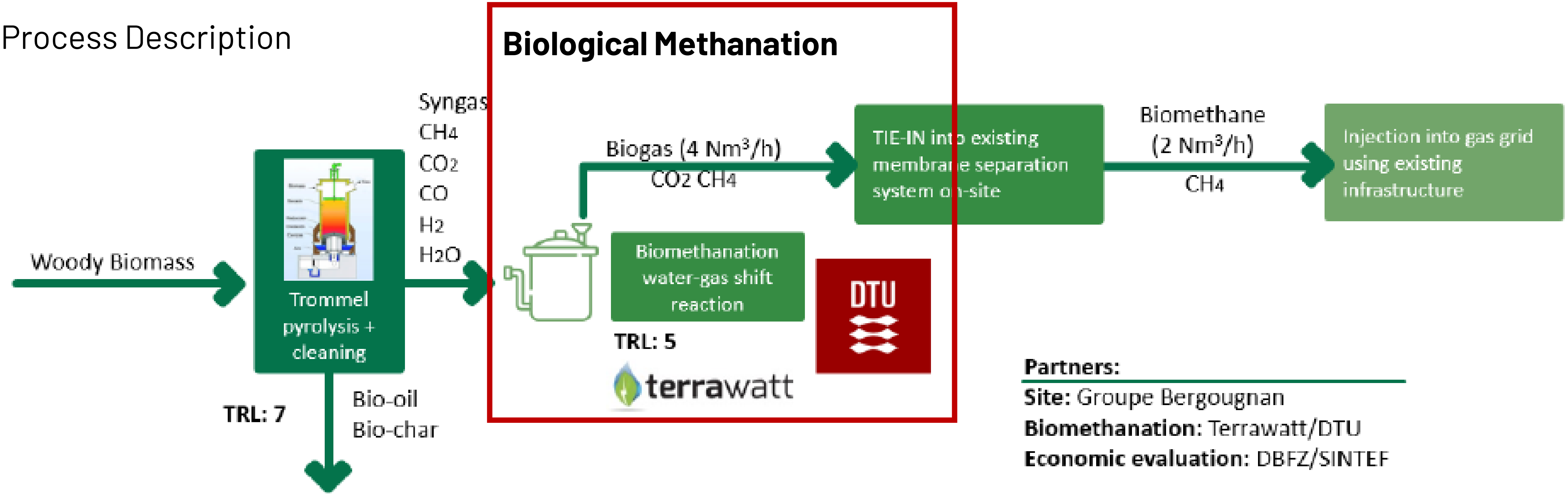
General Description

Process Description



Partners:
Site: Groupe Bergougnan
Biomethanation: Terrawatt/DTU
Economic evaluation: DBFZ/SINTEF

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Biological Methanation

GENERAL DESCRIPTION

Methanogenous micro-organisms are able to transform the syngas (pyrolysis gas) into biogas in controlled conditions.

Syngas
(H_2, CO et CO_2)

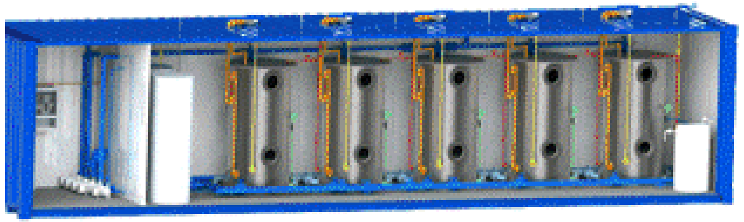
Biogas
(CH_4 et CO_2)

$$CO_2 + 4H_2 \dashrightarrow CH_4 + 2H_2O$$

$$CO + 3H_2 \dashrightarrow CH_4 + H_2O$$

$$4CO + 2H_2O \dashrightarrow CH_4 + 3CO_2$$

Patented by TW:
PCT WO 2017/158024
PCT WO 2018/210960



Terrawatt's Pilot unit

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Reactor configuration
Experimentation and optimization by DTU

Reactor configuration

DTU had a large impact regarding process design and bioreactors configuration.

1/ Selection of the reactor configuration

2/ Selection of the matrix (microbial growth)

3/ Optimization of parameters (Liquid/gas flows)

4/ Optimization of Biological process (Temperature, nutrients, micro-organisms)

Figure 1. Schematic and photo of the bubble column reactor used in bench-scale experiments.

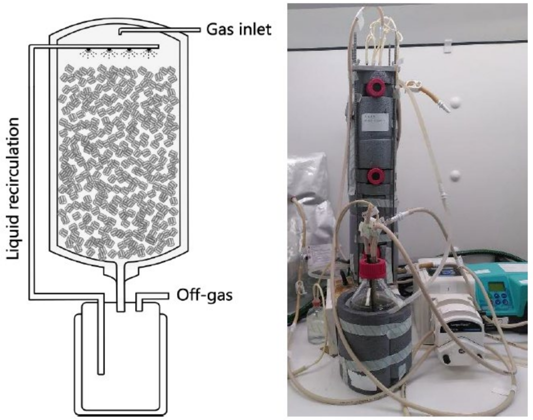

Figure 2. Schematic and photo of the trickle bed reactor used in bench-scale experiments.

Here is a comparison between two reactor type (bubbles and trickle bed)

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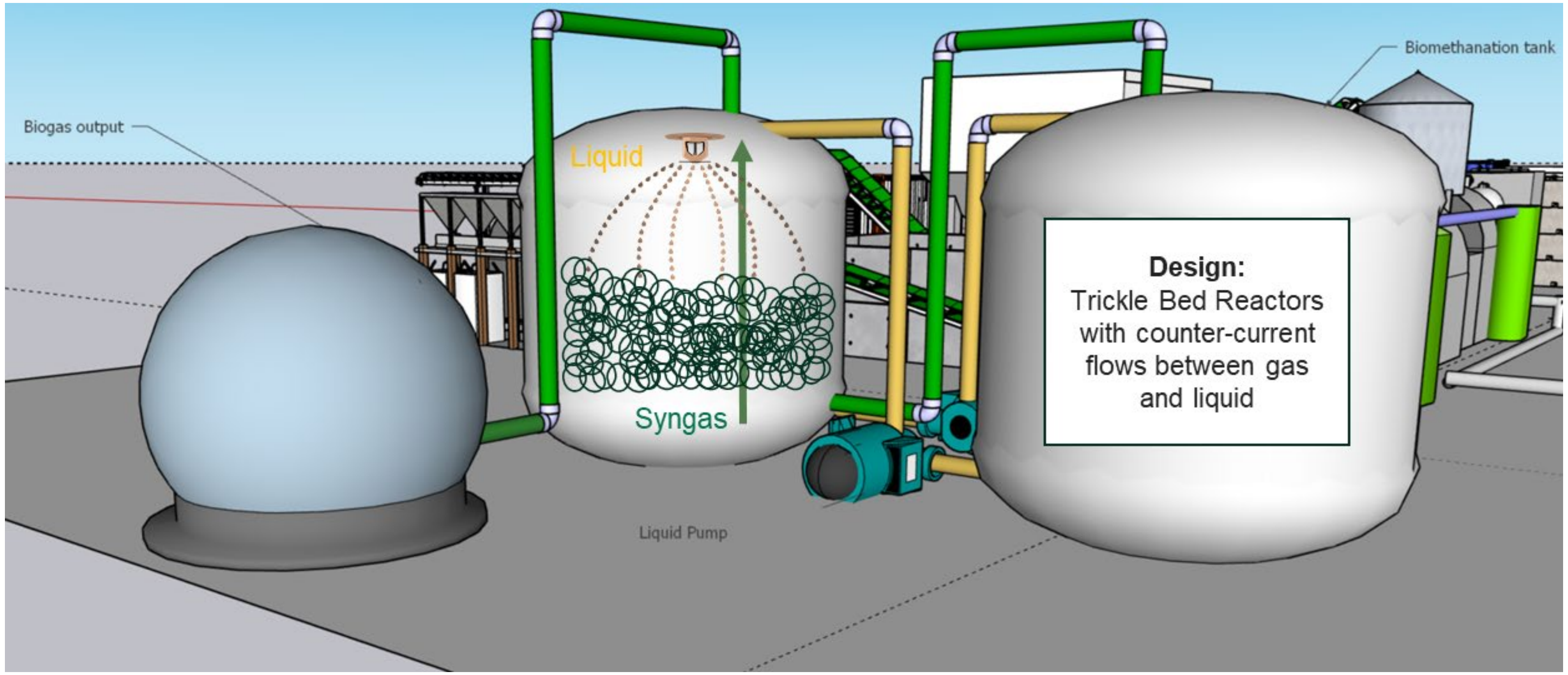
Reactor configuration
Experimentation and optimization by DTU

Reactor configuration



Syngas analysis in progress

Follow our next steps by registering our Newsletter!

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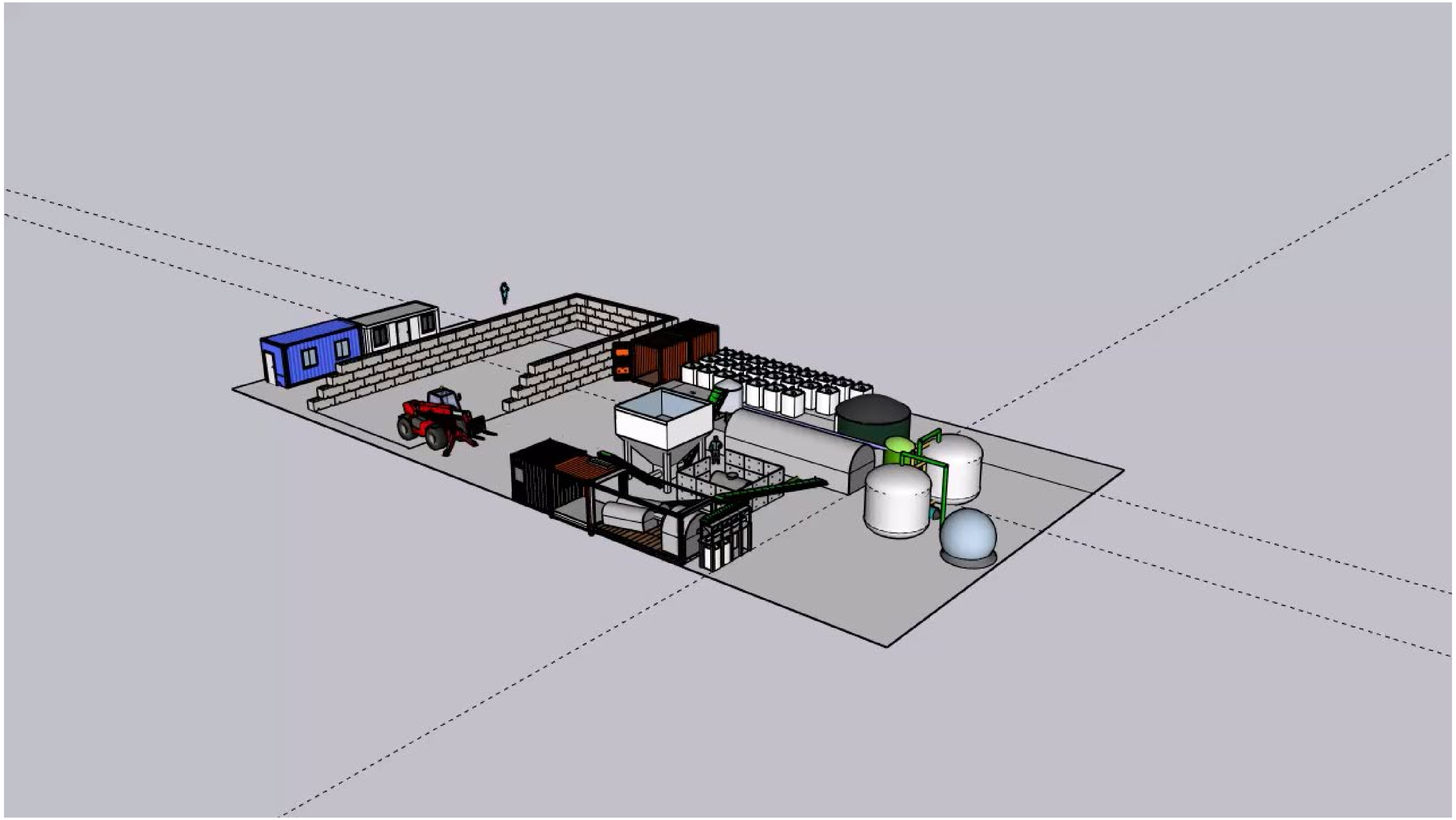
3D model of the experimental site



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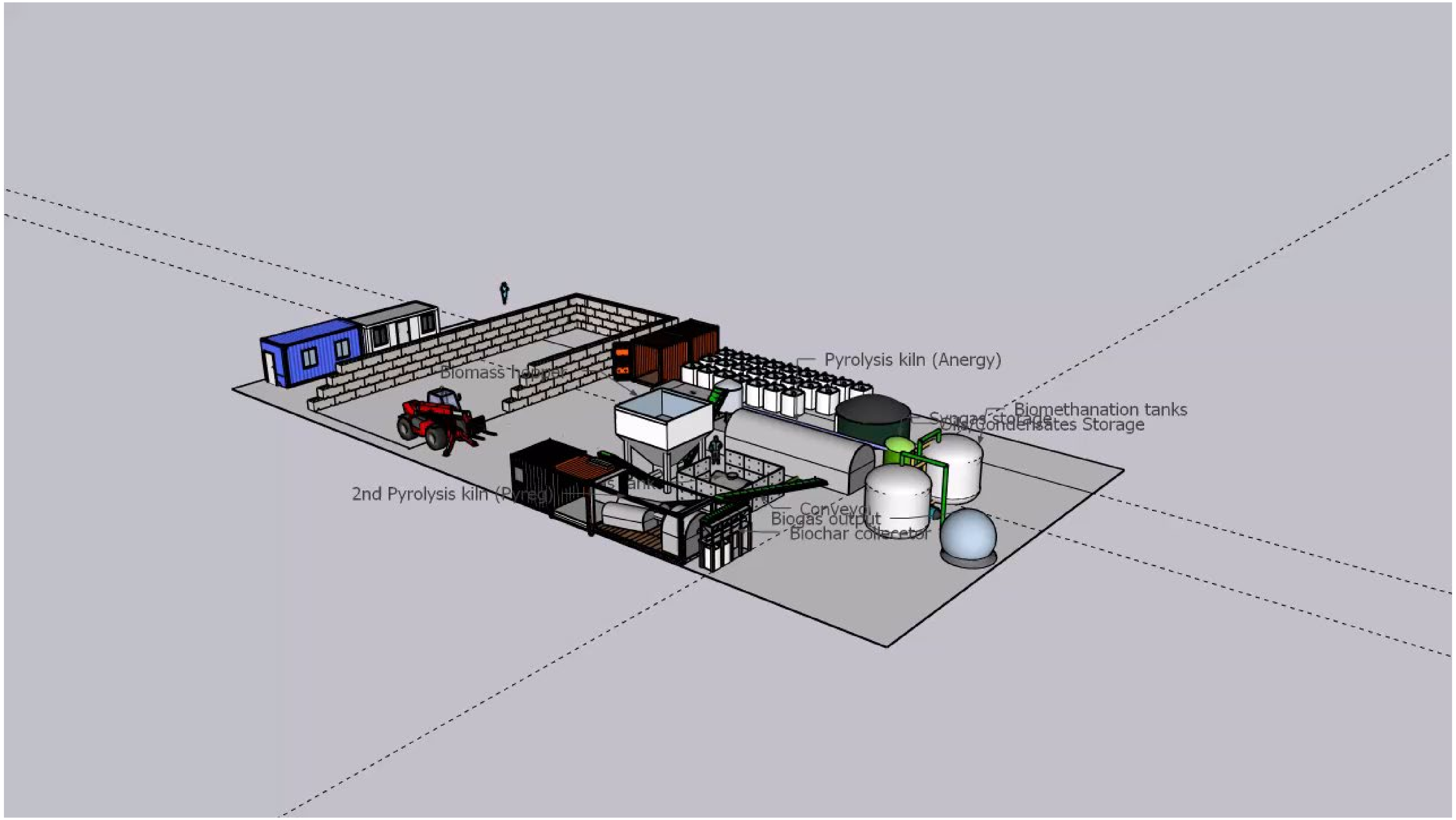
3D model of the experimental site



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Case Study 3

Çağrı Akyol

Postdoctoral Project Manager

UNIVERSITEIT GENT

Andrea Munaretto

Strategy & Business Development, M&A Post-Merger Integration

Pietro Fiorentini

Downscaling a biogas upgrading solution

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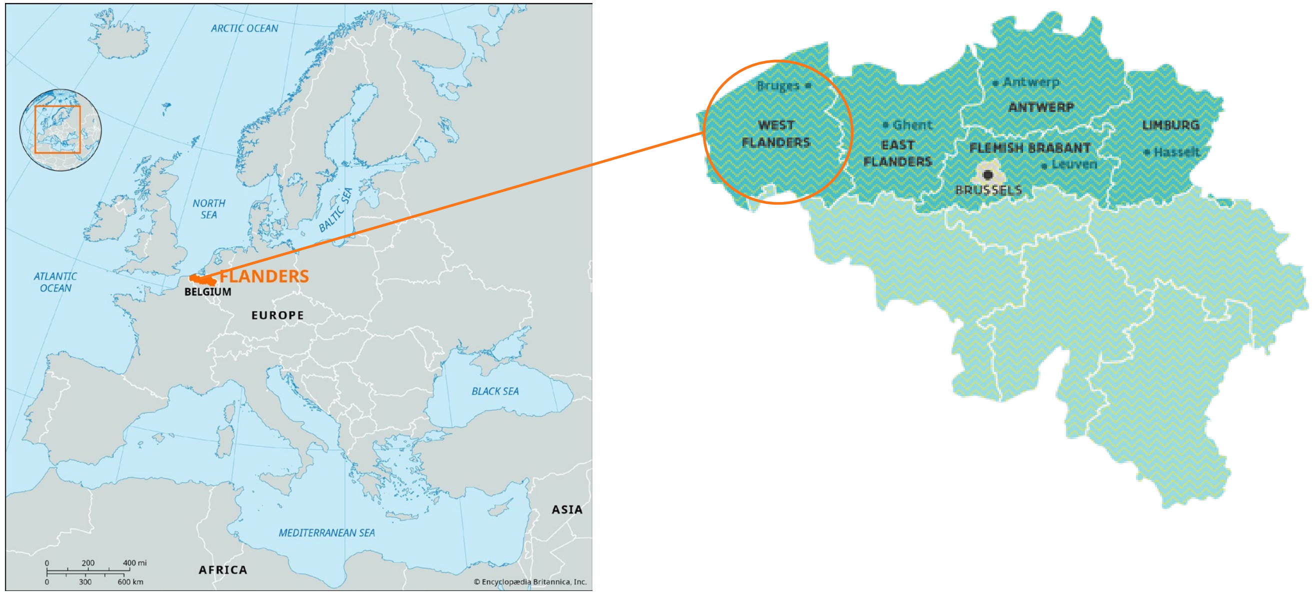
Integrating biomethane upgrading technology in downscaling and retrofitting scenarios

The potential and feasibility of downscaling a biogas upgrading solution (cryogenic solution) to produce BioLNG and Liquid CO_2 from biogas at farm-scale



- There are about 8,000 farms - 35% of all the farms in the Flemish region. 200,000 hectares – 63% of the province's total surface area – is used for agriculture and horticulture.

- More than half of all pigs, one third of all cattle and chickens, half of all potatoes and two thirds of all vegetables grown outdoors in the Flemish region come from the province of West Flanders.

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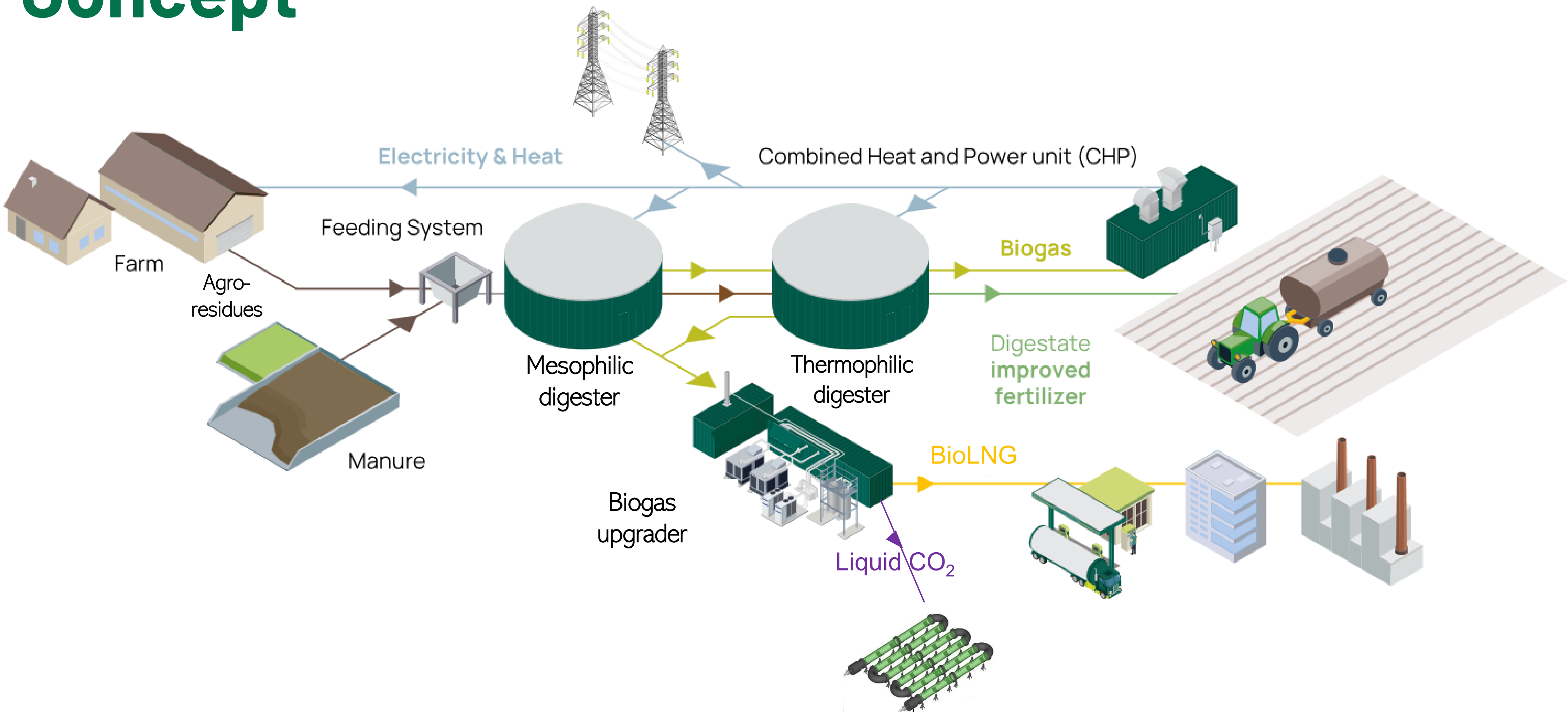
MASSCHELEYN dairy farm, Adinkerke, BE

- A dairy farm, with a biogas permit for processing 25.000 t/y of cattle manure together with 5.000 t/y of co-substrate
- Plant operational for about 8 months
- No. 2 digesters: first mesophilic, then thermophilic (post-digestion)
- Processing manure from 900 cows, mixing and sending to digesters
- Digestate to be transported to France
- Permit and installation of the biogas upgrading demo plant in Q1/2025

Concept



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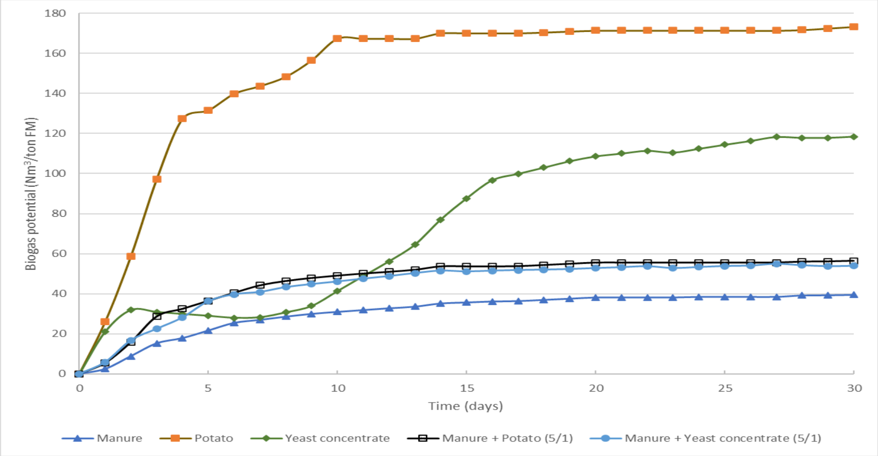
*taken and modified from PlanET Biogas
https://planet-biogas.com/na/biogas/

First things first

- Ensure continuous feedstock supply
- Know your feedstock and their BMP
- Conduct a preliminary study (lab- and pilot-scales)

Feedstock characterization & BMP tests

- Tested feedstock: manure, potato waste, residual yeast concentrate, and their combinations.
- Potato waste is not practical; preference shifted to manure and yeast concentrate.
- Laboratory BMP tests assessed biogas production from these feedstock.



Feedstock	pH	EC (mS/cm)	Moisture content (%)	Dry weight content (%)	Volatile solids (%fresh matter)	Fixed solids (%fresh matter)
Manure	6.95	17.53	88.73	11.27	9.50	1.78
Yeast conc.	3.45	11.18	73.29	26.71	24.38	2.33
Potato waste	-	-	78.2	22.6	21.62	-

Feedstock	Total N (%)	Total C (%)	Total organic C (%)	Total inorganic C (%)	C/N
Manure	2.52	38.8	38.8	0	15.4
Yeast conc.	4.83	43.7	43.7	0	9.0

Feedstock	Total N (%)	Total P (%)	Total K (%)
Manure	2.52	0.5	2.6
Yeast conc.	4.83	1.2	3.1

Feedstock	*Salmonella*	*E. coli* (MPN/g)	Biuret (mg/kg)	Cr(VI) (mg/kg)
Manure	ND	95000.0	< 10.0	< 0.11
Yeast conc.	-	-	-	-

Substrate	DM (%)	ODM (%)	Biogas potential (Nm^3/ton FM)	Biomethane potential (Nm^3/ton FM)	Biomethane potential (Nm^3/ton ODM)
Manure	10.92	9.07	39.5	24.8	273.9
Potato waste	22.60	21.62	173.3	114.7	530.7
Yeast conc.	27.20	24.70	118.5	72.5	293.6
Manure + potato (5:1)	12.86	10.95	56.5	35.9	327.6
Manure + yeast conc. (5:1)	13.57	11.37	54.9	32.8	288.8

Substrate	CH_4 (%)	CO_2 (%)	H_2S (ppm)
Manure	62.9	31.4	246
Potato waste	66.2	27.3	99
Yeast conc.	61.2	22.2	1119
Manure/potato (5:1)	63.5	30.4	142
Manure/yeast conc. (5:1)	59.8	27.5	2128

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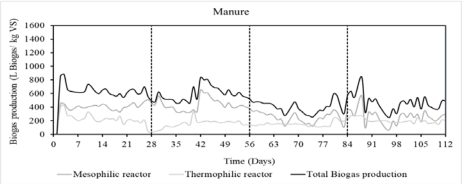
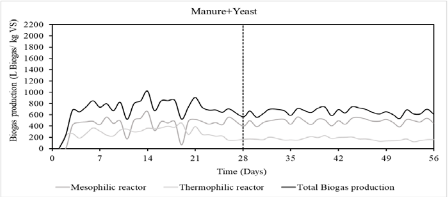
One step closer...
Pilot-scale anaerobic digestion tests

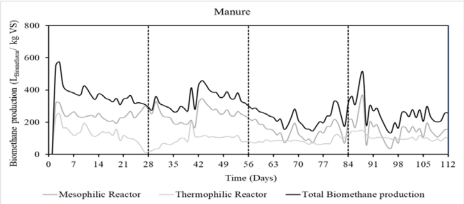
Mimicking the operating conditions of the farm-scale anerobic digesters:

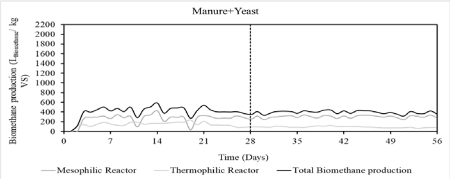
- 2 72L CSTR's
  - Digester 1: Mesophilic conditions (38°C),
  - Digester 2: Thermophilic conditions (52°C)
- HRT: 28 days
- Mono-digestion of manure for 4 HRTs, then added yeast concentrate (5:1) for 2 HRTs
- Affirmative effect of the thermophilic post-digestion (higher biogas yield, increased digestate quality)
- High H_2S in the biogas

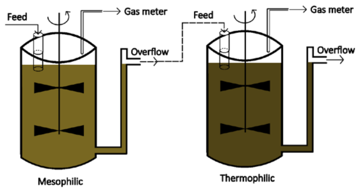
- Co-digestion of **manure and yeast** showed higher (x 1.6 times) and more stable biogas production compared to mono-digestion of manure











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Up and running! Farm-scale anaerobic digesters

- 80 m^3 manure/day + 2 tons corn cob mix
  - Mesophilic digester (40°C)
  - Thermophilic digester (52°C)
- 110 m^3 of biogas/hour
- Biogas composition
  - Mesophilic digester: 55% CH_4, 2130 ppm H_2S (goes down to 1000ppm after activated carbon)
  - Thermophilic digester: 50% CH_4, 75 ppm H_2S

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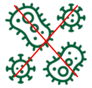
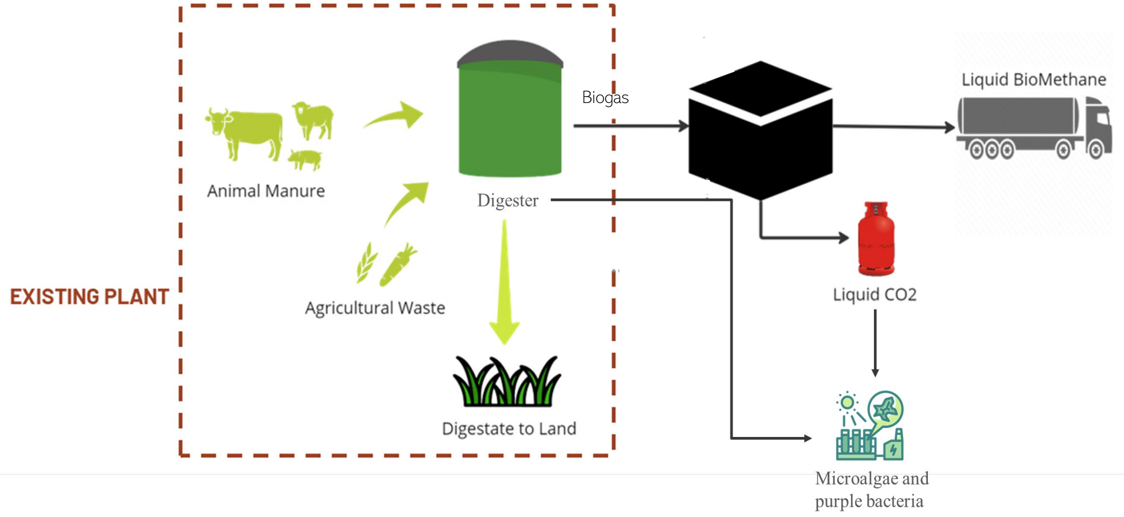
Biogas and biomethane by-products: digestate and liquid CO_2

- The resulting digestate is used for microalgae and purple bacteria cultivation (together with liquid CO_2) in Belgium and as organic fertilizer in France.
- Digestate characterization according to the Products Function Categories of the Fertilising Products Regulation (EU) 2019/1009.
- Macronutrients (N, P, K) and micronutrients are adequate.
- Metal content generally meets the limits, except for higher iron concentration.
- No pathogens in the digestate 
- Food-grade 



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Demo plant

De zwanebloem, De Panne, Belgium

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the European Union

Purpose

Leveraging **advanced cryogenic technology** to explore (and demonstrate in a relevant environment) the potential downsizing of a solution capable of producing BioLNG and Liquid CO2 from raw Biogas with integrated cleaning process, sized at 50 Nm3/h, for applications at the farm-scale digestion level; and the **promoting cleaner energy solutions**

The Case Study focuses on a dairy farm in Belgium, with a biogas permit for processing 25,000 tons per year of cattle manure (from approximately 1400 cows) together with 5,000 tons per year of co-substrate.

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Carbon footprint reduction

Under REDIII, the goal is to reduce greenhouse gas emissions by capturing CO_2 from biomass to replace fossil-based CO_2, prioritizing biofuels, bioliquids, and biomass fuels to achieve significant carbon footprint reduction.

Reduction Target	Due date	Target g CO_2 eq/MJ
50%	October 5, 2015	47,0
60%	December 31, 2020	37,6
70%	December 31, 2025	28,2
80%	from January 1, 2026	**18,8**

For biomass fuels used in the transportation, the reference fossil fuel value shall be:
94 g CO eq/MJ.

Focus on quality, but also efficiency:

Carbon Capture: - 42,34 g CO2 eq/MJ

Energy Efficiency: 464,4 g CO2/kWhe

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RED III directive (Renewable Energy Directive), officially known as **Directive (EU) 2023/2413** of the European Parliament and of the Council of 18 October 2023 **amending Directive (EU) 2018/2001**, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards **the promotion of energy from renewable sources**, and repealing Council Directive (EU) 2015/652

Test bench

CO2 capture Membranes & Cryopolish tests

Test bench aimed at testing the cryogenic capture of CO2 in a Bio Methane stream:

- Testing of Membranes operation
- Testing of Cryopolish operation
- Testing of 2 compositions: 20% CO2 & 1% CO2
- Target: Achieve a CO2 level below 100 ppm

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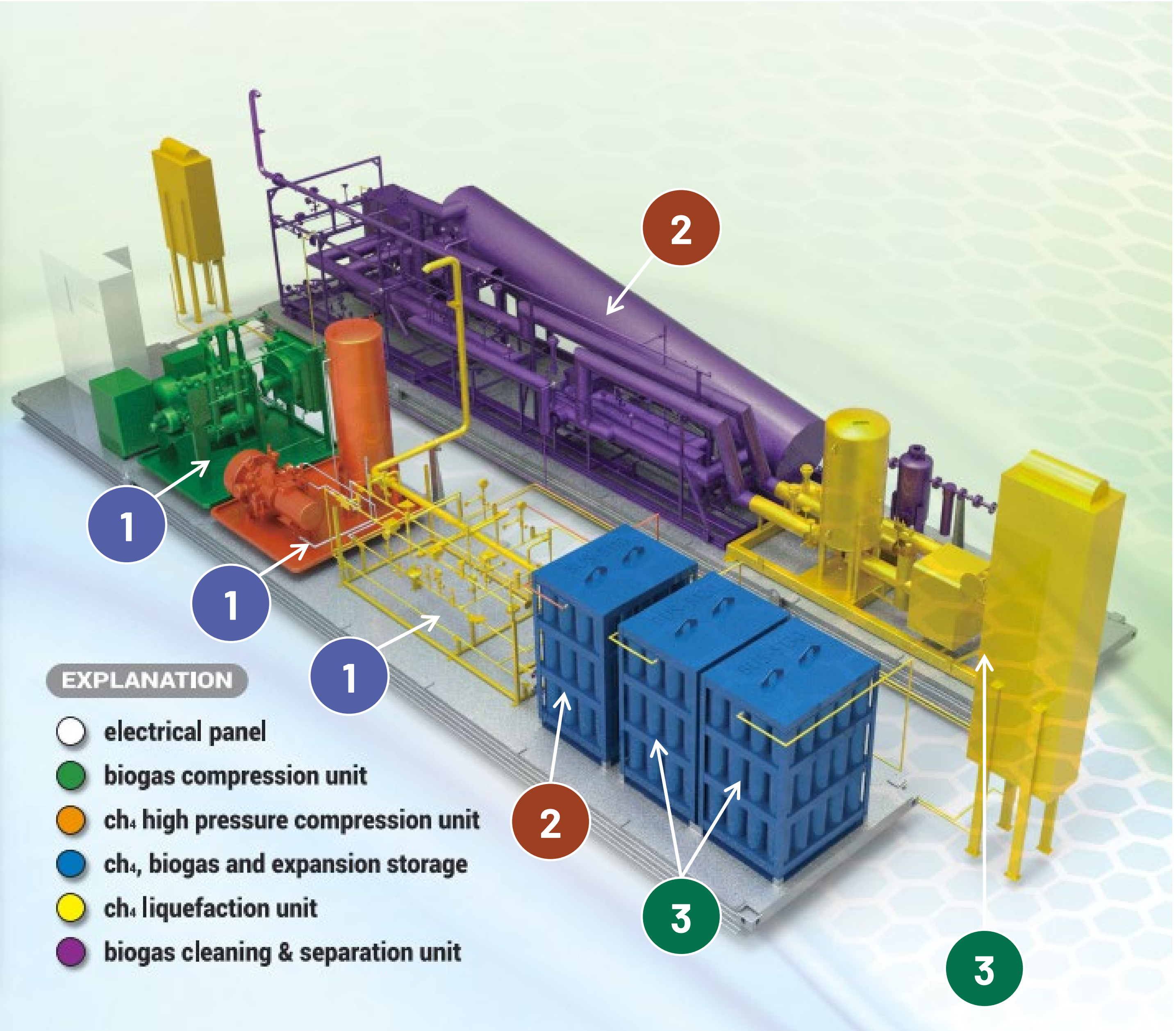
Demo Plant

- **GROUP 1:** H2S removal , Biogas Compression & Dehydration
- **GROUP 2:** Cryogenic cleaning and Upgrading
- **GROUP 3:** Methane Liquefaction



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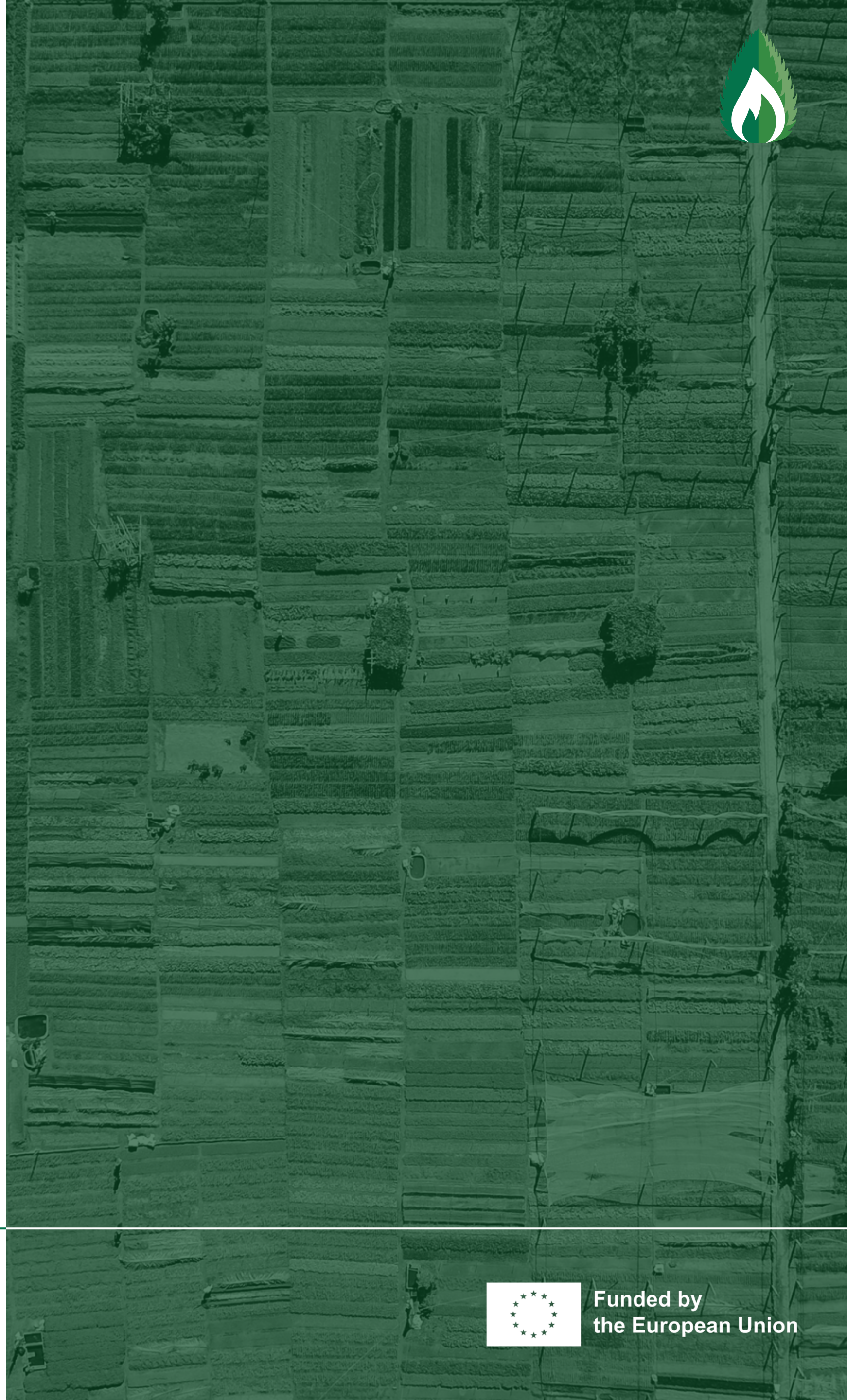
Highlights

Optimized Integrated System: This system directly converts biogas into two valuable liquid products—biomethane and food-grade CO_2.

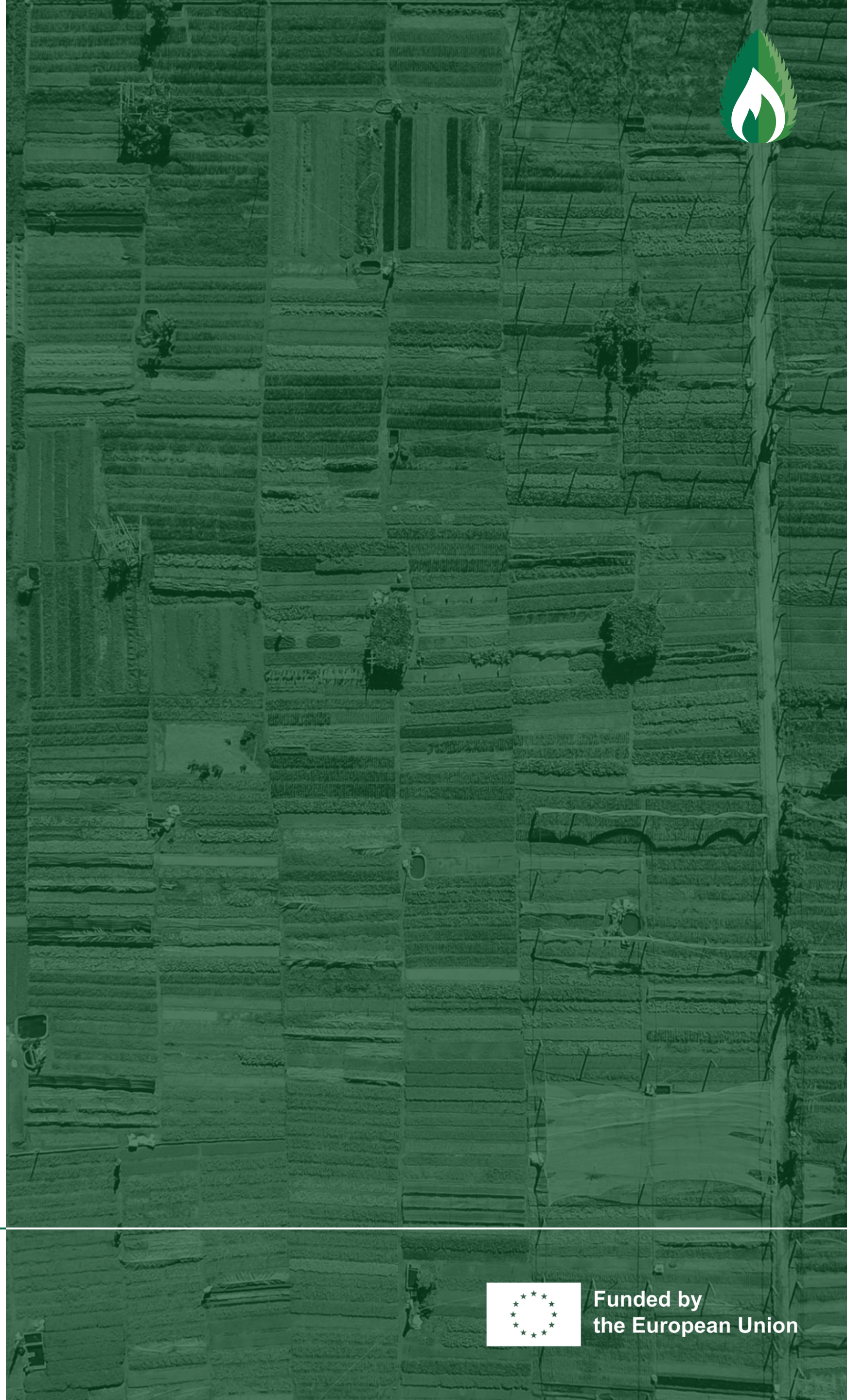
Quality and Efficiency: A solution that ensures food-grade quality CO_2 while optimizing CAPEX and OPEX costs, strengthening the business case.

Value of Renewable CO_2: With government support for renewable CO_2 as a fossil CO_2 substitute, its price is expected to rise, boosting the value of liquid biomethane and creating opportunities to sell certificates.



Next Steps

- Delivery, Installation and Startup of the Demo Plant
- Focus on microalgae cultivation on digestate and (recovered) CO_2 (Lab and pilot-scale) in WP4
- Study towards further business case optimization by addressing biogas & biomethane based by-product costs (and valorisation)



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Webinar
BIo-Impact

CO2 valorisation from biogas streams

Georgina del Puerto Tañà
Biotechnologist Specialized in Microbiology

Beta
Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària

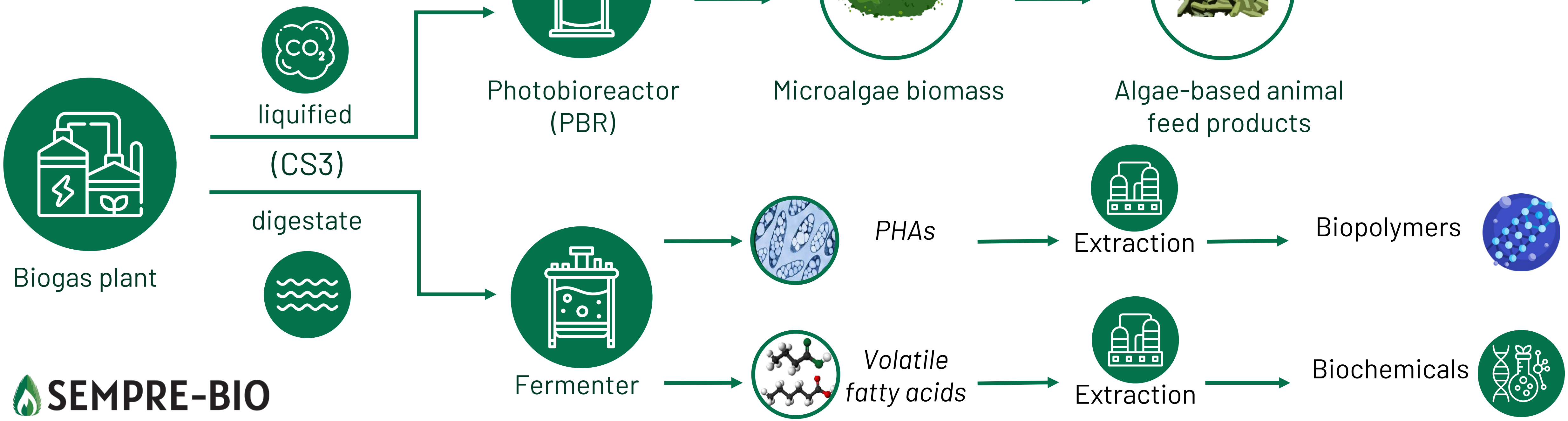
UVIC
UNIVERSITAT DE VIC
UNIVERSITAT CENTRAL DE CATALUNYA

Marcella Souza
Postdoctoral researcher and Project Manager

UNIVERSITEIT GENT

CO_2 conversion into valuable products

CO_2 valorisation from biogas streams



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Biopolymers & biochemicals from CO_2

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Biopolymers & biochemicals from CO_2

Selection of biochemicals and biopolymers to be produced

	Biochemicals Biopolymers	Market Price USD/Kg	Market Size (2018 - 2028)	Downstream Applications
Organic acids	Caproic Acid	7.97	+15%	
Organic acids	Succinic Acid	2.5	+8%	
Organic acids	Butyric Acid	1.6	+6%	
Organic acids	Propionic Acid	1.1	+5%	
	PHA / PHB	2 - 11	+27%	

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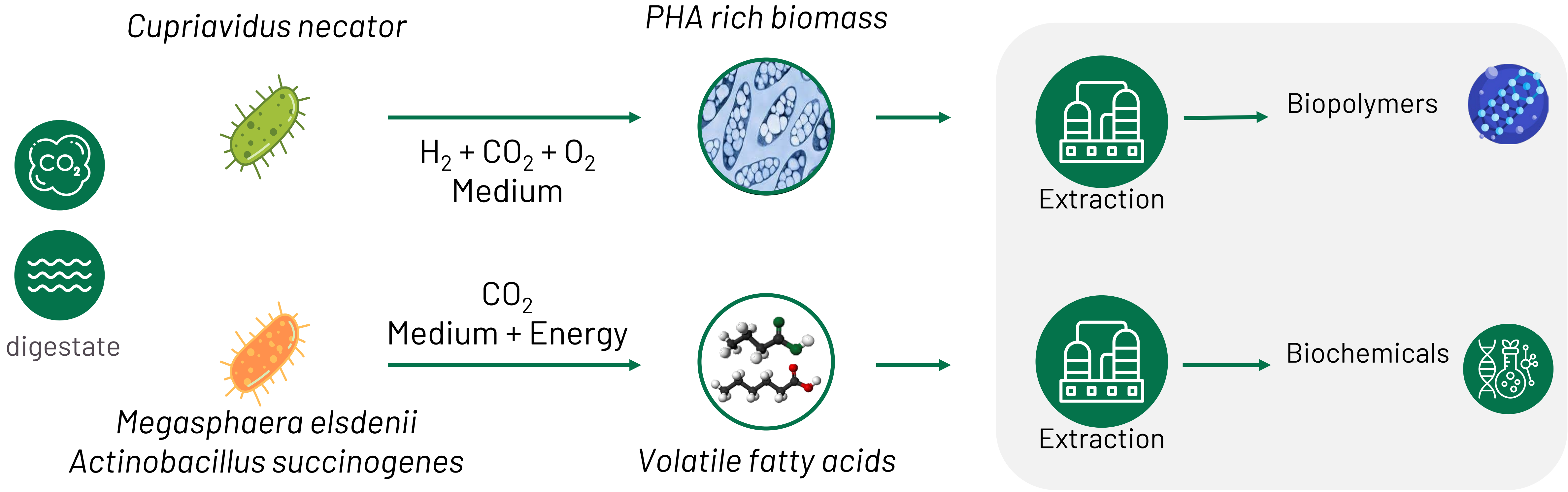
Biopolymers & biochemicals from CO_2

Selection of the microbial strains



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Biopolymers & biochemicals from CO_2

Production of biopolymers at lab-scale

Microbial strain and substrate

Digestate`s liquid fraction

Cupriavidus necator

- High PHA/PHB content (60 - 90%)
- CO_2 as the main carbon source
- PHA/PHB of CDM (cell dry matter)
- High productivity (1.97 g/L/h)

Operational conditions

- 30°C , 180 rpm, 2 days, pH_0: 7
- Injection of CO_2, H_2 and air in 1 L bottles
- Synthetic growing medium vs. digestate's liquid fraction

Gas bags and their linkage to the reactors within a controlled temperature shaker environment

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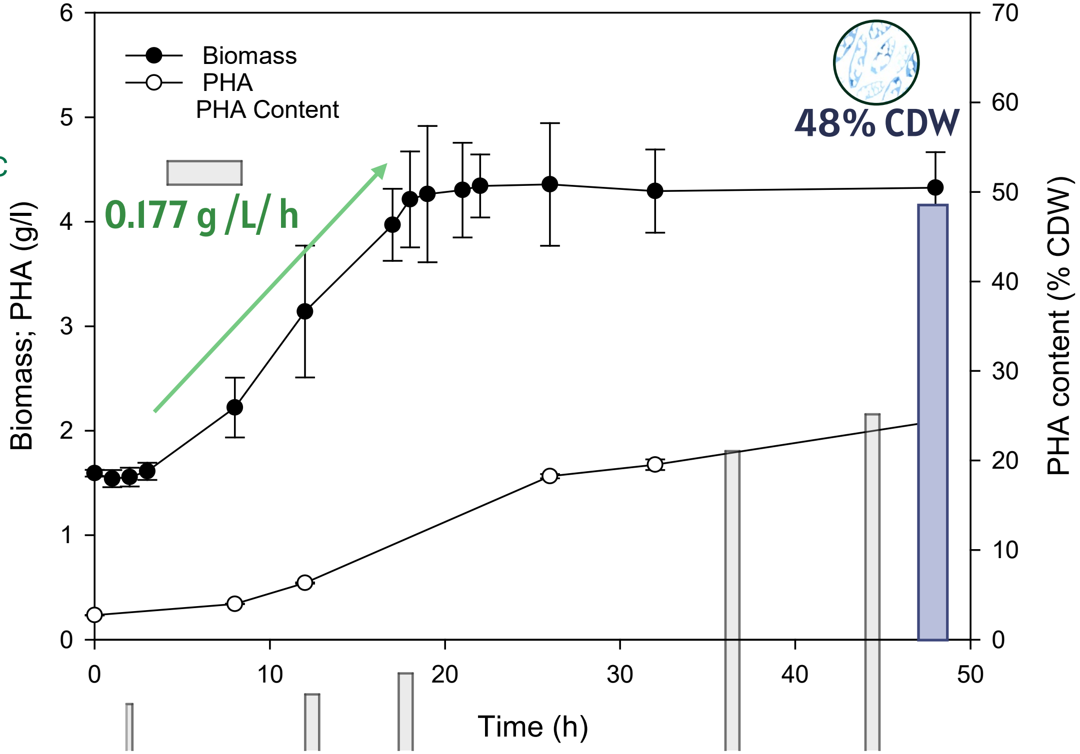
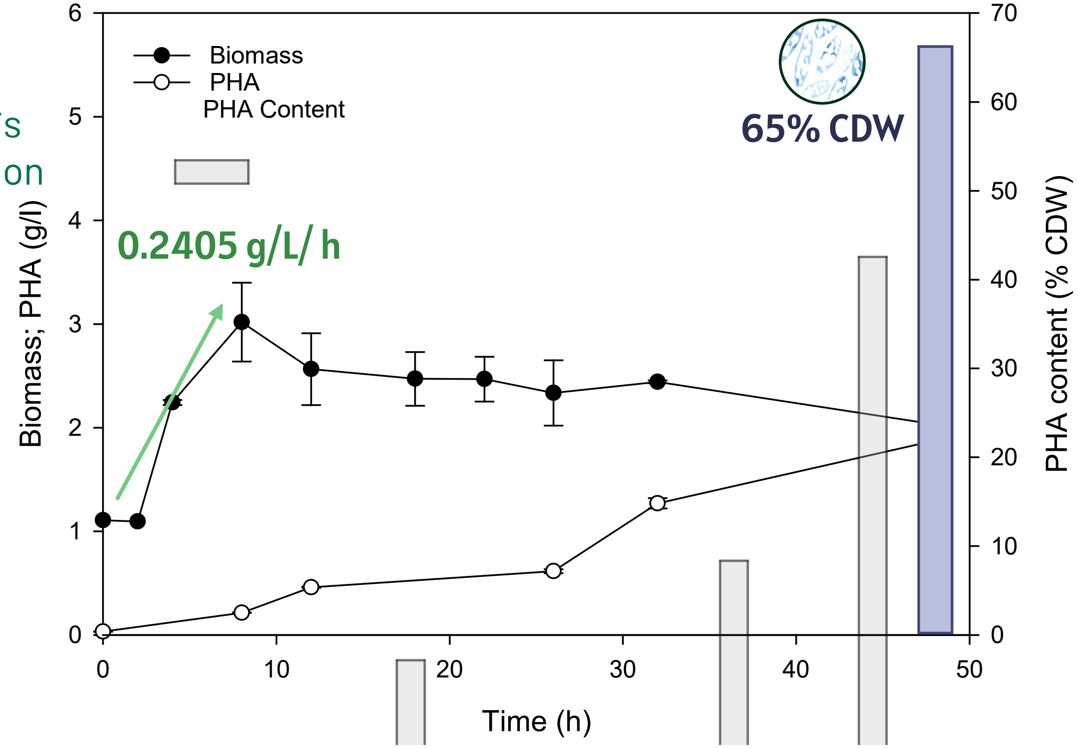
Biopolymers & biochemicals from CO_2

Production of biopolymers at lab-scale

Synthetic medium



Digestate`s liquid fraction



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Biopolymers & biochemicals from CO_2

Production of succinic acid at lab-scale

Microbial strain and substrate

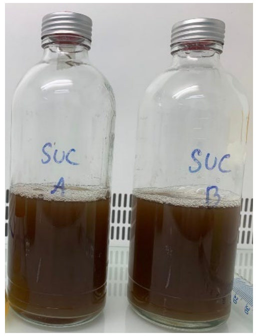
Digestate`s liquid fraction

Actinobacillus succinogenes

- 40 g/l of succinic acid , of 1.06 g SA/L/h
- Acetate (0.14-0.20 g/g) and formate (0.08-0.13 g/g) as main byproducts
- Biogenic CO_2 sparging as C-source

Operational conditions

- 150 mL – 1 L bottles
- Synthetic growing medium vs. digestate
- 37°C , 150 rpm, 2-7 days
- Initial purge with CO_2



- *Succinic acid lab trial production in anaerobic and pressurized serum bottles of 0.15 L.*
- *1 L fermenters employed for the succinic acid production with digestate`s liquid fraction.*

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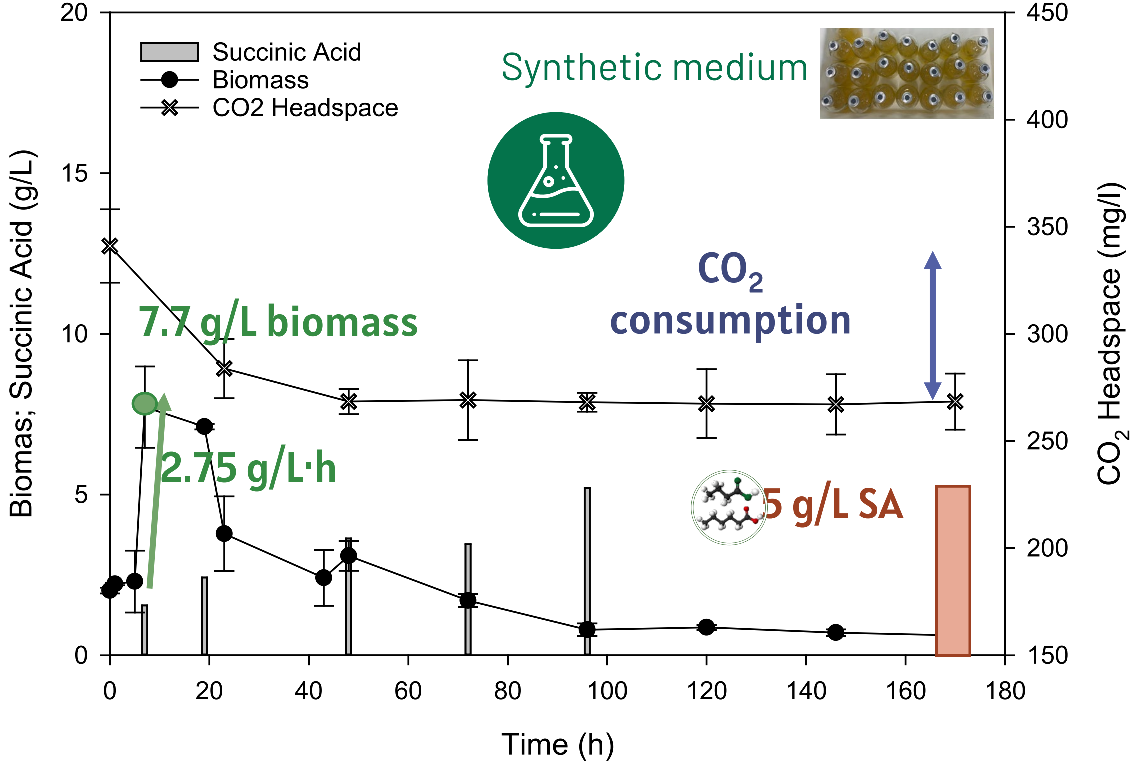
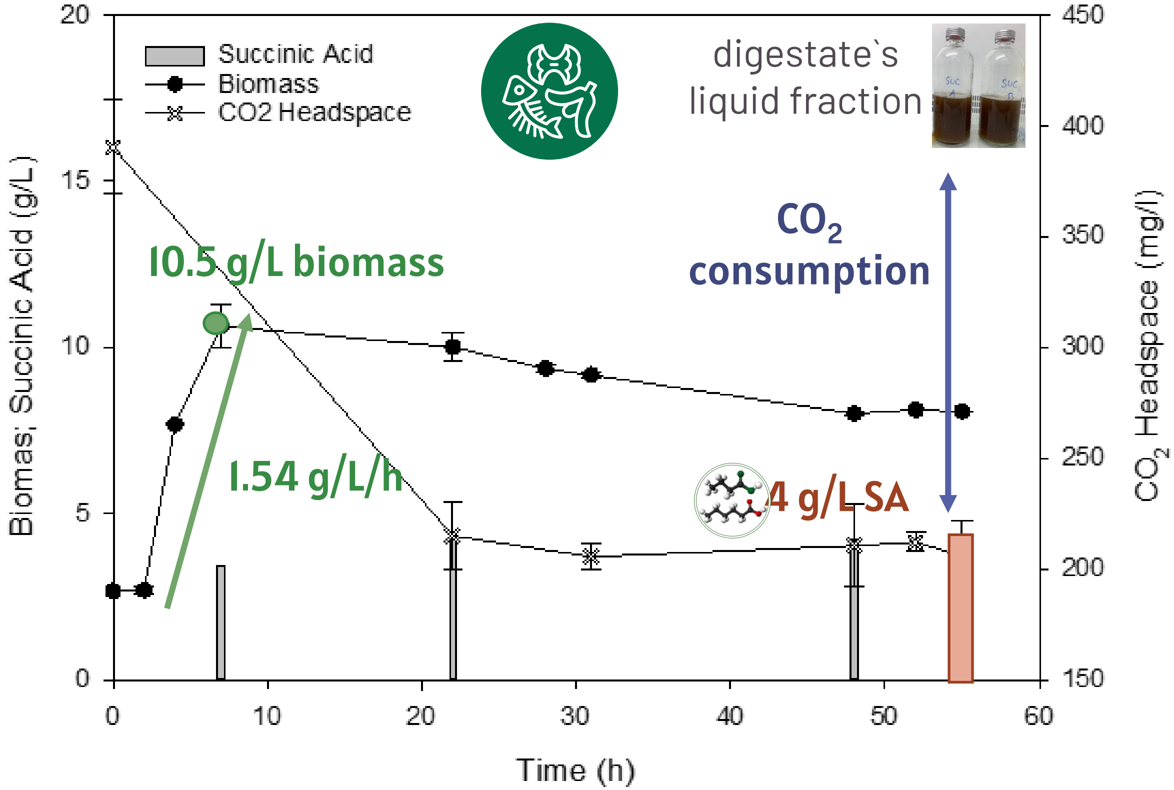
Biopolymers & biochemicals from CO_2

Production of succinic acid at lab-scale





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Biopolymers & biochemicals from CO_2

Lab-scale findings

Biopolymers

- Successful growth of *C. Necator* in digestate`s liquid fraction.
- Limitation in gas mixture gas/liquid mass transfer into the fermentation broth.
- More efficient gas injection system to improve the effectiveness of the fermentation process.

Succinic Acid

- Preliminary data to optimize the process in the upscaled operation.
- Lower headspace overpressure and gas/liquid mass transfer.
- Pilot-scale reactor design optimize the fermentation mode, increasing headspace overpressure and improving gas/liquid mass transfer.

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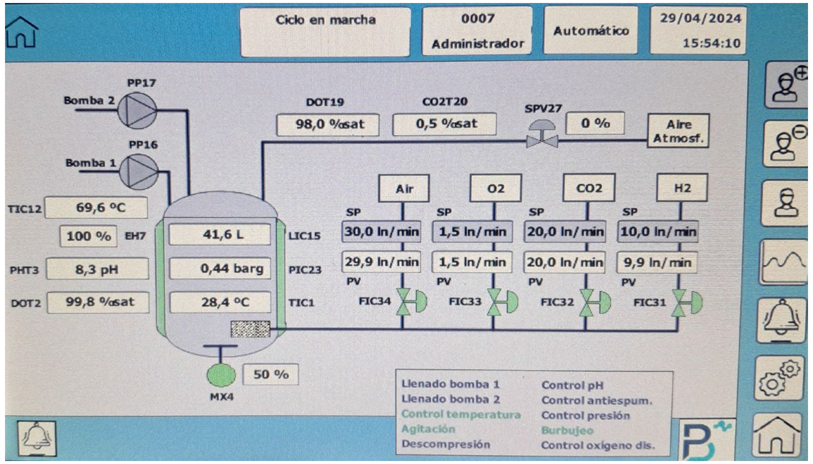
Biopolymers & biochemicals from CO_2

Pilot hybrid fermenter

Reactor design:
- Automatic / Programable
- Temp, stirring, pH, DO, CO2 controls
- Gas inlets / mixing
- Pumps for feeding / emptying
- Gas detection & measuring
- Cleaning in Place
- Bottom drain
- Sampling Ports
- Pressure control valves
- PLC – Control Unit



PLC – Control Unit

Volume: 50 L
Pressure: max. 3 bar

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Microalgae as alternative protein source from CO_2

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Microalgae as alternative protein source from CO_2

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Biogas plant

liquified (CS3) CO_2

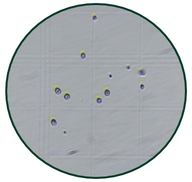
digestate

Photobioreactor (PBR)

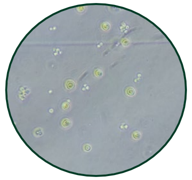
Microalgae biomass

Algae-based animal feed products

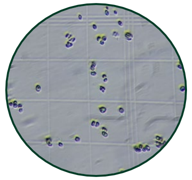
Microbial strains



Chlorella vulgaris

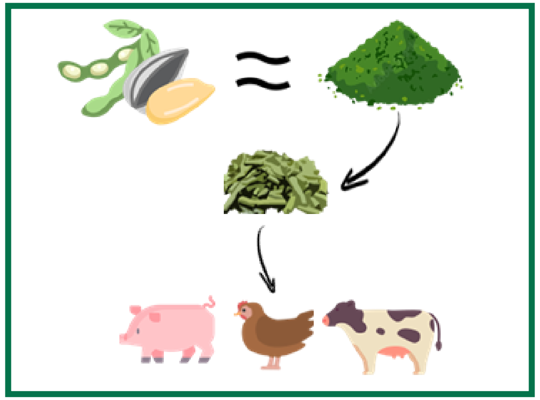


Parachlorella kessleri



Tetradesmus obliquus

- ✓ Regulated consumption in the EU
- ✓ % protein > 50%, good amino acid score
- ✓ Used in feed formulation, good digestibility
- ✓ Freshwater, digestate nutrients uptake capability
- ✓ Efficient CO_2 uptake
- ✓ Opt Temp. 25-27 °C. Resistance to a high range
- ✓ PBR vertical tubular productivity > 1 g/L



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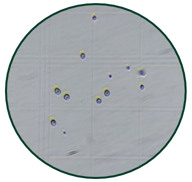
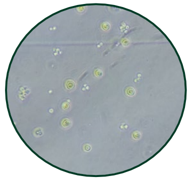
Microalgae as alternative protein source from CO_2

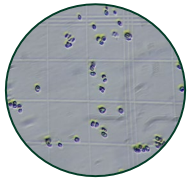
Micralgae strains



Chlorella vulgaris



Parachlorella kessleri



Tetradesmus obliquus

Culture medium: digestate's liquid fractions

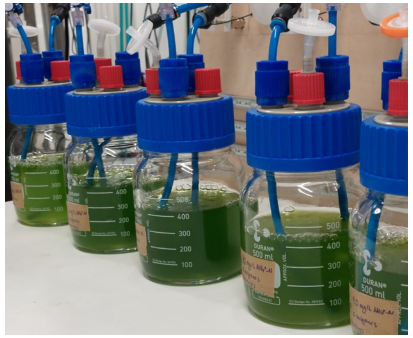
Digestate from Cheese-whey valorisation **(CWD)**

Agri-food waste digestate **(AFWD)**

Cow-manure digestate **(CMD)**

Operation

Lab-scale trials



Pilot Photobioreactor (PBR)

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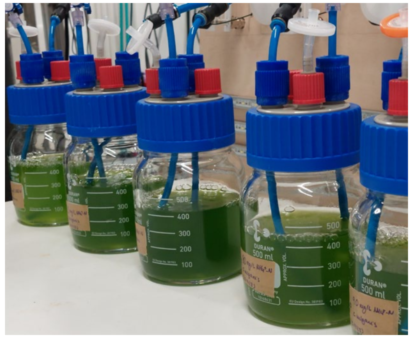
Microalgae as alternative protein source from CO_2

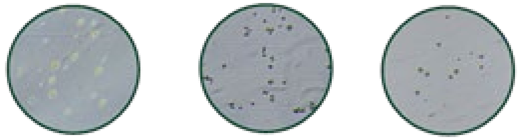
Activities conducted in Spain: lab-scale

- Evaluation of the influence of the strain on the production of protein.
- Assessment of the influence of 3 types of digestate's liquid fractions on the production of protein.
- Acclimatisation of the microalgae strains at increasing concentration of nitrogen.



Operational conditions

- 26 ± 3 °C , 10 days, pH_0: 8, 0.5 L reactors
- 100 μmol m^{-2} s^{-1}, 0.3 vvm aeration rate, 1.62 % CO_2
- 100 mg NH_4^+-N L^{-1}
- Synthetic growing medium vs. digestate's liquid fraction



Parachlorella kessleri *Tetradesmus obliquus* *Chlorella vulgaris*

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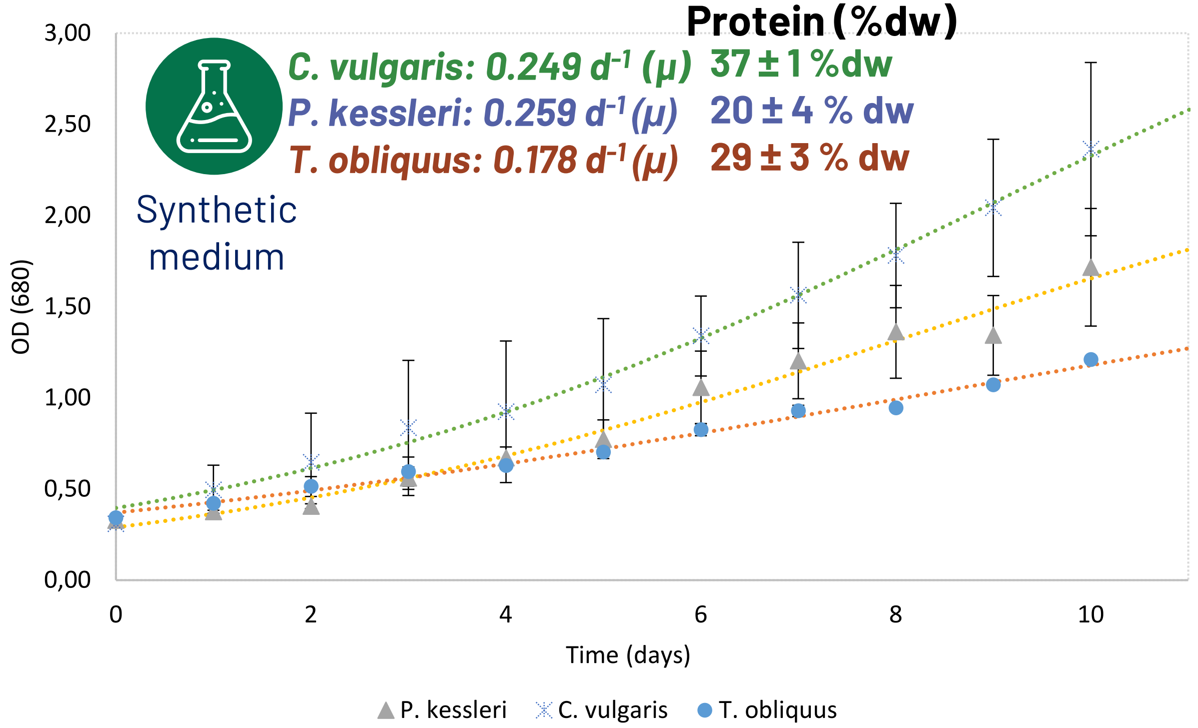
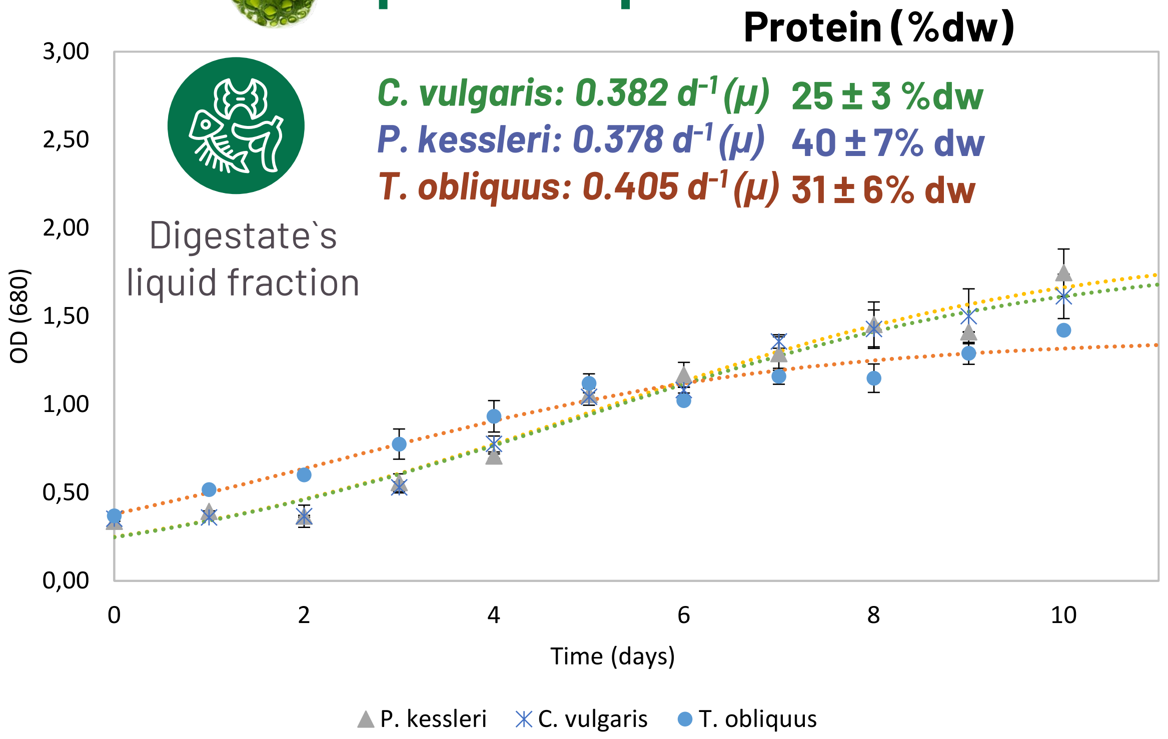
Microalgae as alternative protein source from CO_2

- **Lab-scale experiments: growth curves**

Up to 40 % protein content





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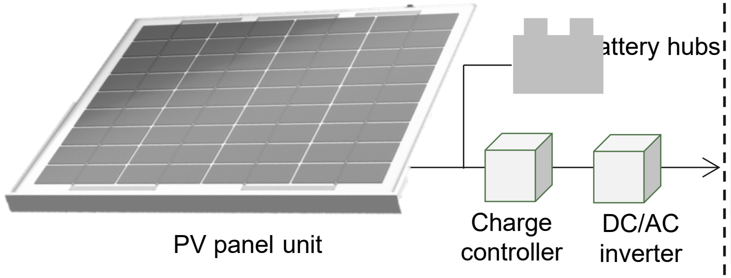
A B C

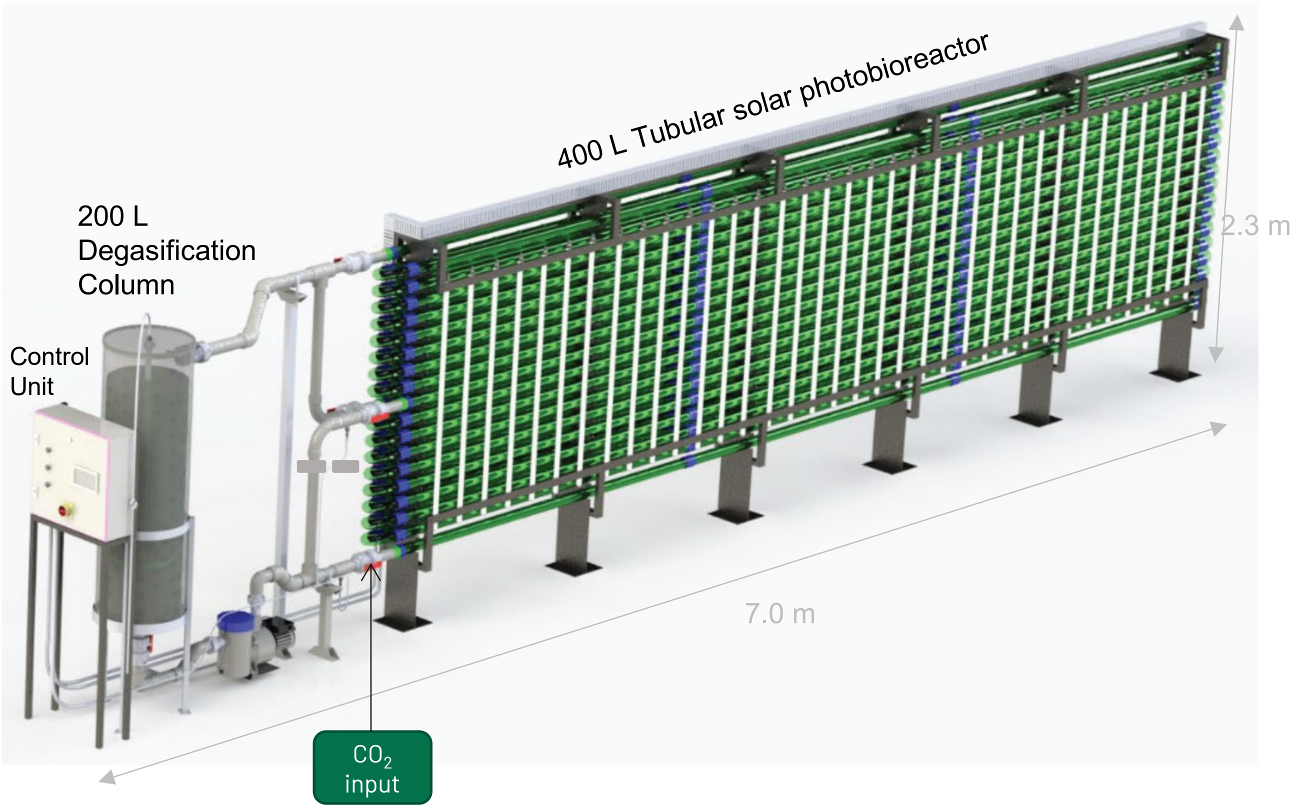
Microalgae as alternative protein source from CO_2

Pilot-scale photobioreactor (PBR) design

Considerations for the design:

- Control system for temperature: 28-30°C
- pH control by CO2 addition
- Sensors and probes: pH, Tª, CO2, DO, turbidity, energy consumption and solar irradiance
- Gas inlets/mixing, peristaltic pump for feeding
- Harvesting: centrifugation
- PLC – Control Unit
- PV unit 6 kWh/day





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Microalgae as alternative protein source from CO_2

Pilot-scale photobioreactor (PBR)

- Microalgae strain: *Parachlorella kessleri.*
- Validation of the production of microalgae at pilot scale using synthetic CO_2 and digestate.
- Optimization of the PBR operation to maximize the productivity and CO_2 recovery.
- Validate the production of alternative protein sources at pilot scale using liquified CO_2 and digestate from CS3.

Pilot-scale photobioreactor (PBR) implemented in BETA TC facilities

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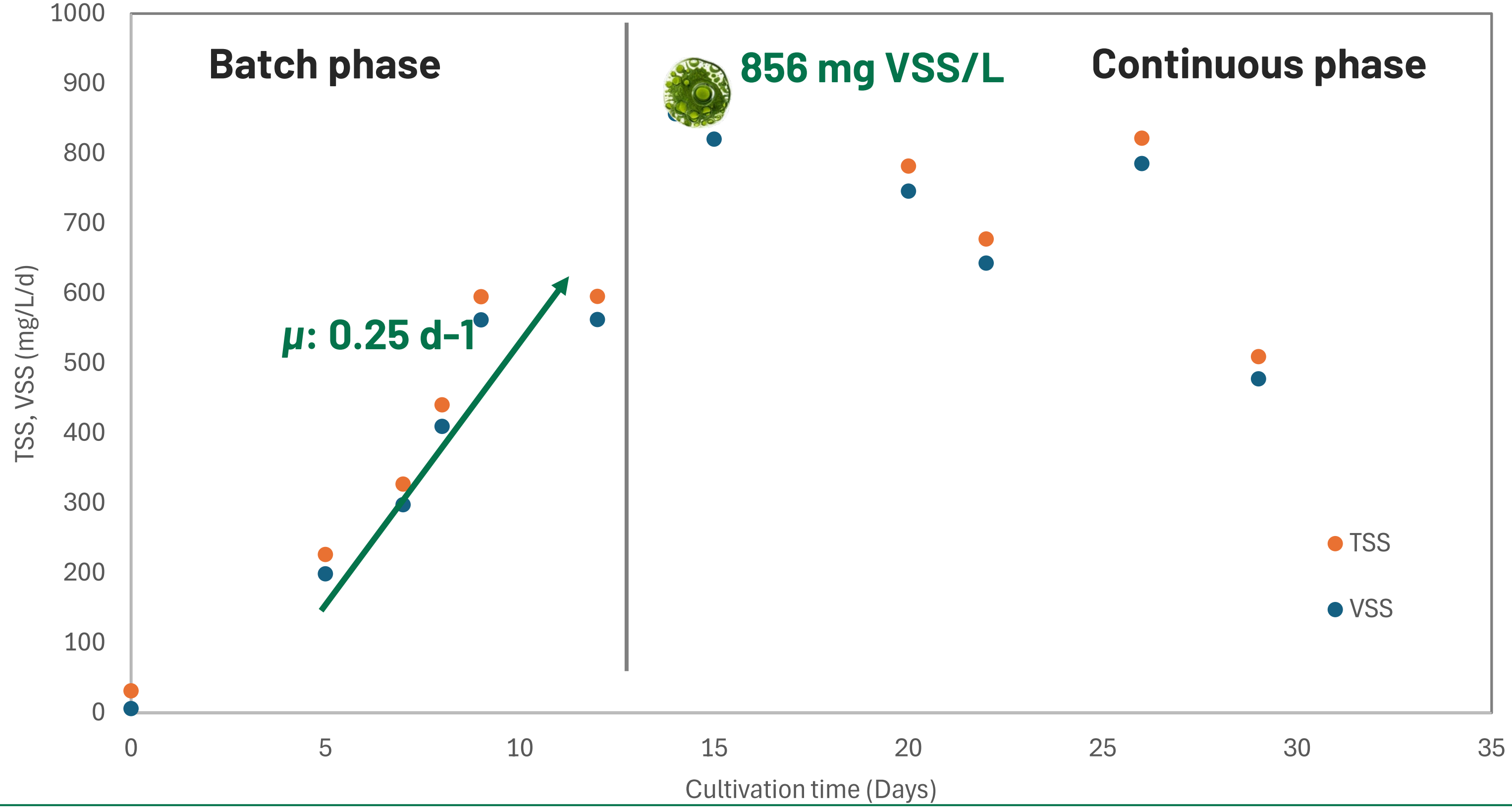
Microalgae as alternative protein source from CO_2

Pilot-scale photobioreactor (PBR)

Synthetic medium

- μ: 0.25 d^{-1}
- Max biomass production: 856 mg VSS/L
- Average biomass productivity: 37 mg VSS/L/d

Synthetic medium



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Microalgae as alternative protein source from CO_2

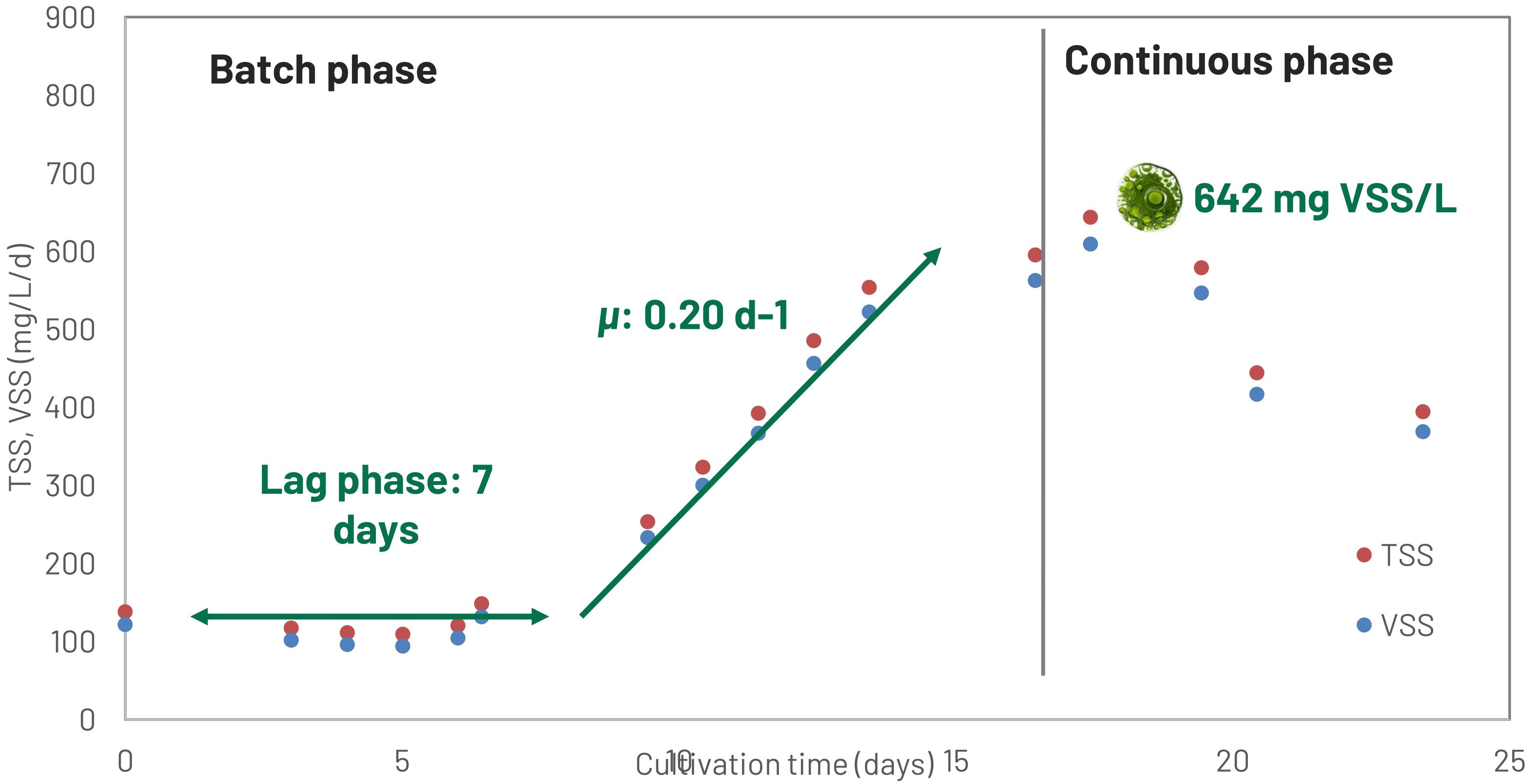
Pilot-scale photobioreactor (PBR)

di… `s

- Max bi… oduction: 642 mg VSS/L

digestate's liquid fraction

- Average biomass productivity: 40 mg VSS/L/d



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Microalgae as alternative protein source from CO_2

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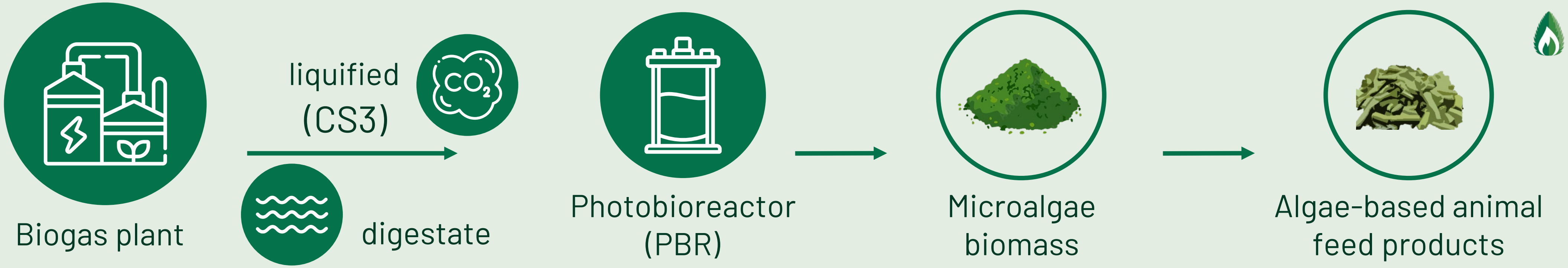

Findings

- Successful microalgae cultivation from CO_2 and digestate in the lab and pilot-scale.
- Growth performance with digestate similar to synthetic media.
- Optimization of the operation with recovered CO_2 and digestate from biogas plants.

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Potential of growing microalgae at the Belgian pilot

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Belgian pilot

25,000 t manure/y

23,475 t digestate/y

15,000 t excess digestate/y

845 t CO_2/y

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Algae – digestate N balance

15,000 t
0.58% N → 87 tN

↓

7% N → 1200 t algae

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Algae – CO_2 balance

845 t/y

1.8 kg CO_2/ kg algae

460 t algae

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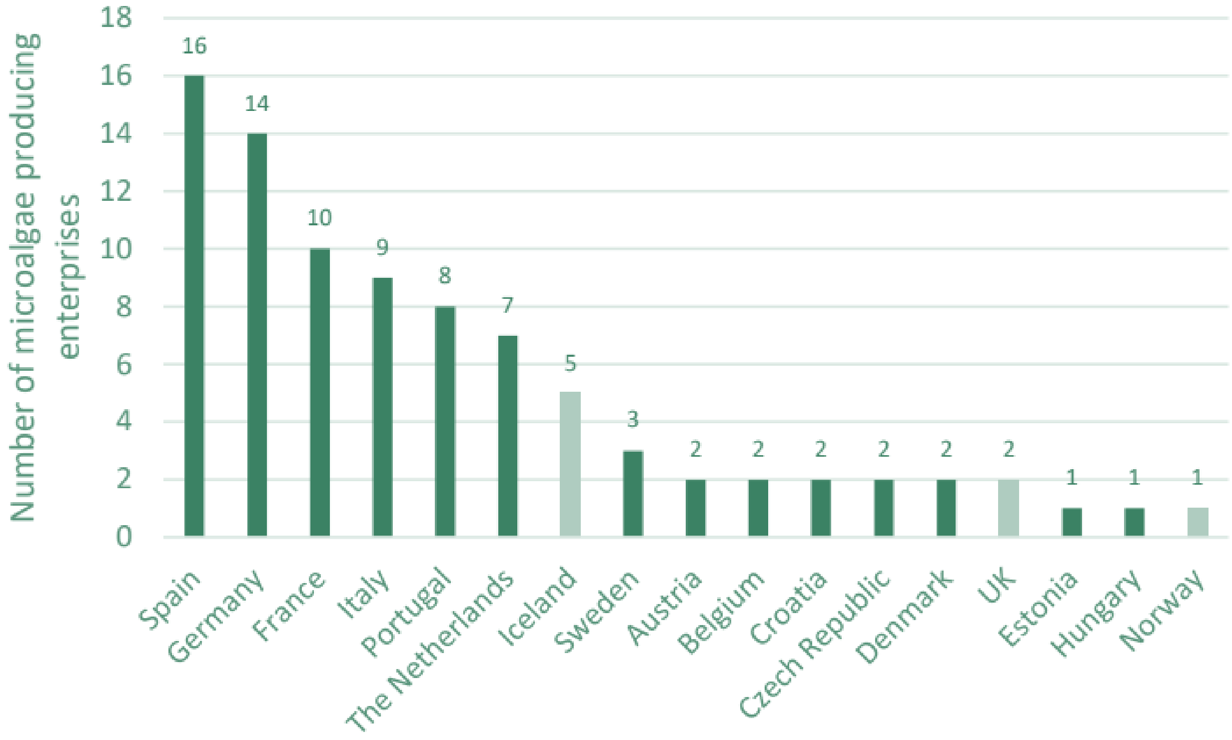
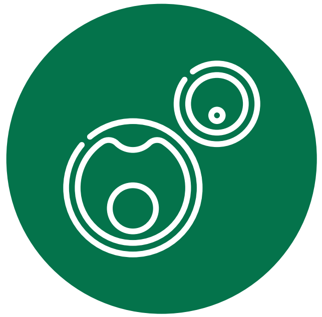
Current algae production in the EU



182 t/year microalgae



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Vazquez Calderon, F., Sanchez Lopez, J., An overview of the algae industry in Europe. 2022

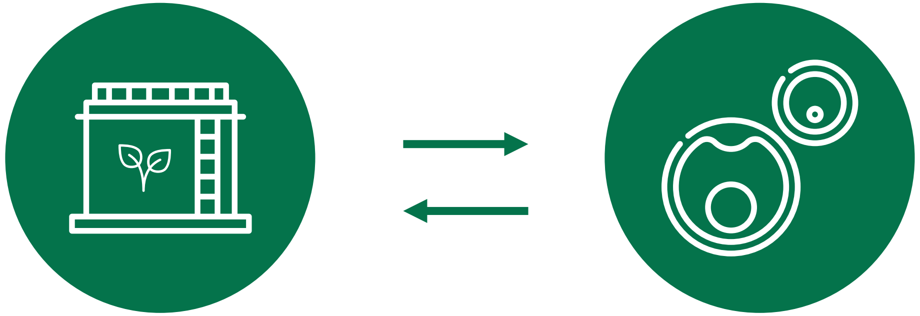
Araújo R et al. Current Status of the Algae Production Industry in Europe: An Emerging Sector of the Blue Bioeconomy. 2021

How to integrate algae in a dairy farm?

460 t
algae

↓ 100 t/ha

4.6 ha



Industrial symbiosis

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Webinar

BIo-Impact

2 Years of Innovation in Biomethane Production with SEMPRE-BIO

Q&A

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