CETAQUA
WATER TECHNOLOGY CENTRE

VEOLIA

Why are we here?

SEMPRE-BIO Final Event

WHERE
INNOVATION
HAPPENS

Mateo Pastur
Head of Technical Strategy
23/09/2026

European Macro Context

European Green Deal

Climate neutrality by 2050

Fit for 55

-55% GHG emissions by 2030

UWWTD

100% energy neutrality by 2045

RED (Renewable Directive)

Promotes renewable gases and green hydrogen deployment.

REPowerEU

Energy independence from fossil fuels

Need for Renewable Gases: 35 bcm biomethane by 2030

Strategic Focus

- Energy Dependence
- Decarbonization
- Regulatory Alignment

Europe’s figures

Biomethane

5.2 bcm/yr

Total Biogas + Biomethane

22 bcm/yr

REPowerEU Biomethane Target

35 bcm/yr

Source: 15th EBA Statistical Report

Spain’s figures

Installed Capacity

Status in 2026

1.4 TWh/yr

2030 Official Targets

National Biogas Roadmap

10.4 TWh/yr

PNIEC Target

20 TWh/yr

Technical Potential

Sedigas Assessment

163 TWh/yr

Source: Hoja de ruta del biogás del MITECO. Plan Nacional Integrado de Energía y Clima. Estudio de la capacidad de producción de biometano en España de SEDIGAS

Main Scaling Barriers

Permitting & Admin

Grid & Infrastructure

Regulation & Market

Digestate & Circularity

Social Acceptance

Technological Opportunities: Advanced Conversion & Valorisation

Advanced Pre-treatments to maximize biogas production

Thermo-chemical processes to unlock feedstock

Upgrading & CO2

Digestate & Biofertilisers

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SEMPRE-BIO

SEcuring doMestic PRoduction of cost-Effective BIOmethane



Alejandra Córdova

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

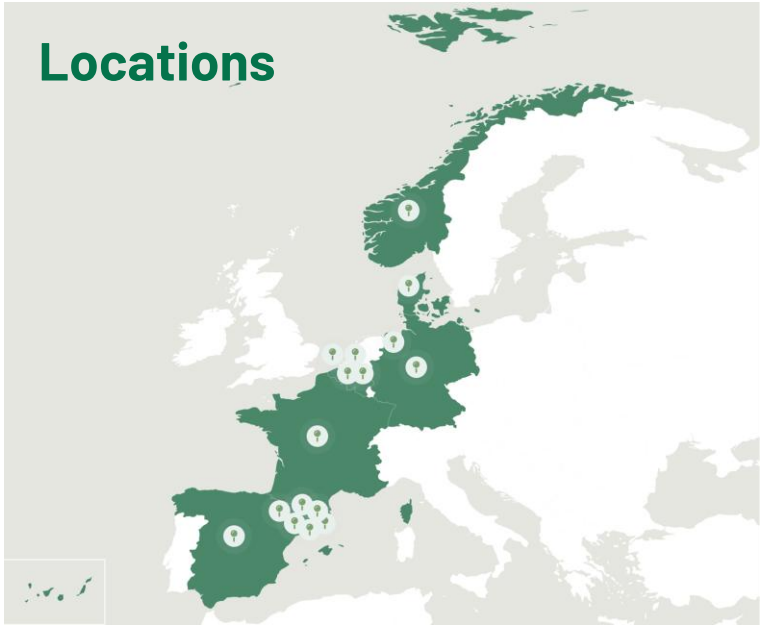
47 Months

17 Partners

7 Countries

9.9M Funding

Locations

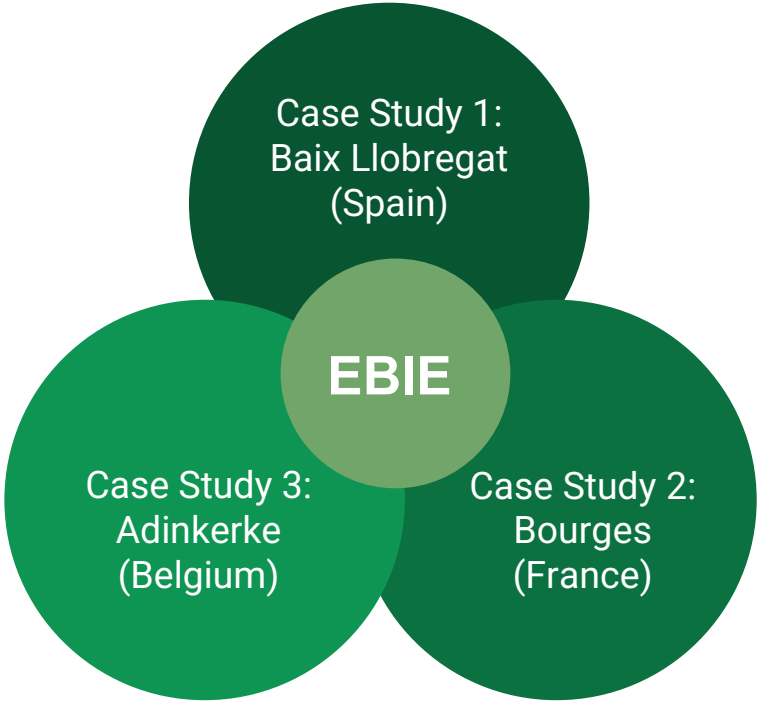


Funded by the European Union

Research organizations	CETAQUA CENTRO TECNOLÓGICO DEL AGUA, DBFZ, SINTEF, Innolab
Industry	Aigües de Barcelona, CRYO inox, ProPuls, terrawatt, BIOTHANE by VEOLIA
Academia	DTU, UNIVERSITEIT GENT, Beta Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentaria
End-users	TMB, Naturgy
Consulting agency	inveniam
Stakeholder's engager	Biogas-E platform voor anaerobe vergisting
Farmers	NV De Zwanebloem

17 Partners

Funded by the European Union

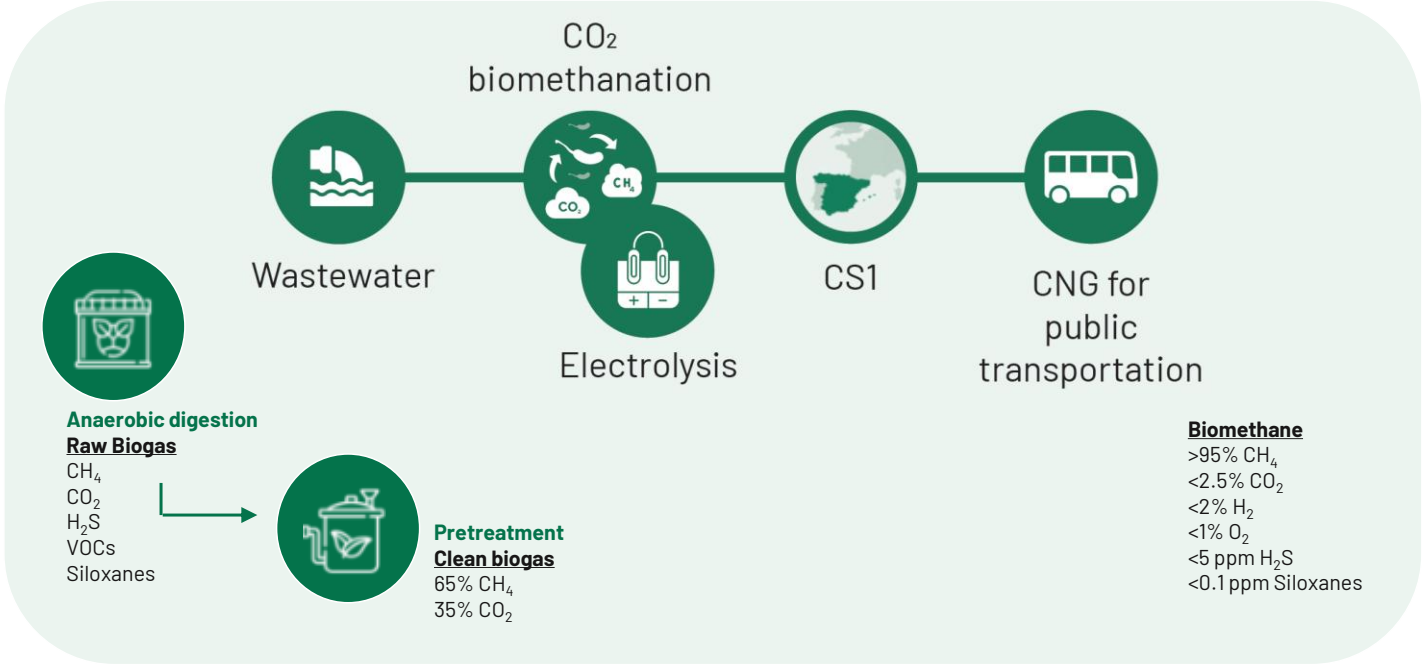


European Biomethane Innovation Ecosystem

Funded by
the European Union

Case Study I: Baix Llobregat (Spain)

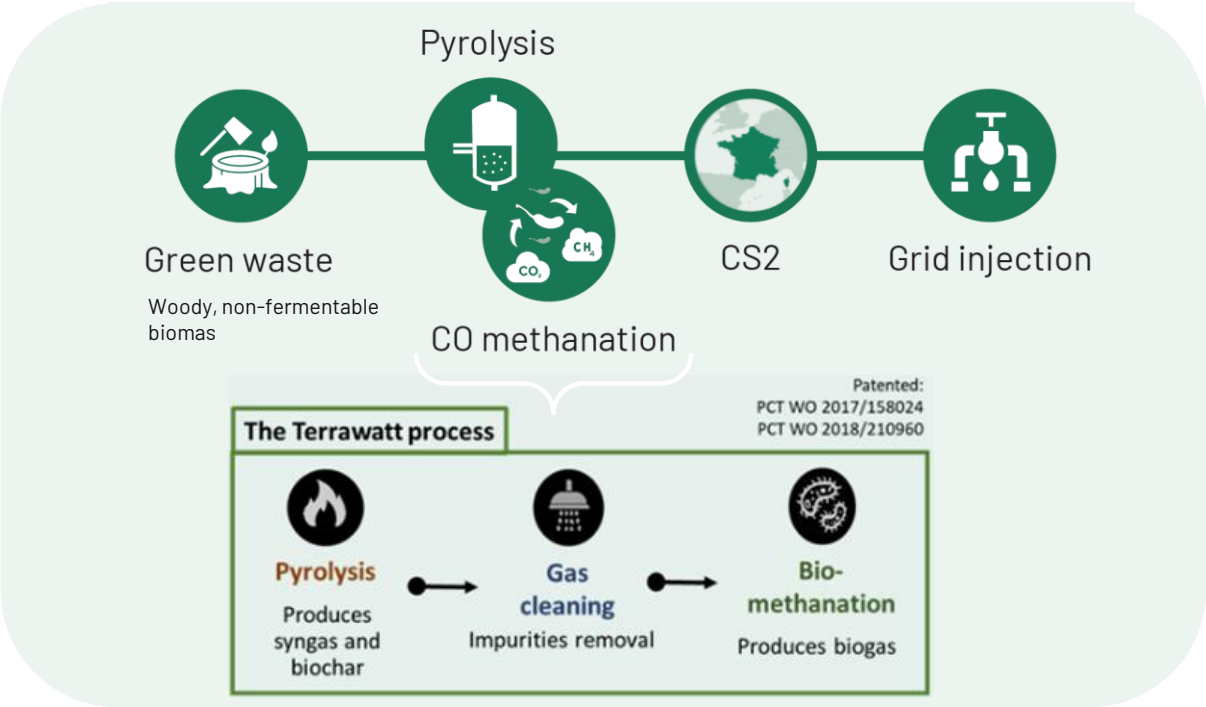




Funded by the European Union

Case Study 2: Bourges (France)

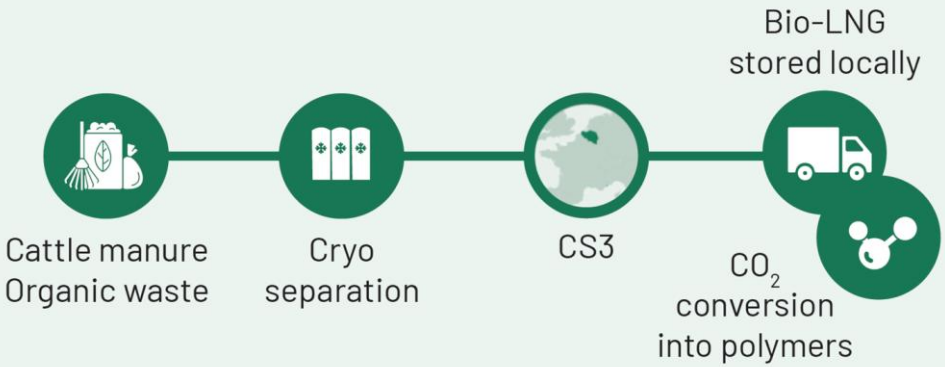




Funded by the European Union

Case Study 3: Adinkerke (Belgium)

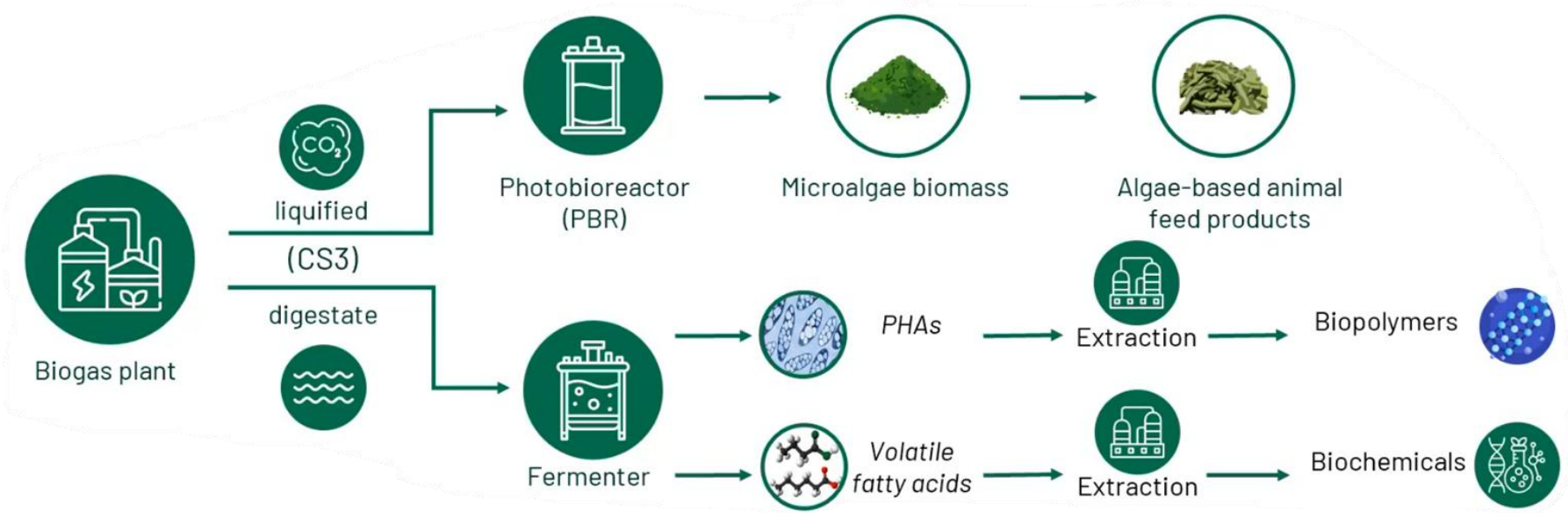




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CRYOinox NV De Zwanebloem Beta Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària DBFZ SINTEF Innolab UNIVERSITEIT GENT

Advanced technologies for efficient valorization of CO2 from biogas/biomethane streams



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SEMPRE-BIO
Case Study I - El Baix Llobregat WWTP

Cetaqua Centre Tecnològic de l'Aigua

23/09/2026

David Checa Sánchez

Case Study 1: Baix Llobregat (Spain)



Feedstock	Technology		Site	Final use of biomethane
Wastewater	CO^2 Biomethanation	Electrolysis	Case Study 1: El Prat de Ll (ES)	Compression to CNG for public transportation

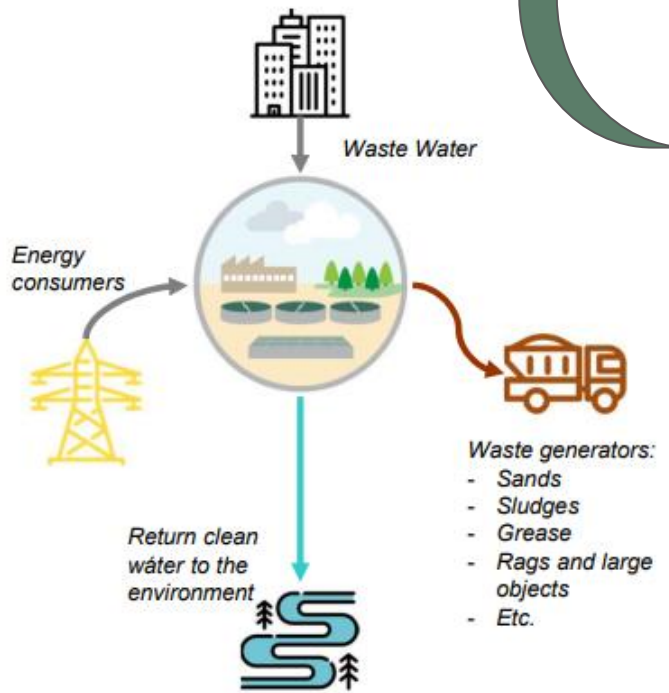


Aigües de Barcelona · CETAQUA Centro Tecnológico del Agua · ProPuls · DTU · SINTEF · DBFZ · TMB · BIOTHANE by VEOLIA

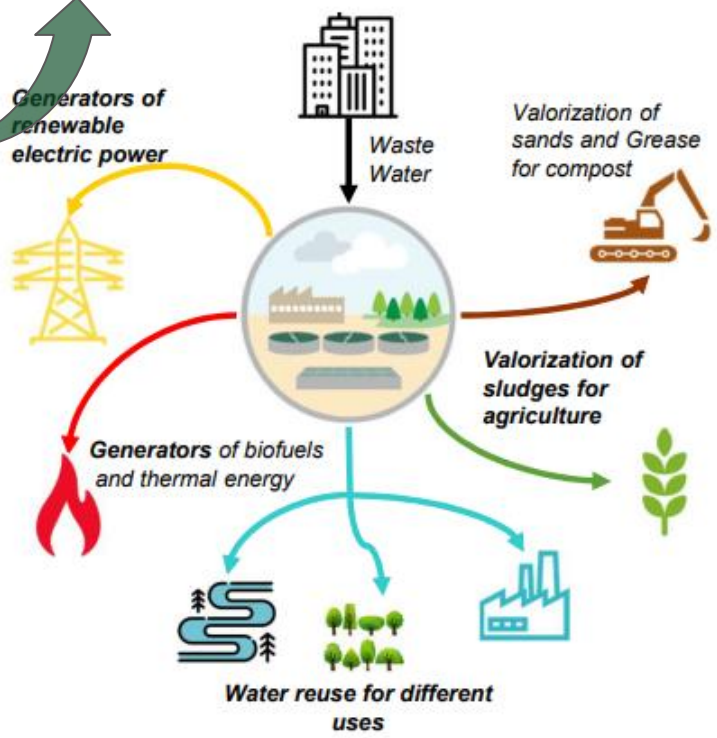
From linear to circular

Aigües de Barcelona

Old Paradigm: Sewage Treatment Plant



New Paradigm: Biofactory







Sludge

Anaerobic digestion

Pilot location

EDAR del Baix Llobregat
WWTP Baix Llobregat,
Barcelona -Espanya
Spain



Regenerated water

Energy with guarantee of origin

Biogas



PEMEL

H_2

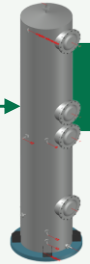
Biogas conditioning



Clean biogas
65% CH_4
35% CO_2

Biogas compression





Biological methanation

Biomethane

>95% CH_4

Biomethane compression



Bus CNG fuelling station



TMB buses



Funded by the European Union





Sludge

Anaerobic digestion

Pilot location

EDAR del Baix Llobregat
WWTP Baix Llobregat,
Barcelona -Espanya
Spain

Regenerated water



Energy with guarantee of origin

Curtailed Renewable Energy

Biogas



PEMEL

H_2

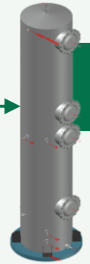
Biogas conditioning



Clean biogas
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35% CO_2

Biogas compression





Biological methanation

Biomethane

>95% CH_4

Biomethane compression



Bus CNG fuelling station



TMB buses



Funded by the European Union

Case Study 1: Baix Llobregat (Spain)



Consumes:

- 20 Nm^3_{H2}/h ; 15 Nm^3_{biogas}/h
- 100 KW_e(BOL) + 55 kW_e

Produces:

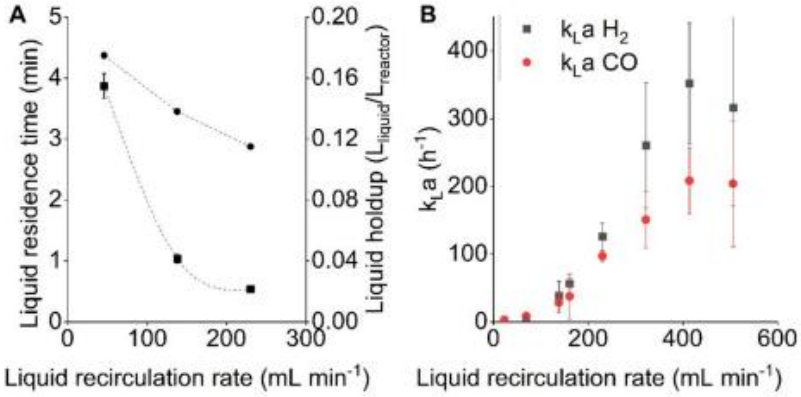
- 15 Nm^3_{CH4}/h (>95% CH_4 ; ~0% H_2)
- 15 kW_t(BM) + 70 kW_t(PEM)
- 10 Nm^3_{O2}/h

Results at lab scale (DTU)

- H_2 excess

	GRT (h)	Inlet (%)		Outlet (%)			CH_4 productivity [$L_{CH4}/L_{reactor}/d$]	CH_4 Yield [e^-mol/e^- mol]
		H2	CO2	H2	CO2	CH4		
R1 (4:1)	0.75	80.1	19.9	20.6 ± 4.8	1.9 ± 1.9	77.4 ± 4.4	3.59	0.72
R2 (5:1)	0.9	83.7	16.3	55.6 ± 0.7	0.2 ± 0.2	44.2 ± 0.7	4.43	0.76

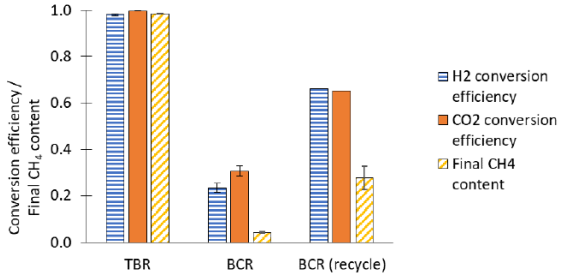
- LLR optimization



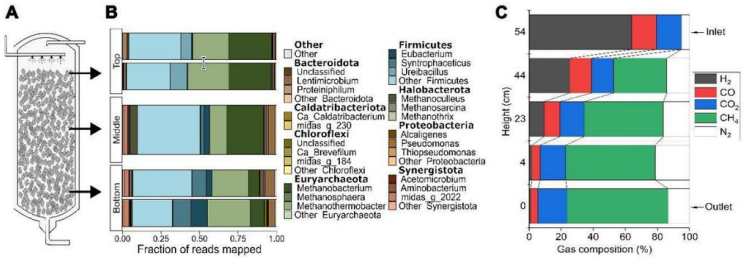


Results at lab scale (DTU & SINTEF)

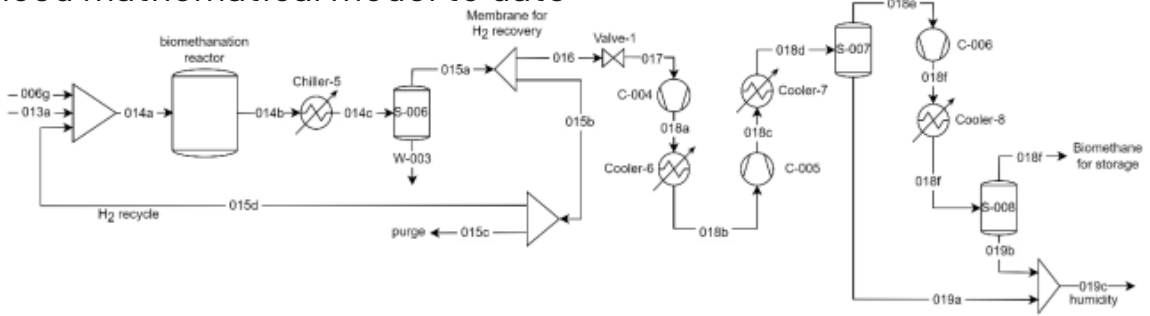
- Reactor selection



- Biofilm analysis

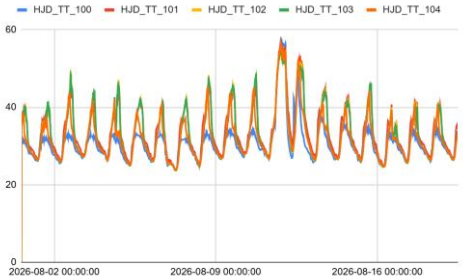


- Most advanced mathematical model to date



Results at pilot scale

- Biogas purification verified

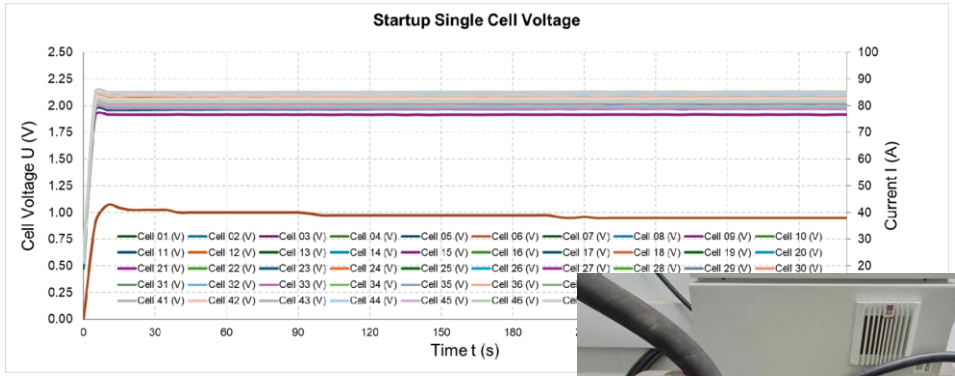


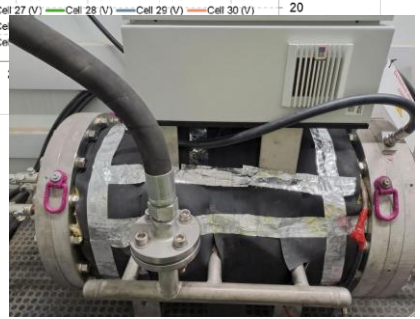


- Compression to 250 barg



- PEMEL commissioned: operated during a few hours
  - Initial 40A (0.08 A/cm^2) @ 2V
  - High degradation in few hours

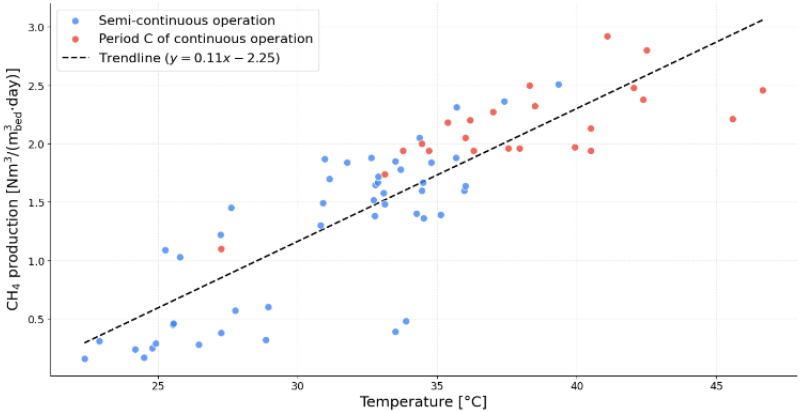


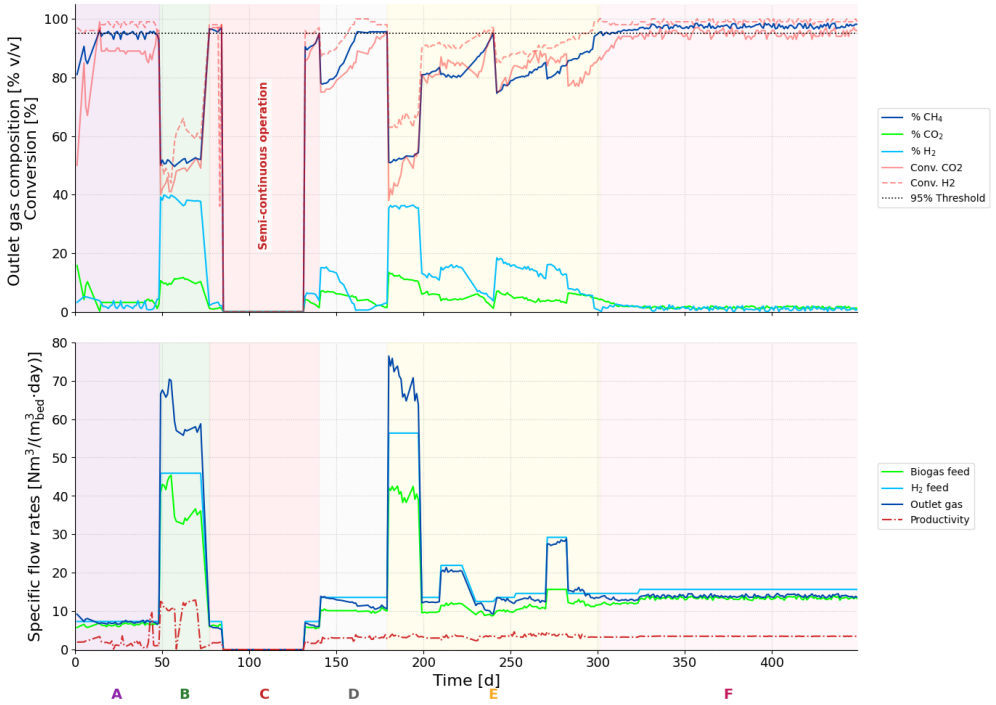


Biomethanation in El Baix Llobregat WWTP

Purity: >95% CH_4 ; <3.1 mg Si/m³

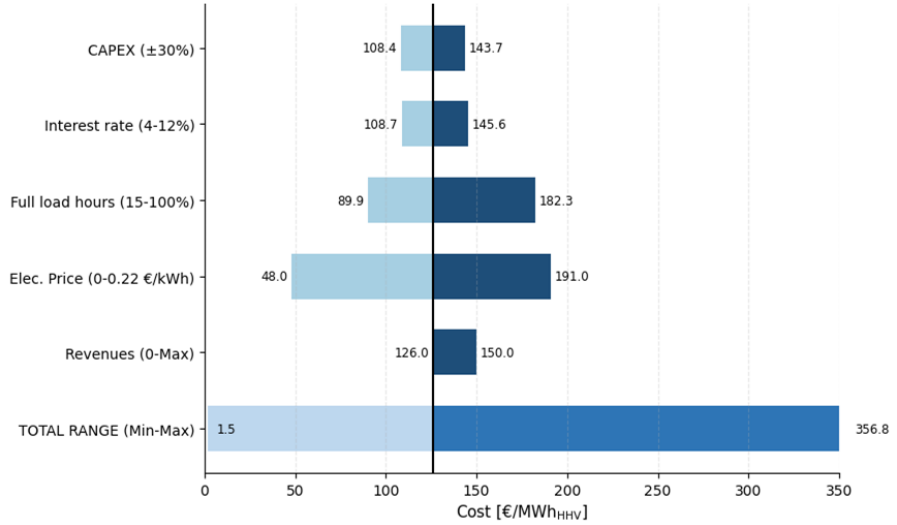
Conversion: 96 % (CO_2) ; 99% (H_2)



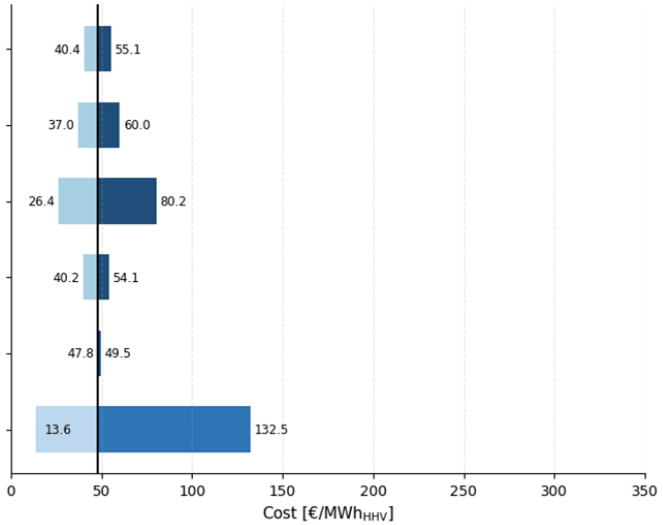


Biogas upgrading viability

Biological methanation (126.0 €/MWh)



Membrane upgrading (47.8 €/MWh)



Natural gas (average 2025): 37.8 €/MWh

What is the future of biomethanation?

VIABLE BY 2030–40

LOW-COST ELECTRICITY

- **Threshold: <0.05 €/kWh**
- Electricity = ~79% of operating costs
- Curtailed renewables at zero or negative cost
- Geographic bias: regions with >40% renewable grid share

CURTAILED RENEWABLES

- PtG designed to exploit intermittent surplus energy
- Avoids grid emissions: cleaner biomethane
- Negative-price events increasingly frequent
- High load factor (>50%) essential to reduce CAPEX impact

WATER AVAILABILITY

- **Electrolysis needs high-purity water**
- Southern Europe: renewable-rich but water-stressed
- Opportunity: regenerated water losses intrinsic to WWTPs
- Must be assessed in site-specific evaluations

CAPEX REDUCTION

- Electrolyser cost must fall: 1,000–1,500 → <500 €/kWe
- Projected achievable by 2030–2040
- Critical material supply chains are a risk factor
- Lower discount rates (<6%) reduce LCOB by ~13%

PREMIUM MARKETS & POLICY

- **Guarantees of Origin (GoO): >60 €/MWh premium**
- Carbon pricing strengthens biomethane value
- O_2 sales: 6.5 €/MWh credit
- Waste heat: 17.5 €/MWh additional value

→ **Biomethanation is competitive when curtailed renewables + electrolyser CAPEX <500 €/kWe + water access + load factor >50% + policy premiums align**

SEMPRE-BIO

SEMPRE-BIO
Case Study 2

Technology & Demonstration Results – CS II

CHALLENGE:
Non-digestible woody green was, a plentiful, untapped biomass resource, currently escapes biomethane production because conventional anaerobic digestion cannot process it.

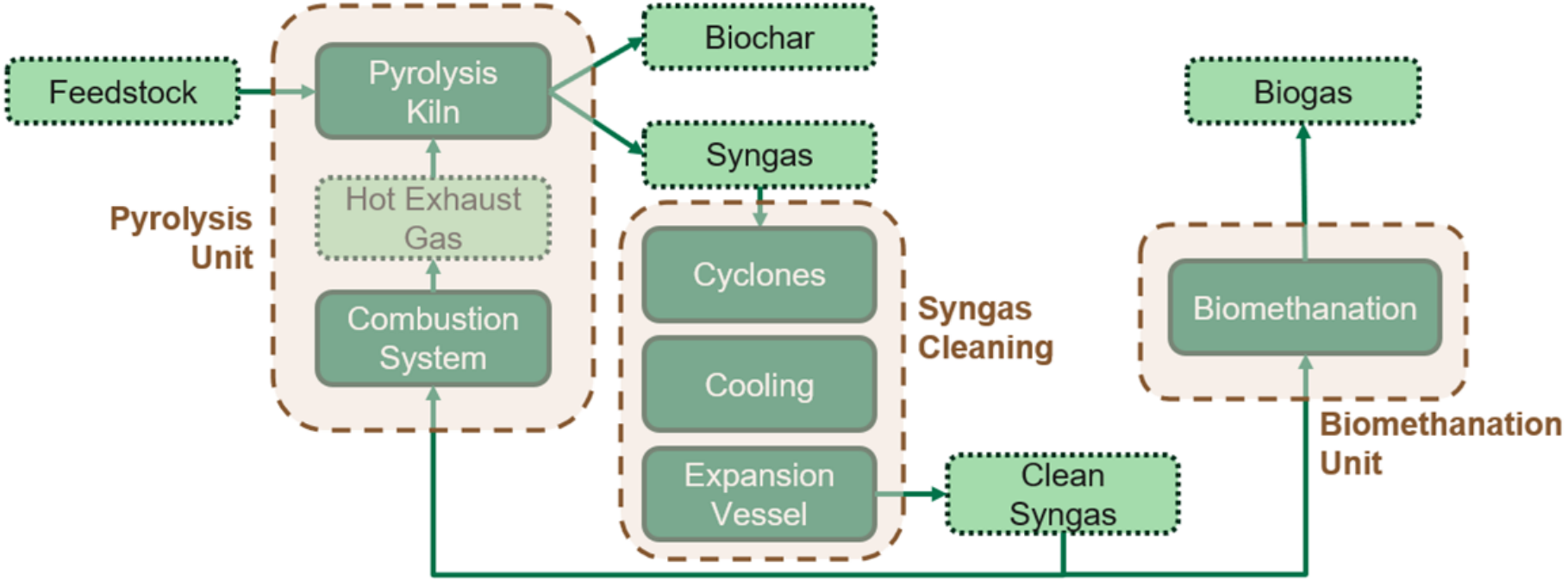
SOLUTION:
Pyrolysis converts the woody waste into syngas, which is cleaned and then bio-methanated into biogas, unlocking this waste stream for upgrading and grid injection.

OBJECTIVE:
Design, build, and operate a small-scale green waste-to-biomethane plant, integrating a pyrolysis unit, a syngas cleaning stage, and bio-methanation technology.



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Technology & Demonstration Results – CS II



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Technology & Demonstration Results – CS II

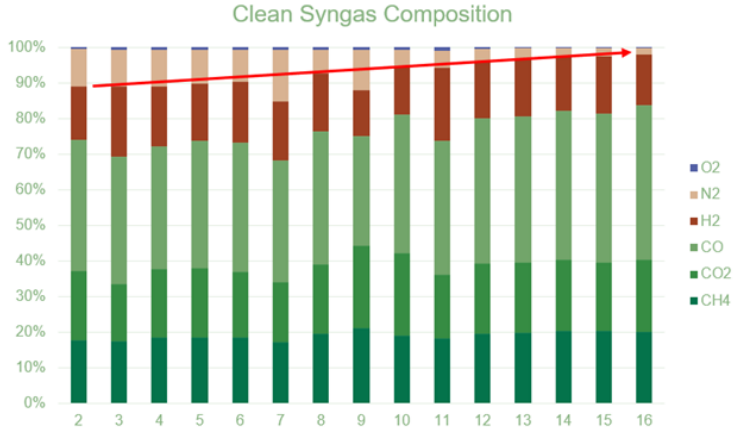
BIOMETHANATION NOMINAL CAPACITY: 25 m3/h

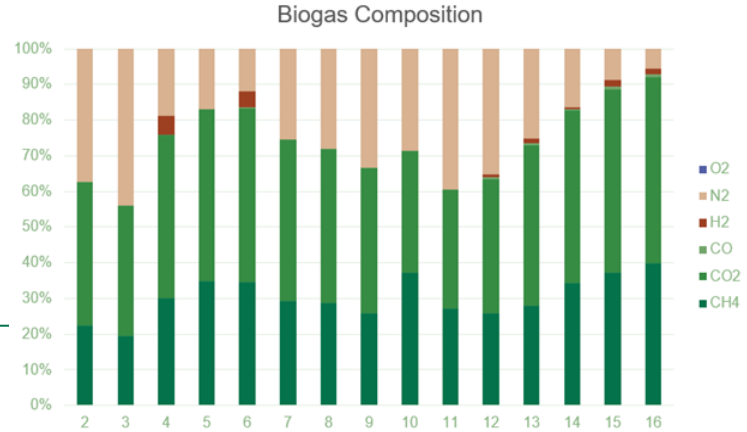
Undergoing through acclimatation batches: 10 m3/batch

NUMBER OF BATCHES: 16
SYNGAS TREATED: 160 m3

BIOGAS COMPOSITION:

- **40% CH4**
- **52% CO2**
- **8% Other** (mainly N2 from acclimatation)





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Technology & Demonstration Results – CS II

ACHIEVEMENTS:

- Integrate pyrolysis, syngas cleaning and biomethanation to produce biomethane.
- Scale-up of the biomethanation unit to a nominal capacity of 25 m3/h.
- Work with real syngas rather than bottled CO and H2.
- CO and H2 conversion rates are almost 100%.
- Produce a biogas with a good composition (40% CH4, 52% CO2).



MAIN CHALLENGES:

- Pyrolysis unit delivery delayed.
- Commissioning and modifications on the pyrolysis and syngas cleaning circuit.

NEXT STEPS:

- Modification of gas storage from syngas to biogas.
- Complete acclimatation and reach nominal capacity.
- Techno-economic feasibility study for residual pollutants treatment for further biogas upgrading and grid injection.

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SEMPRE-BIO

SEMPRE-BIO
Case Study 3

CS3: The Zwanebloem Dairy Farm

BELGIAN DEMO — Cryogenic technology for the production of BioLNG from Biogas

CHALLENGE

Explore and demonstrate the potential downsizing of a solution capable of producing BioLNG and liquid CO_2 from raw biogas with integrated cleaning process, sized at 50 Nm3/h, for applications at the farm-scale digestion level; and promoting cleaner energy solutions

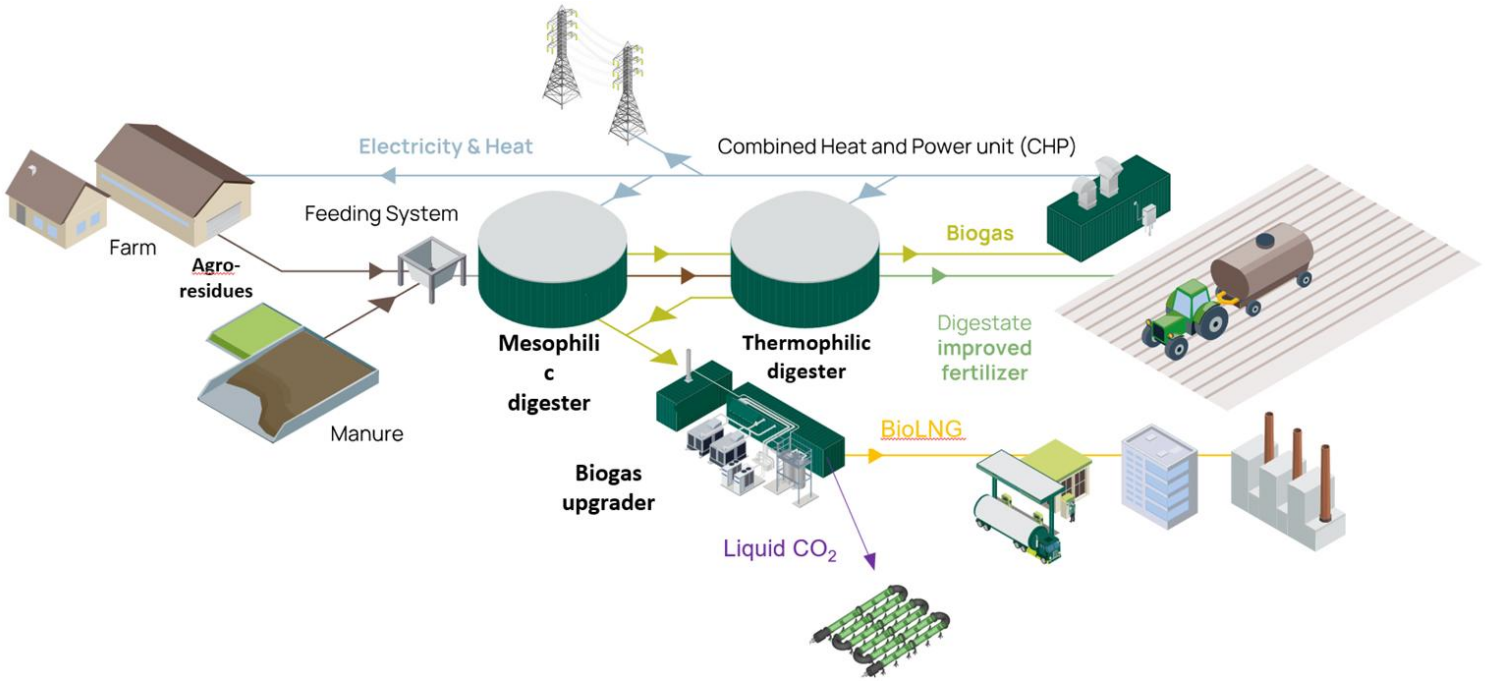






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Concept



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

The demo plant in three groups

A complete cryogenic upgrading unit designed around ~50 Nm^3/h of farm biogas

1 Biogas pre-treatment

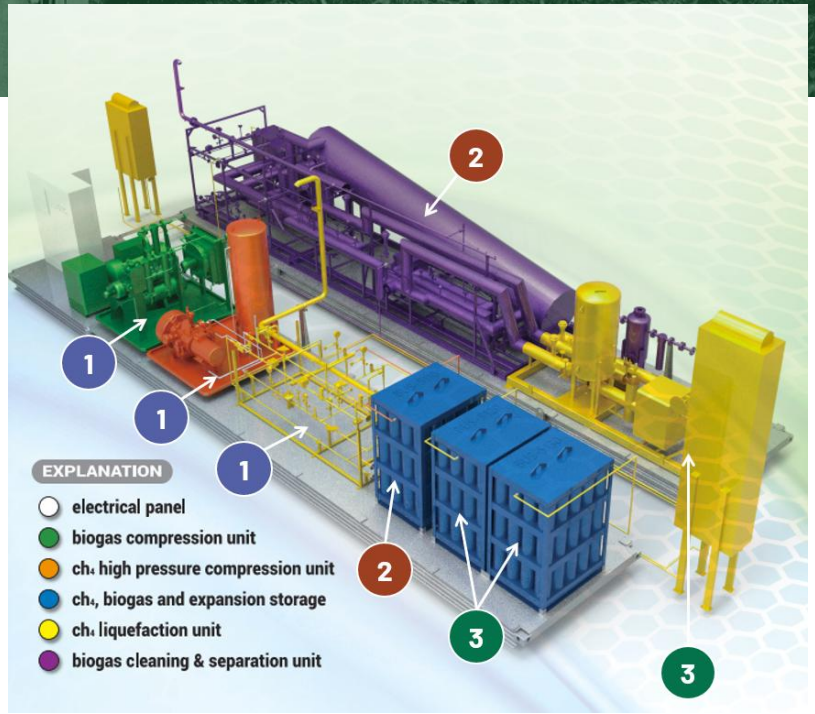
H_2S removal, compression and dehydration.
The gas is cleaned and dried before it goes cold.

2 Cryogenic cleaning & upgrading

The biogas is cooled and CO_2 is captured in the desublimator.
The technological core of the plant.

3 Methane liquefaction

The methane-rich gas is cooled further to Bio-LNG.
It closes the full technology chain.



The numbers on the 3D layout correspond to the three groups

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Built, installed and operated at a real dairy farm









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One raw biogas stream, two valuable products

The demonstrated process logic, from farm biogas to two separate streams

RAW BIOGAS

from the farm digesters

~50 Nm^3/h design capacity
~50–55% CH_4
high H_2S content

1

Pre-treatment

H_2S removal
compression
dehydration

2

Cryogenic separation

cooling and CO_2 capture
in the desublimator

METHANE-RICH STREAM

> 90% CH_4

measured under tested conditions
further cooled to Bio-LNG in group 3

RECOVERED CO_2 STREAM

> 99% purity

measured under tested conditions
recovered during regeneration

The value is in two molecules, not one: renewable energy plus recovered CO_2, and a lower carbon footprint.

The numbers on the 3D layout correspond to the three groups

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the European Union

What the demo delivered, and where it leads

A first-of-a-kind pilot: validate the process first, then automate and industrialise

Demonstrated in the field

- Complete cryogenic system installed, commissioned and operated at a real dairy farm
- Run on real farm biogas, more demanding than the design basis (high H_2S)
- Core separation principle verified: both product streams generated and characterised
- Effective upstream contaminant removal ahead of the cryogenic section

Identified for the next configuration

- Specific energy consumption higher than the project target: main drivers now understood
- Desublimator cycle progressively moved from manual management to automated control
- Equipment sizing and process configuration to be simplified
- CAPEX and OPEX drivers identified for an industrialisable design

From design assumptions to real operating experience: the basis to design a simpler, more automated and more efficient industrial configuration.

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SEMPRE-BIO

SEMPRE-BIO
CO_2 valorisation

Josué González Camejo Camejo (josue.gonzalez@uvic.cat)
BETA TC-University of Vic (Barcelona, Spain)

Beta
Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària

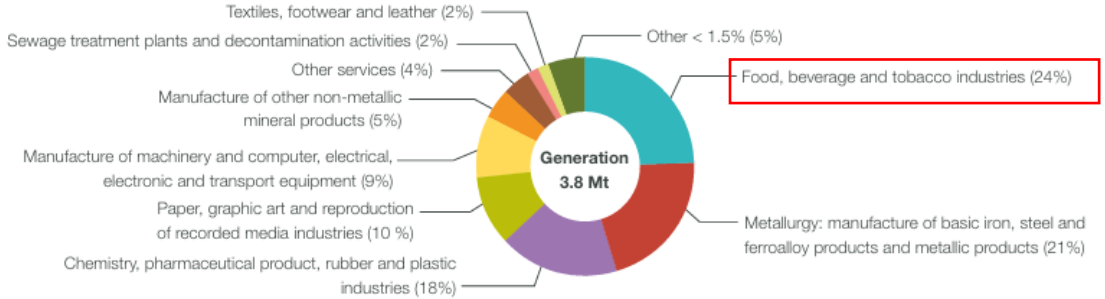
UVIC
UNIVERSITAT DE VIC
UNIVERSITAT CENTRAL
DE CATALUNYA

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AGROINDUSTRIAL SECTOR IN CATALONIA (SPAIN)

GRAPH 25: WASTE GENERATION BY INDUSTRY



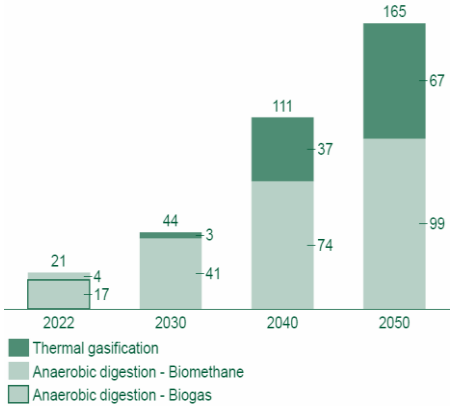
*Waste statistics in Catalonia (2019). estadistiques_2019_en.pdf

ANAEROBIC DIGESTION (AD): WASTE MANAGEMENT AND BIOGAS/BIOMETHANE PRODUCTION



Agri-food wastes





Funded by the European Union

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

ANAEROBIC DIGESTION (AD) BY-PRODUCTS



- **Carbon dioxide (CO_2):** from biogas upgrading (Biomethane production).

CO_2 valorisation

× Necessity to valorise **CO_2** from biogas streams to reduce GHG emissions

- **Digestate:** liquid fraction with high nutrient content

Digestate treatment

× Necessity to treat **digestate** to avoid environmental problems.

HIGHLY CHALLENGING TREATMENT!!!

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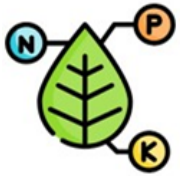
Digestate



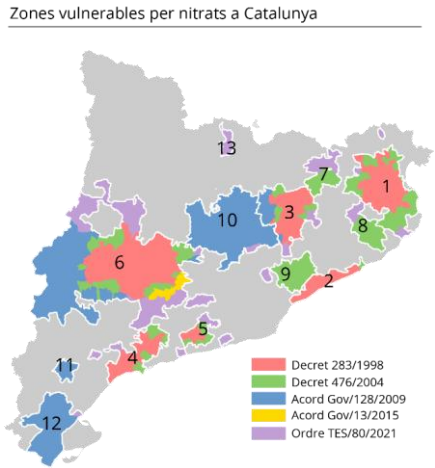
- **Digestate:** liquid fraction with high nutrient content



DIGESTATE: Product with high agronomic value, but.







Necessity to establish **digestate** management plans to avoid environmental problems.

HIGHLY CHALLENGING TREATMENT!!!

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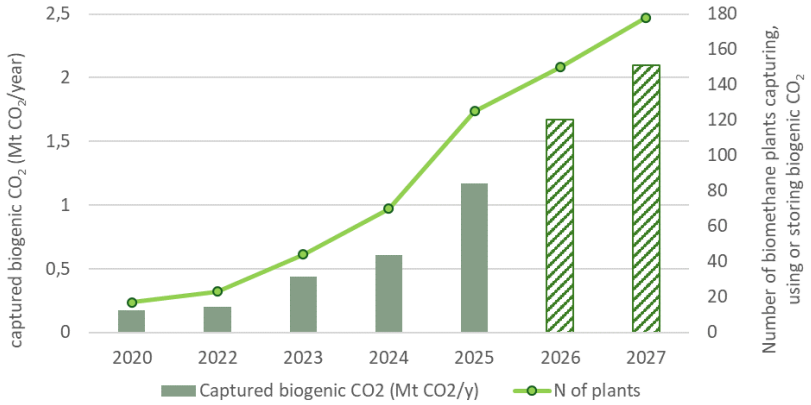
CO_2 valorisation

- **Carbon dioxide (CO_2):** from biogas upgrading (Biomethane production).

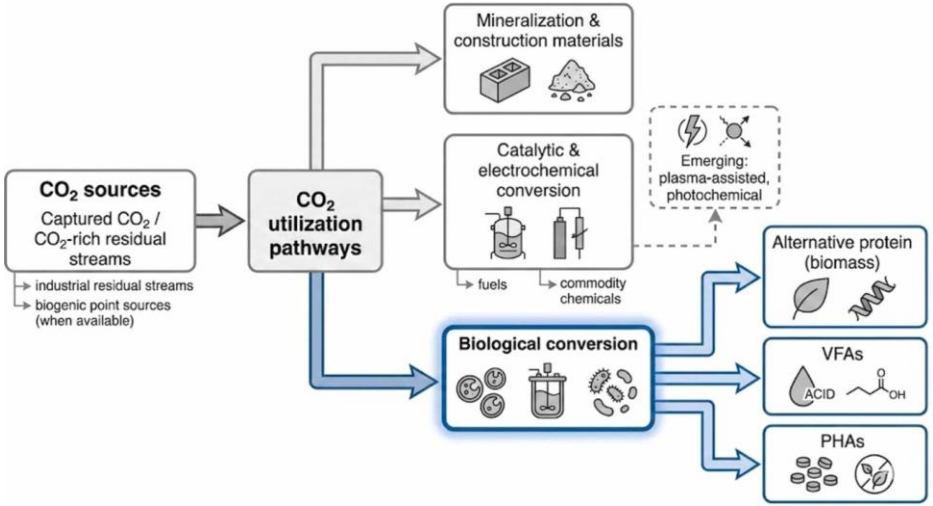


CO_2 valorisation

× Necessity to valorise **CO_2** from biogas streams to reduce GHG emissions



Denysenko et al. (2026). JBB, 109913

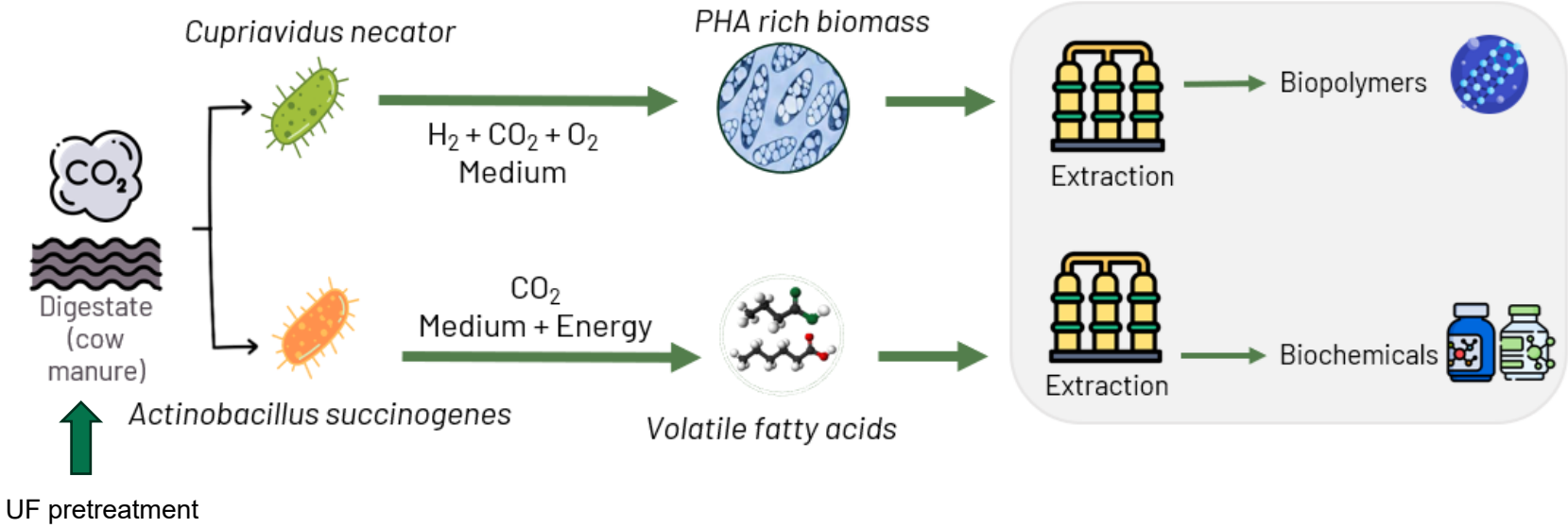


Del Puerto-Tañà et al. (2026). J. CO2 Util. 107, 103413. https://doi.org/10.1016/j.jcou.2026.103413

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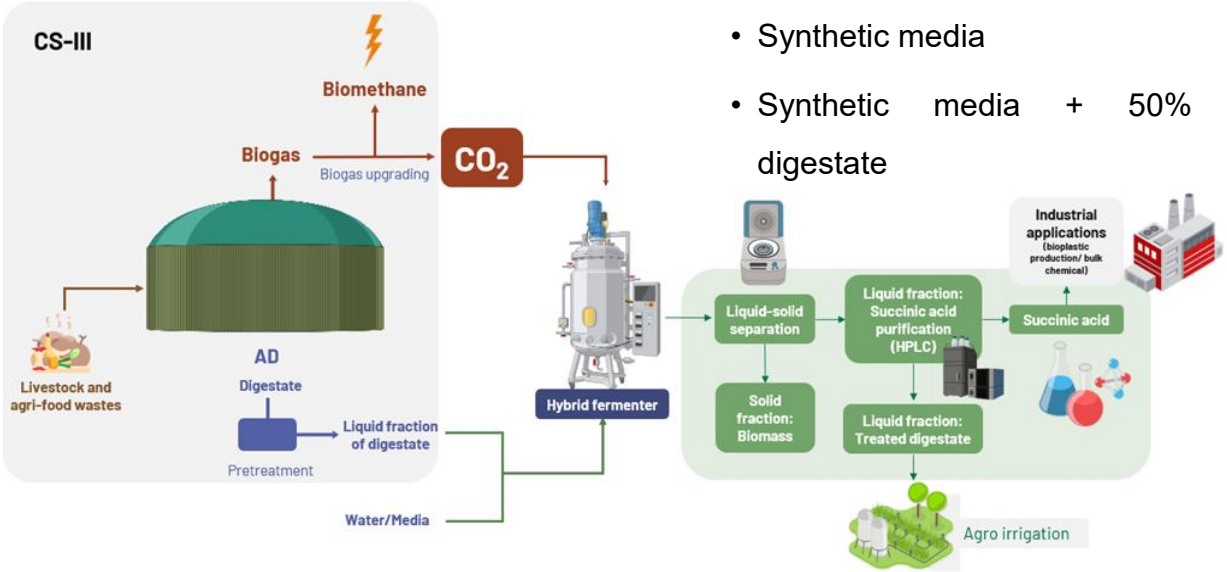
Hybrid fermentation

Fermentation: Biochemicals (succinic acid) and biopolymers (PHA)



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Biochemicals (succinic acid)



- Synthetic media
- Synthetic media + 50% digestate



50L fermenter

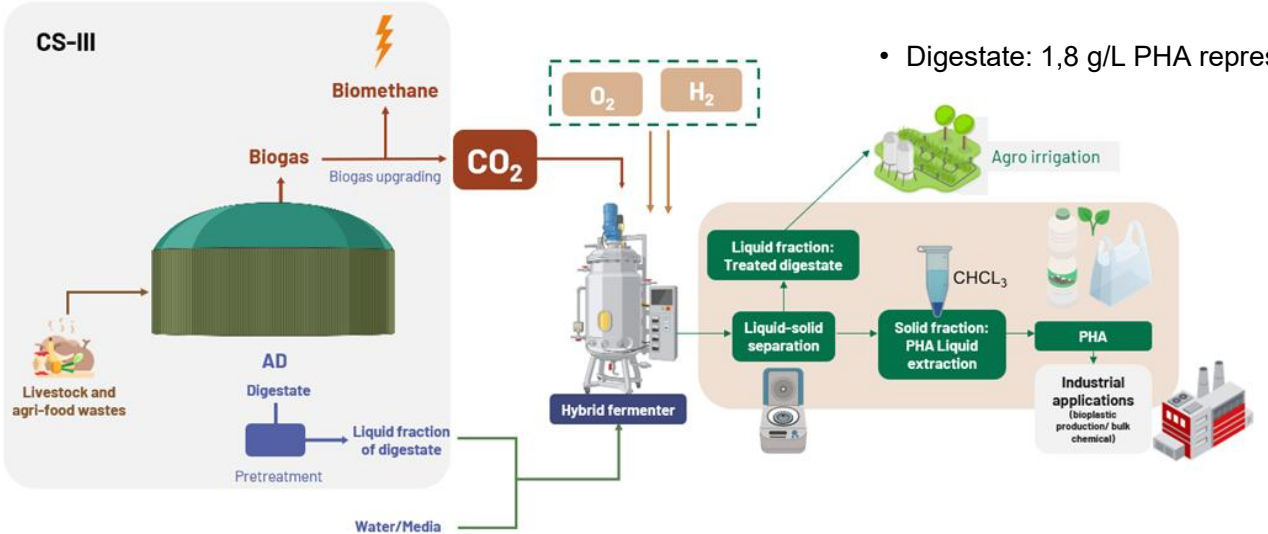
Pressurization achieved a 10x increase over non-pressurized batches.
Digestate as Nutrient Source: A 50% digestate blend supported robust initial growth.
Succinic acid reached a peak at 24h but declined thereafter, suggesting its use as a secondary carbon source under nutrient stress.

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Biopolymers (PHA)

Validated at lab-scale with synthetic media and with digestate.

- Synthetic media: 1,7 g/L PHA representing 48% of the CDW
- Digestate: 1,8 g/L PHA representing 65% of the CDW





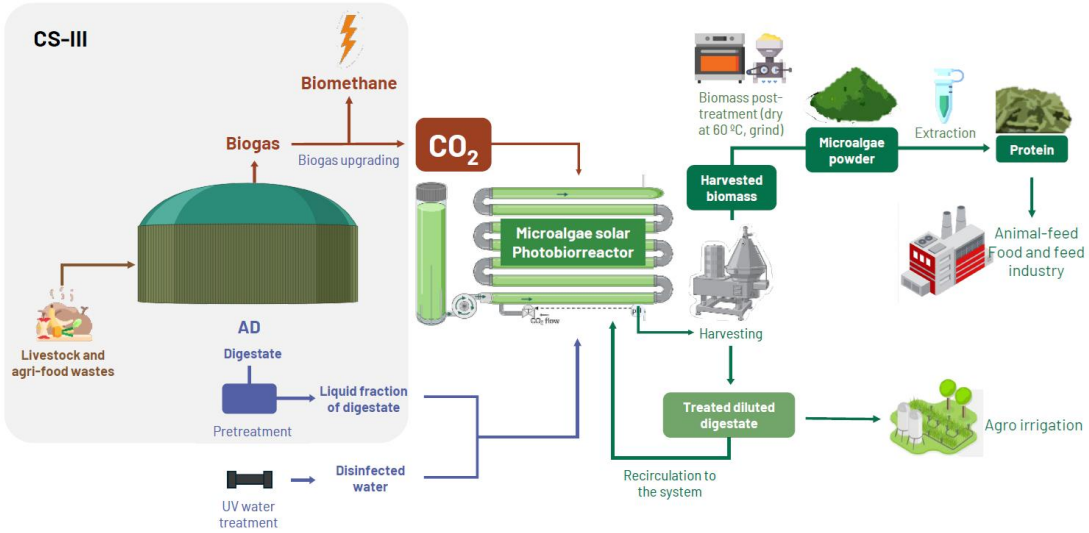
Lab-scale



50L fermenter

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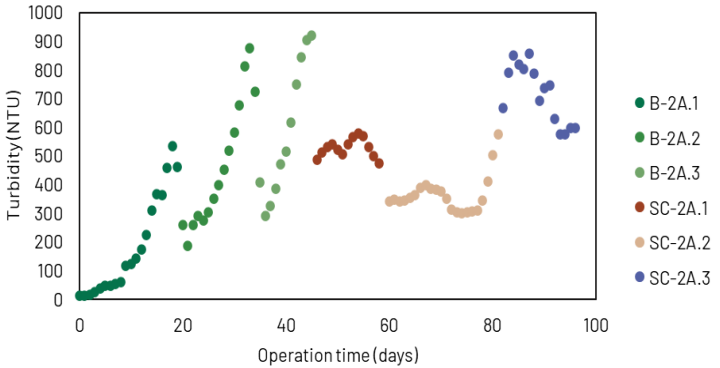
Microalgae biomass: alternative protein



- Digestate dilution: 2-4%
- Protein content (30-40%)

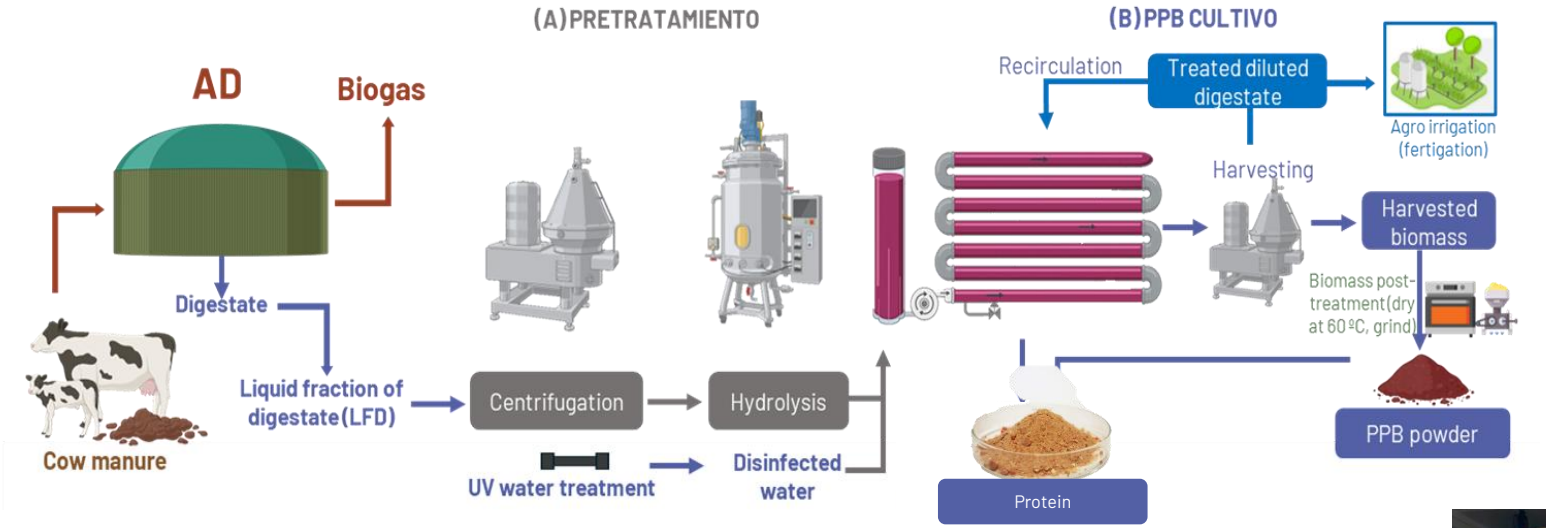


600 L PBR

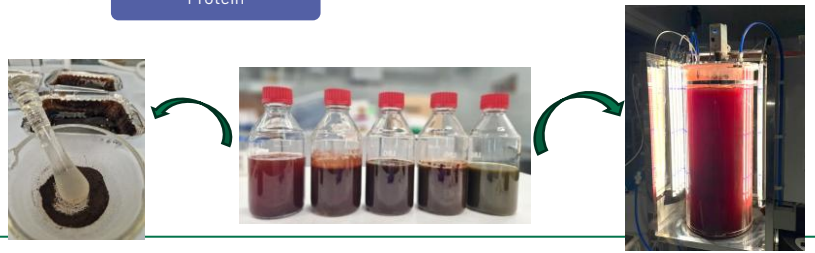


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Purple phototrophic bacteria (PPB): alternative protein



- Digestate dilution: 10-20% (much higher than microalgae)
- Protein content (30-40%) in the range of microalgae



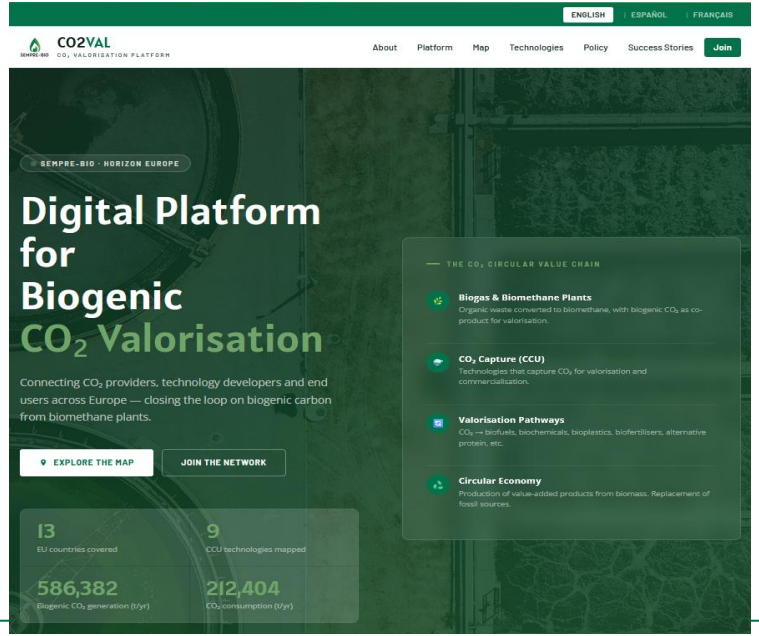
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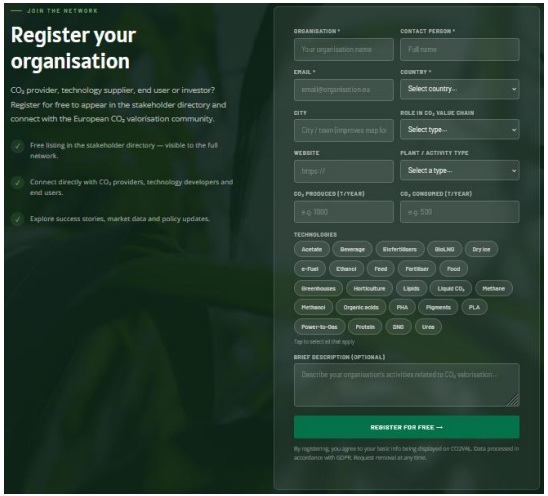
CO2val platform

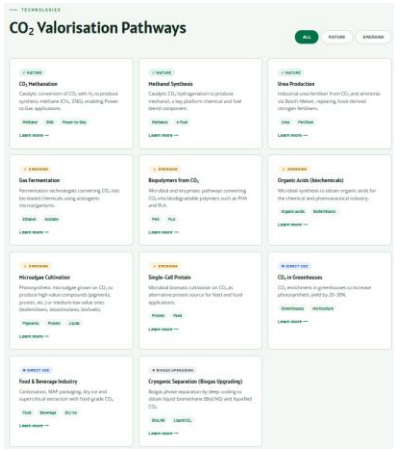
A digital tool to foster the **valorisation of exceeding CO_2** and **CO_2-biobased products** connecting generators and end-users.

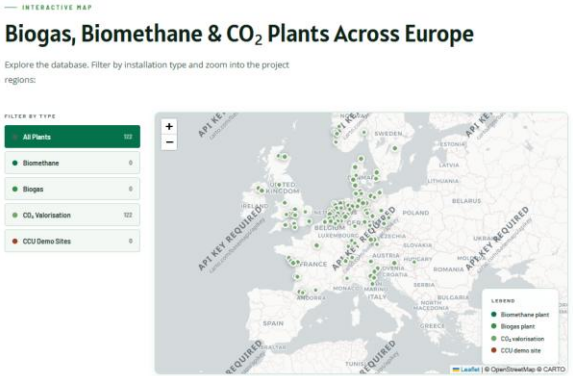
CO2VAL platform

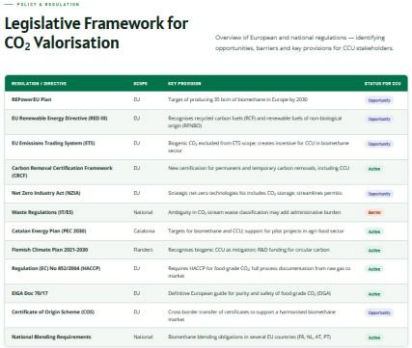
CO2VAL











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SEMPRE-BIO

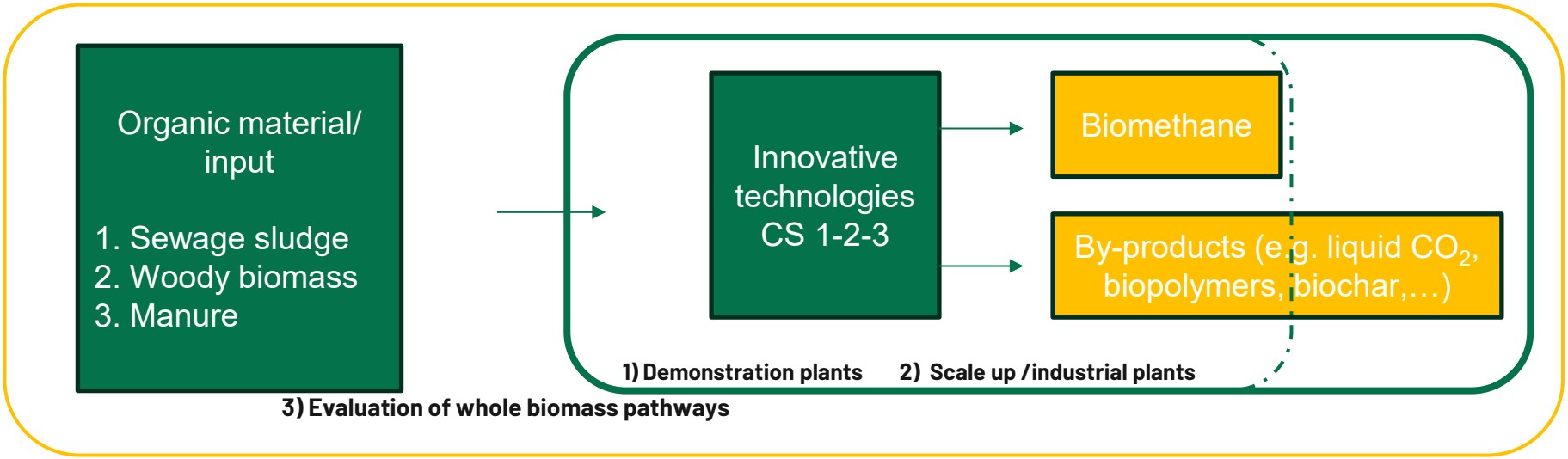
Final Event – 23th September 2026

From Demonstration to Market: Scale-up, Economics, GHG & Market Uptake

Jaqueline Daniel-Gromke, Linus Lefherz, Katja Oehmichen, Velina Denysenko (DBFZ)

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Evaluation CS-concepts



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Scale-up – plant sizes

- Referring to **biomethane production output**
- Scale up plants to reflect the market
  → 125 – 250 – 500 – 1.000 - 2.000 m^3/h biomethane

Parameter	Scenario	1	2	3	4	5
biomethane production (output)	**m^3/h**	**125**	**250**	**500**	**1.000**	**2.000**

- Data based on process modelling (SINTEF), technology providers, estimations and literature

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Cost analysis CSI - RED III from 2030

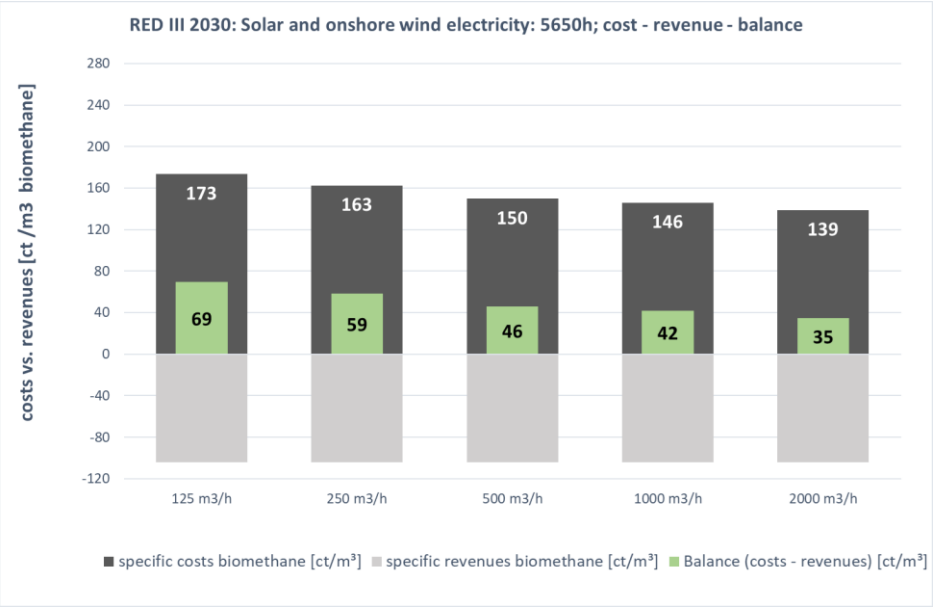
Biomethane LCOE with solar and onshore wind electricity

WWTP-based Biomethanation + PEMEL:
250 bar (fuel); electricity from solar and onshore wind, reduced load hours 5650 h/a, electricity price 5.6 - 6.4 ct/kWh$_e$

- **2 types of biomethane** (revenue 0.9 €/m3): Biomethane from sewage sludge + e-Methane (green electrolysis +biogenic CO2)
- **E-Methane compliant to RED III**

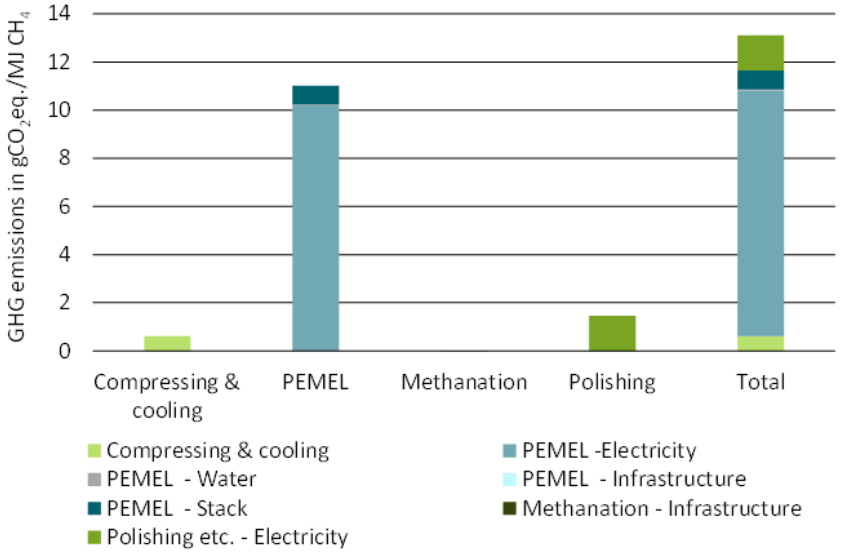
→ **LCOE in range of 1.73 €/m³ to 1.39 €/m³**

– Onshore wind + PV cheaper than grid electricity



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GHG Analysis – CS 1 | base case



Assumptions

- Electricity from a mix of solar tower power plant, PV and wind onshore plant for PEMEL
- Electricity from the grid for compression, conditioning etc. processes (214gCO_2eq./kWh)

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Biomethane – challenges CS1

- **High electrolyzer CAPEX** making the investment challenging
- High degree of dependence on renewable electricity to upgrade biogas
- Profitable operation is dependent on **a competitive hydrogen price**
- Hydrogen should reach **RED III conformity (RFNBO)**

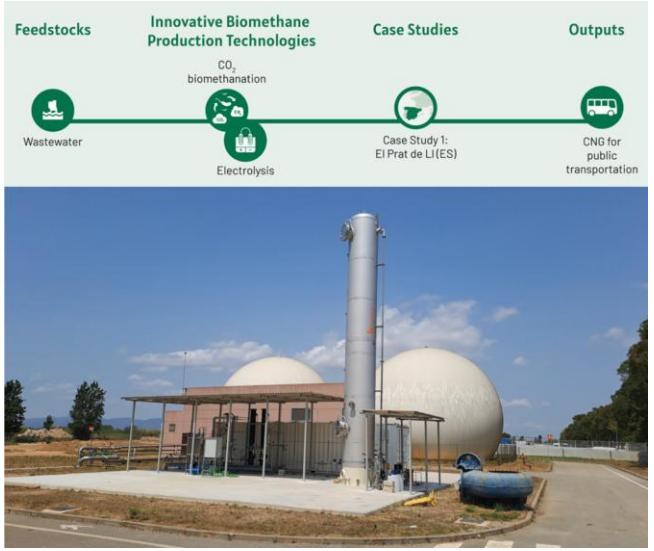


Illustration: SEMPRE-BIO.com; Image: SEMPRE-BIO.com (CS 1)

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Cost analysis CS2 – Base Case

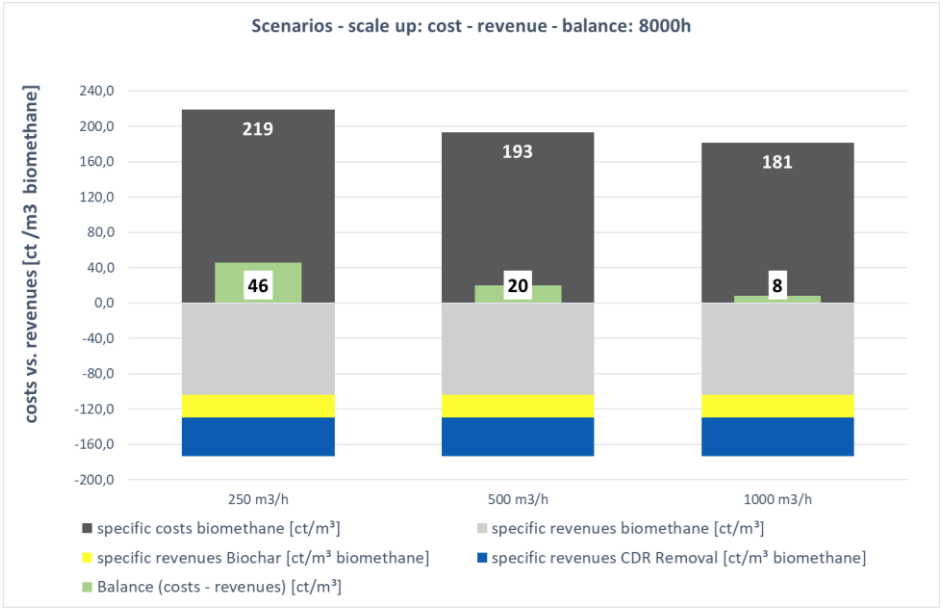
upgrading and grid injection

Pyrolysis, bio-methanation, biogas upgrading (membrane), grid injection, 8000 hours/a

-revenue for biochar (200 €/t) and CO_2 removal (140 €/t CO2)

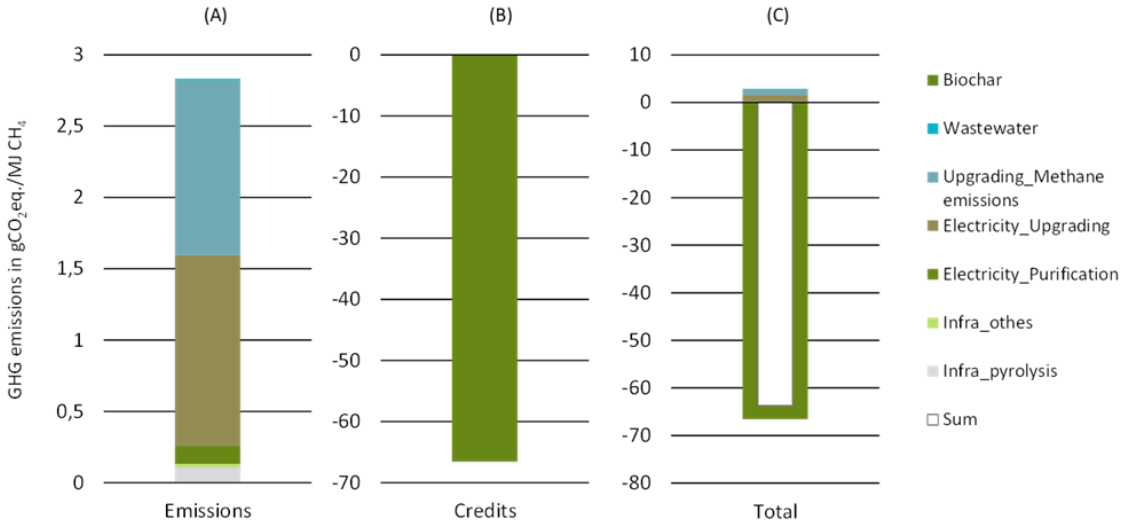
→ **LCOE in range of 2.19 €/m³ to 1.82 €/m³**

- Sensitivity: CAPEX largest cost factor
- Biomass costs depending on plant location
- Continuous market development for CDR and Biochar necessary



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GHG Analysis – CS 2 | base case



Assumptions

- Electricity from a mix of solar tower power plant, PV and wind onshore plant for PEMEL
- Electricity from the grid for compression, conditioning etc. processes (77 gCO2eq./kWh)
- Wood chips 70% DM, Transport 100km
- Biochar C-content 77%, perm c 89% (IPCC 2019, vol 4, Ap 4)
- DIN ISO 14040/44 vs. RED II/III

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Biomethane – challenges CS2

- Produced biogas (low methane content) **cannot be injected directly into the grid** due (additional upgrading plant calculated)

→ Complex permitting processes

→ Strict **safety permitting** due to safety concerns

- **biochar markets currently not strongly developed (depend on quality and application)**

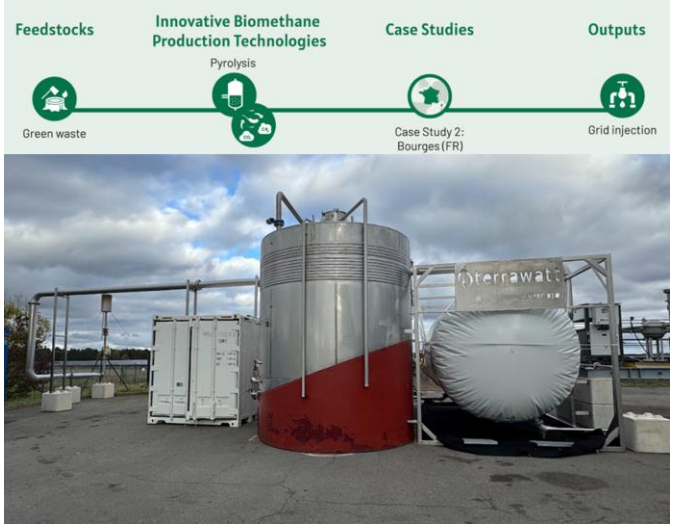


Illustration: SEMPRE-BIO.com; Image: SEMPRE-BIO.com (CS 2)

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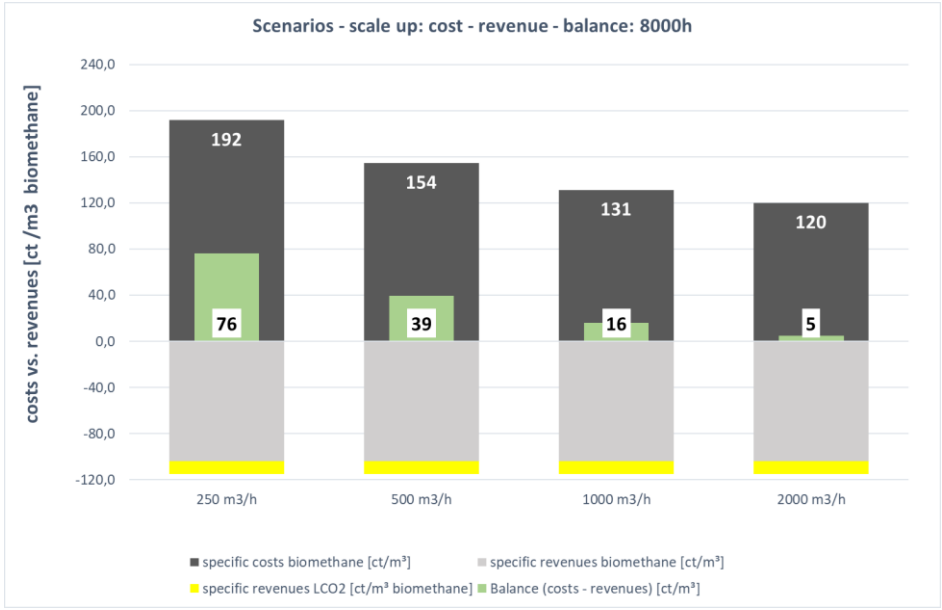
Cost analysis CS3 – Base case

Cryogenic separation - LCOE

Biogas upgrading with cryogenic separation, liquefaction, 8000 hours/a, liquid CO_2 and Bio-LNG

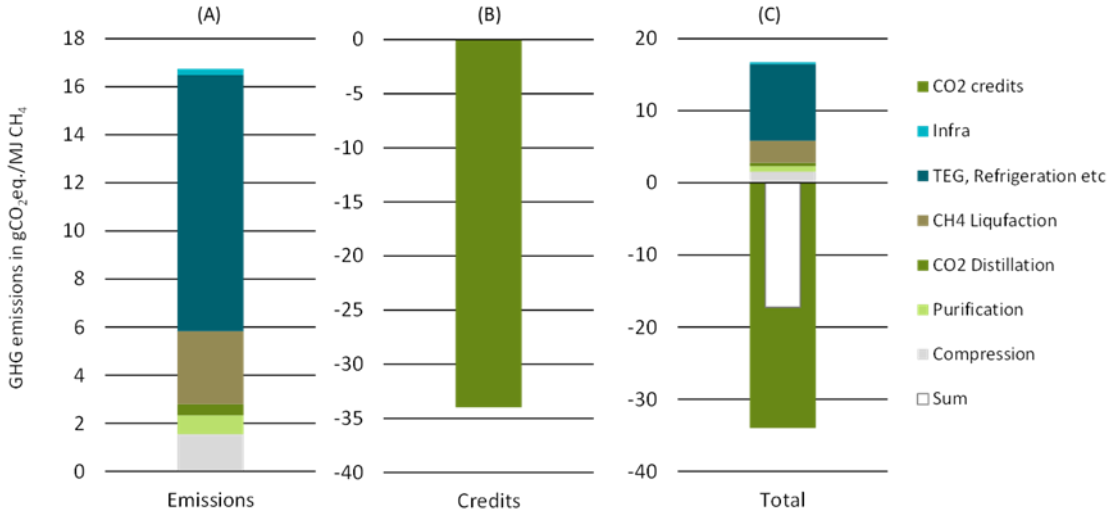
→ **LCOE in range of 1.92 €/m³ to 1.20 €/m³**

- Distribution network essential due to expensive transportability of liquified goods (CO2 transport cost not included)
- Sensitivity: High energy costs



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GHG Analysis – CS 3 | base case



Assumptions

- Electricity from the grid for compression, conditioning, separation etc. processes (177 gCO2eq./kWh)
- Manure 9% dm

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Biomethane – challenges CS3

- **CAPEX sensitivity for small plants**; Obtaining food grade quality of CO_2 in cost effective manner.
- cryogenic separation is **energy intensive**; energy demand is a main cost driver
- The **transportation of liquid CO_2** and bio-LNG is an **economic issue**;
- CO_2 transport and reuse frameworks differ by country



Illustration: SEMPRE-BIO.com; Image: SEMPRE-BIO.com (CS 3)

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Summary + main challenges

- **Summary**
  - Three innovative technologies – different feedstocks, technologies, products, markets

→ Currently small gaps to profitability

→ Individual market uptake requirements (location, green energy, distribution network)

→ substantial potential for reducing GHG emissions in renewable methane production (all CS)

- **Main challenges**
  - **Current revenue; ETS, bioenergy targets can be incentives to substitute fossil alternatives**
  - CAPEX
  - Energy costs (CS1, CS2 Hydrogen and CS3)
  - Distribution of pressurized products (CS1 base case, CS3)

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Market uptake requirements

- Optimisations to realise **cost-reduction potentials**. Especially for hydrogen scenarios, cheaper renewable electricity can reduce the costs significantly.
- Future r**evenues** dependent on policies and cost penalties for fossil solutions.
- CO_2 valorisation can improve efficiency and create additional revenues, but transportation infrastructure needed.
- Using alternative substrates (like woody biomass, agricultural residues, catch crops/legumes) for additional gas production → country-specific biomass potential and framework conditions to consider

→ **Individual market uptake requirements** (e.g. location, potential, green energy, distribution network)

→ **Stable supportive regulatory frameworks**, targeted financial incentives, **improved market access** for biomethane, and **stronger cooperation** between stakeholders

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SEMPRE-BIO

Societal Impacts of Biomethane Scale-Up in Europe

Evidence from the SEMPRE-BIO case studies

Meron Assefa Arega, SINTEF

September 23rd, 2026

Funded by the European Union

How does the upscaling of novel biomethane production technologies in Europe influence societal sustainability outcomes through global value chains?

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What happens when biomethane scales up?

- **Investment and operation of scale-up biomethane plants**:
  - Changes demand for goods and services across industries and countries
  - Affect sustainability outcomes: economic, social and environmental
- We assess the **wider societal implications** of biomethane scale-up, beyond plant-level technical and economic performance
- Covering the **three SEMPRE-BIO pathways in Spain, France and Belgium**, representing different technologies and feedstocks

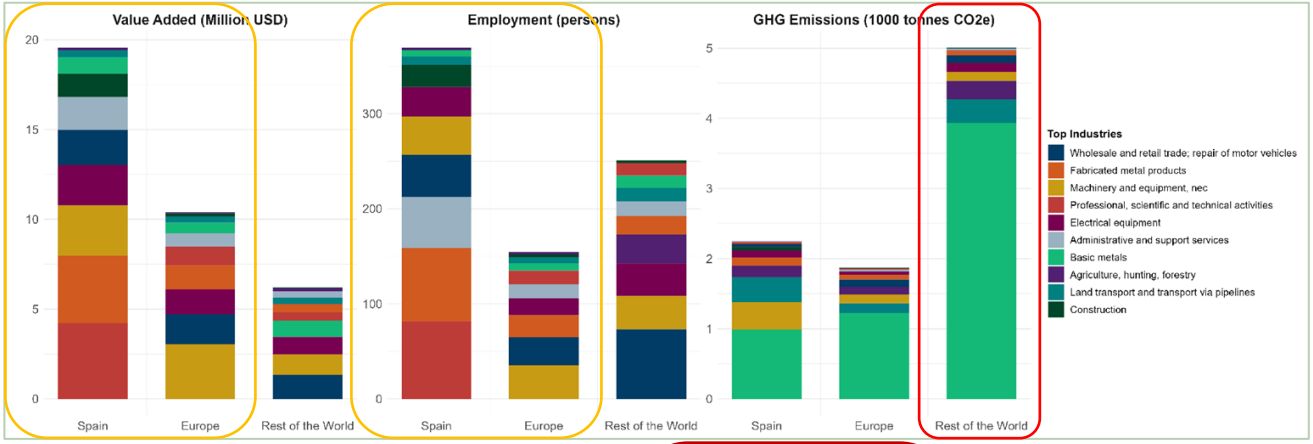
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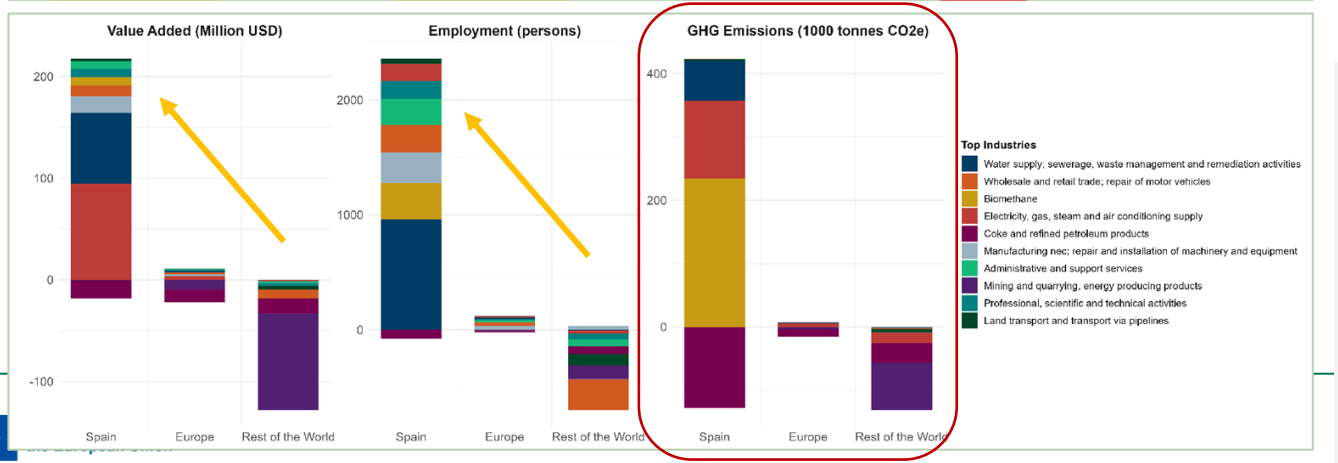
Methodological approach

- **Global Value Chain analysis** based on Wiebe et al (2026)
  - **Macroeconomic, scenario-based multi-regional Input–Output modelling**, based on the OECD Inter-Country Input–Output database, **76 countries × 45 industries**
  - Extended with data on **employment, emissions, and Sustainable Development Goals (SDG) indicators**
- **Scenarios**: **investment** in the biomethane plants and their continued **operation** in **Spain**, **France**, and **Belgium**
- Operation also includes **biomethane replacing conventional petroleum-based transport fuel**
- Traces direct and indirect effects through industry and global trade linkages, estimating impacts on **value added, employment, GHG emissions and selected SDG indicators,** by **industry, country and region**

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CSI: Regional & sectoral impact , investment & operation phases





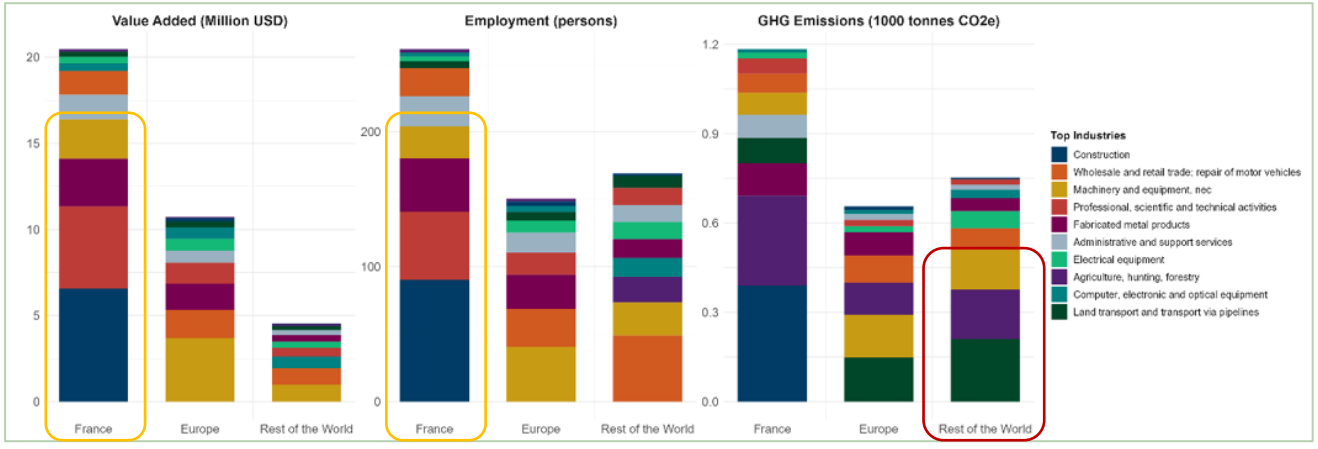
CAPEX scenario vs baseline

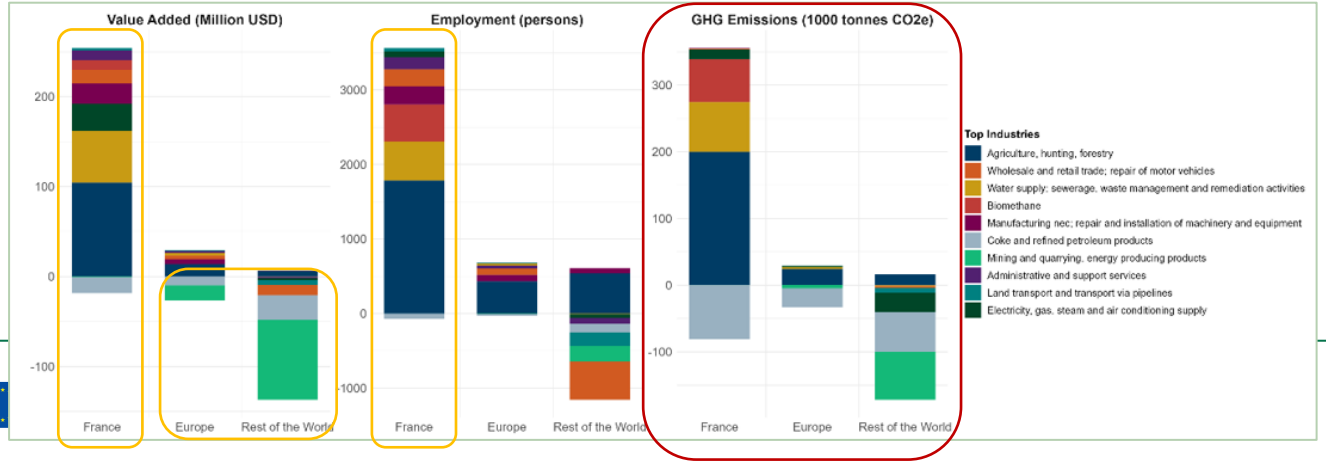
- VA & jobs mainly in Spain and Europe: technical services, fabricated metals, machinery and electrical equipment industries
- Effect on GHG emissions more globally distributed, extend to the ROW, through upstream manufacturing of metals

OPEX scenario vs baseline

- Effects of VA & jobs shift towards Spain: water & waste management, electricity, wholesale & retail industries
- Fossil energy activity declines abroad: coke & refined petroleum products & energy-producing mining
- Net global GHG emissions increase

CS2: Regional & sectoral impact, investment & operation phases





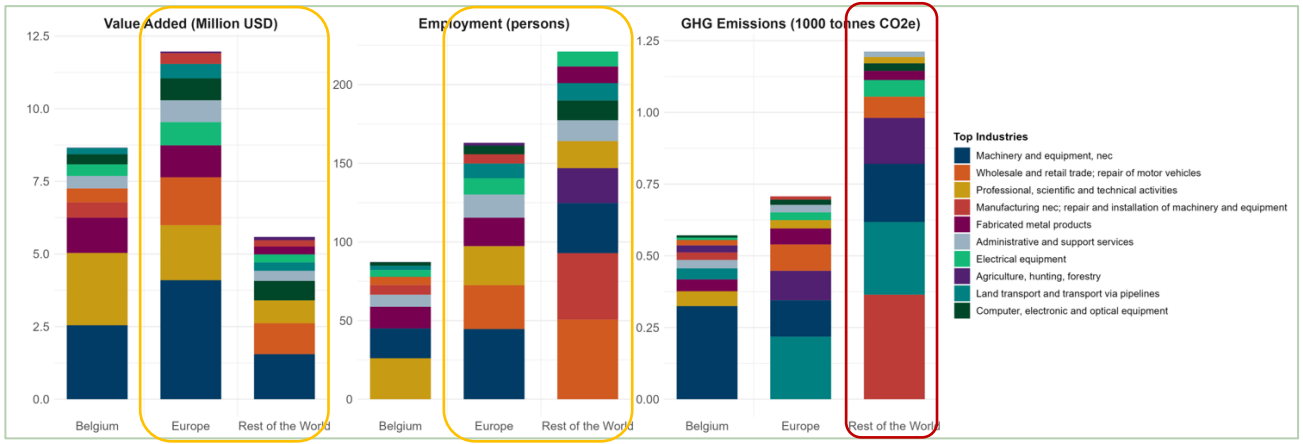
CAPEX scenario vs baseline

- VA & jobs mainly in France: Construction, technical services, machinery & metals
- GHG spillovers in Europe/ROW: transport, agriculture & forestry, machinery

OPEX scenario vs baseline

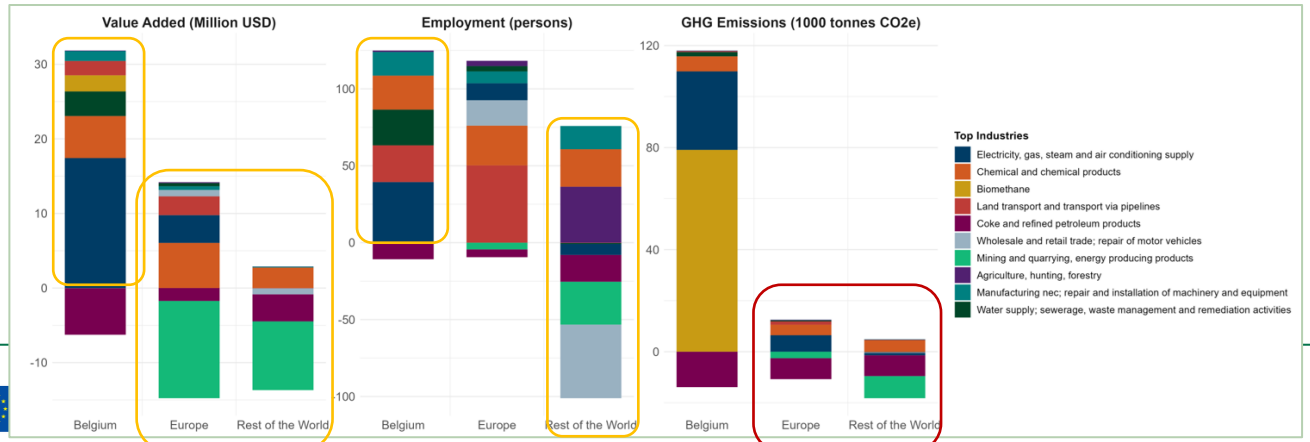
- Domestic gains in VA and jobs: agriculture & forestry, water/waste management and biomethane
- VA losses abroad concentrated in energy mining and refined petroleum
- Net global GHG emissions increase: agriculture & forestry, water/waste mangt

CS3: Regional & sectoral impact, investment and operation phases



CAPEX scenario vs baseline

- VA and employment: widely distributed, with strong spillovers in Europe/ROW, partly reflecting Belgium's small, highly open economy
- GHG effects extend further upstream, with the largest emissions occurring outside Belgium



OPEX scenario vs baseline

- Strong gains in Belgium, mainly through electricity, chemicals and supporting activities
- Positive and negative effects outside Belgium partly offset each other, resulting in a relatively small net global effect

Global value-chain effects

- **Investment creates ripple effects**: increasing demand in industries mainly construction, machinery, electrical equipment, metals and technical services
- These effects generate **cross-border spillovers**: value added, jobs and GHG emissions impacts extending beyond the case study countries
- During operation, **effects differ by technology pathway**: affecting utilities and waste activities in Spain, agriculture and forestry in France, and electricity and chemicals in Belgium
- **Replacing part of conventional transport fuel with biomethane creates trade-offs**: increasing activity in biomethane production and its input industries while reducing upstream fossil-energy activity

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Impact on selected SDG indicators

- Investment phase shows a similar pattern in all three cases: economic, manufacturing and skills related SDG indicators improve, while local emissions and GHG related SDG indicators worsen
- Effects on in operation phase differ more by technology pathway, reflecting differences in feedstock and operating requirements
- Reduced fossil-energy activity improves some energy related SDG indicators, but environmental trade-offs remain

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Conclusion and policy implications

- Supply-chains matter: material sourcing determines where value added, jobs and environmental impacts occur
- **Stronger domestic and European supply-chain structure can retain more economic benefits in Europe**
- Technology and feedstock choices matter: electricity, feedstock and operating needs shape both socio-economic benefits and environmental impacts
- **Policy should connect energy, industrial and circular-economy objectives** and consider impacts beyond the plant level

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Thank you!

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