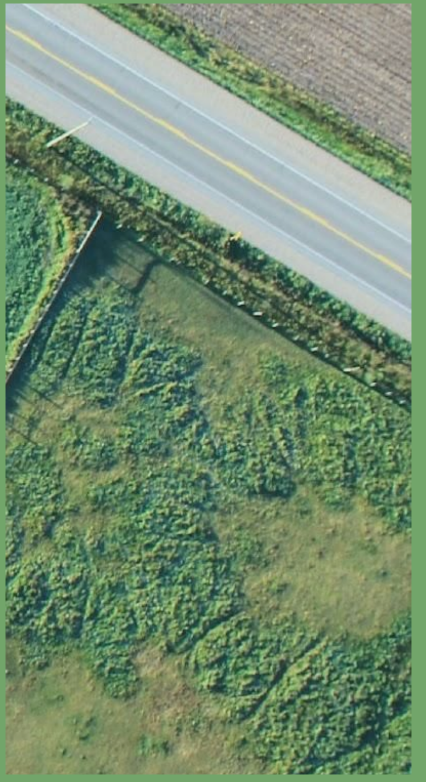
Education project under the EU Erasmus+ Program 2021-2027. Jean Monnet Module

13 June 2025



SEMPRE-BIO

New cost-effective biomethane solutions to support circular economy

Alejandra Córdova Valencia

Project Manager CETAQUA CENTRO TECNOLÓGICO DEL AGUA

SEMPRE-BIO

WE ARE CETAQUA

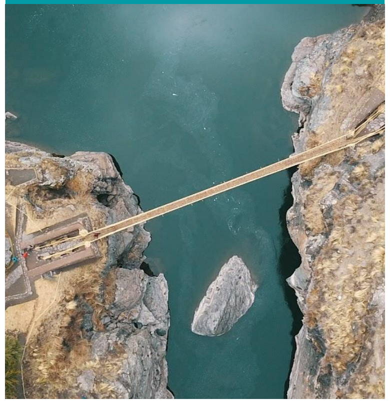
A network of water technology centres based on a **unique public-private collaboration model**.

AREAS OF INNOVATION

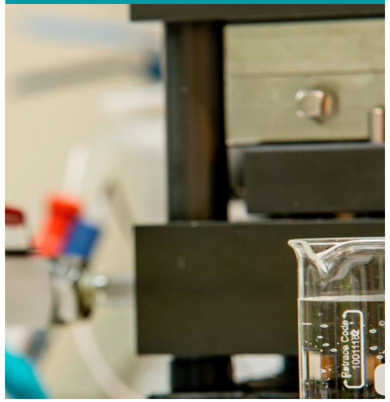
We focus on five **strategic areas of innovation** designed to meet the needs of companies and territories and respond to the challenges of society, directly benefiting people and the planet.

Our areas of innovation are aligned with the Sustainable Development Goals promoted by the United Nations:

Water resource planning and management



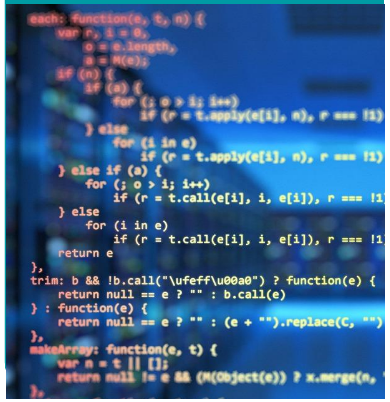
Production and new resources



Zero waste and decarbonisation

Territorial and social sustainability

Efficient, safe and digital operation



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

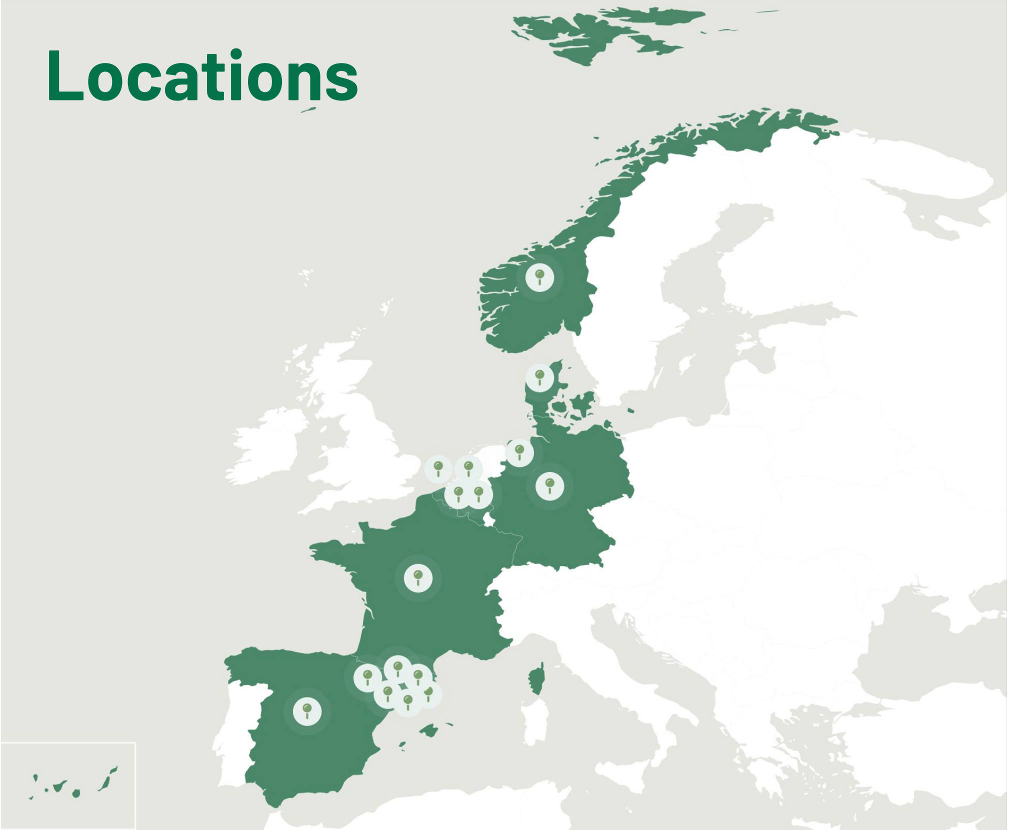
42 Months

17 Partners

7 Countries

9.9M Funding

Locations



Funded by
the European Union

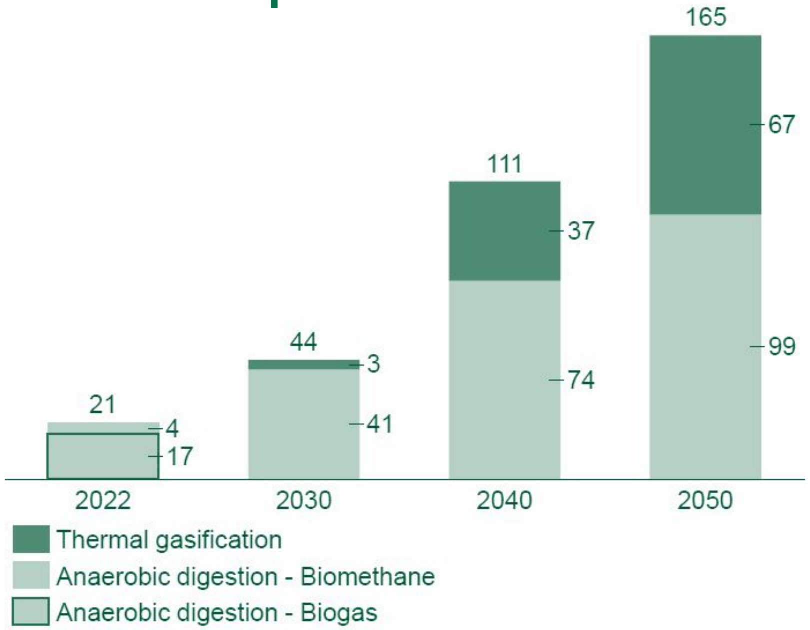
Research organizations	CETAQUA Centro Tecnológico del Agua, DBFZ, SINTEF, Innolab
Industry	Aigües de Barcelona, CRYO inox, ProPuls, terrawatt, BIOTHANE by VEOLIA Water Technologies
Academia	DTU, Universiteit Gent, Beta Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària
End-users	TMB, Naturgy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

17 Partners

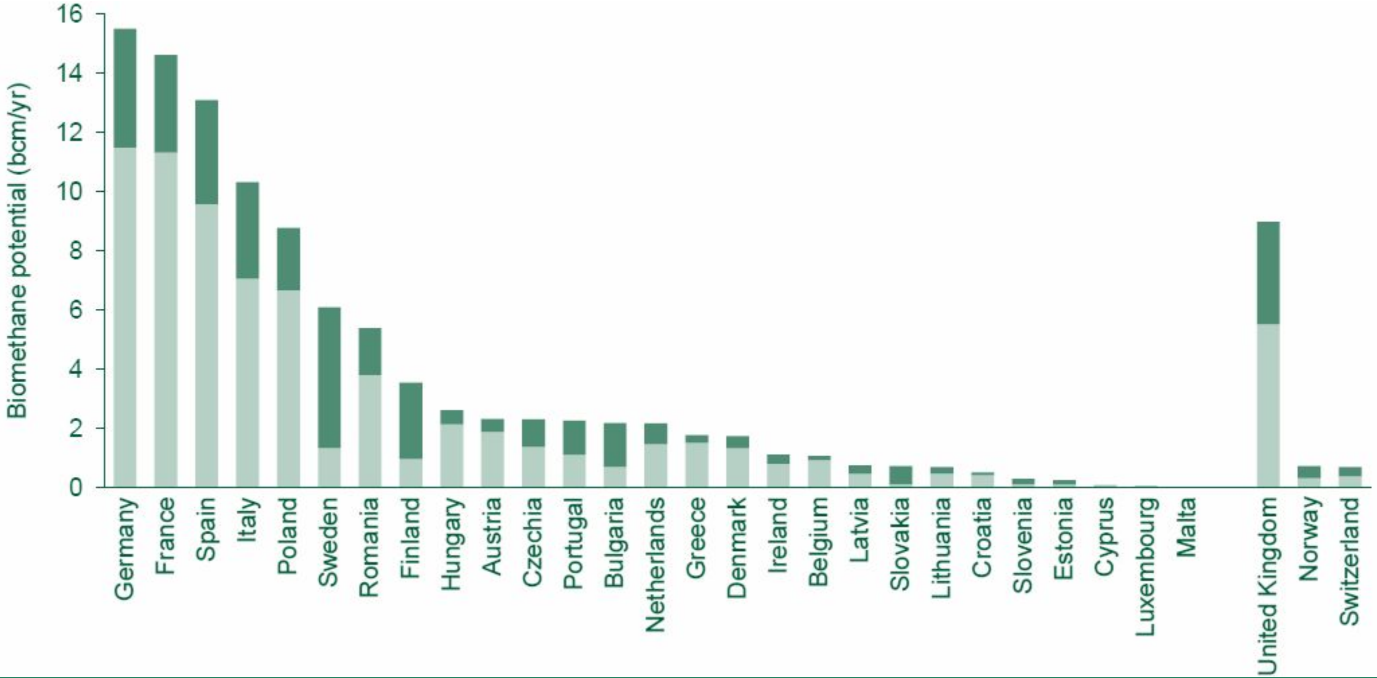
Funded by the European Union

Projected Biomethane Production Potential in Europe (2022-2050)

Potential to scale-up biomethane production



Biomethane potential of 111 bcm/yr in Europe in 2040

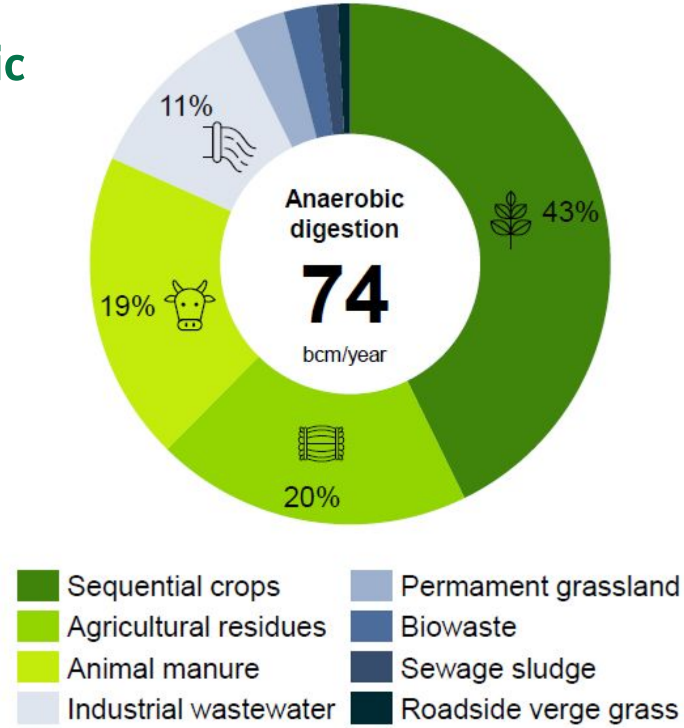


Funded by
the European Union

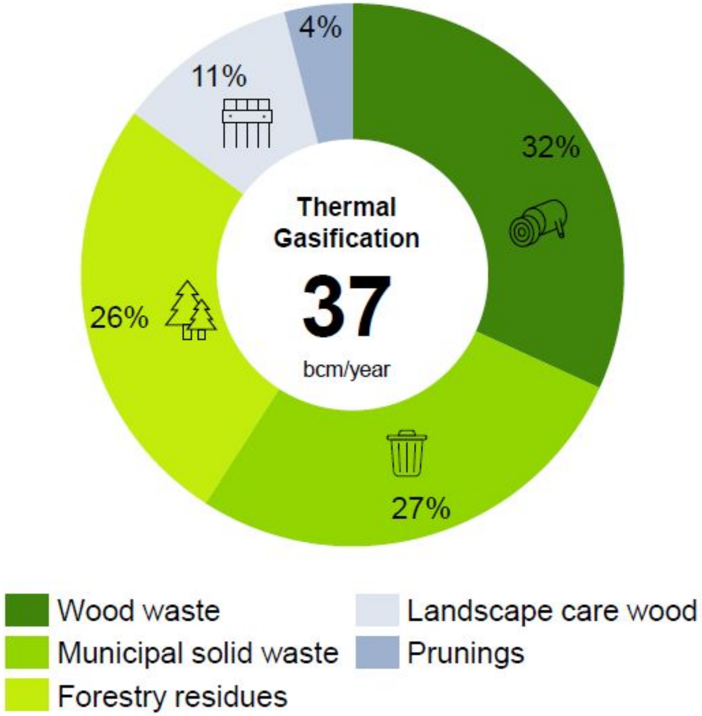
Source: “Biogases Towards 2040 and Beyond” (Guidehouse, EBA)

2040 Feedstock and technology selection

2040 Anaerobic digestion feedstock

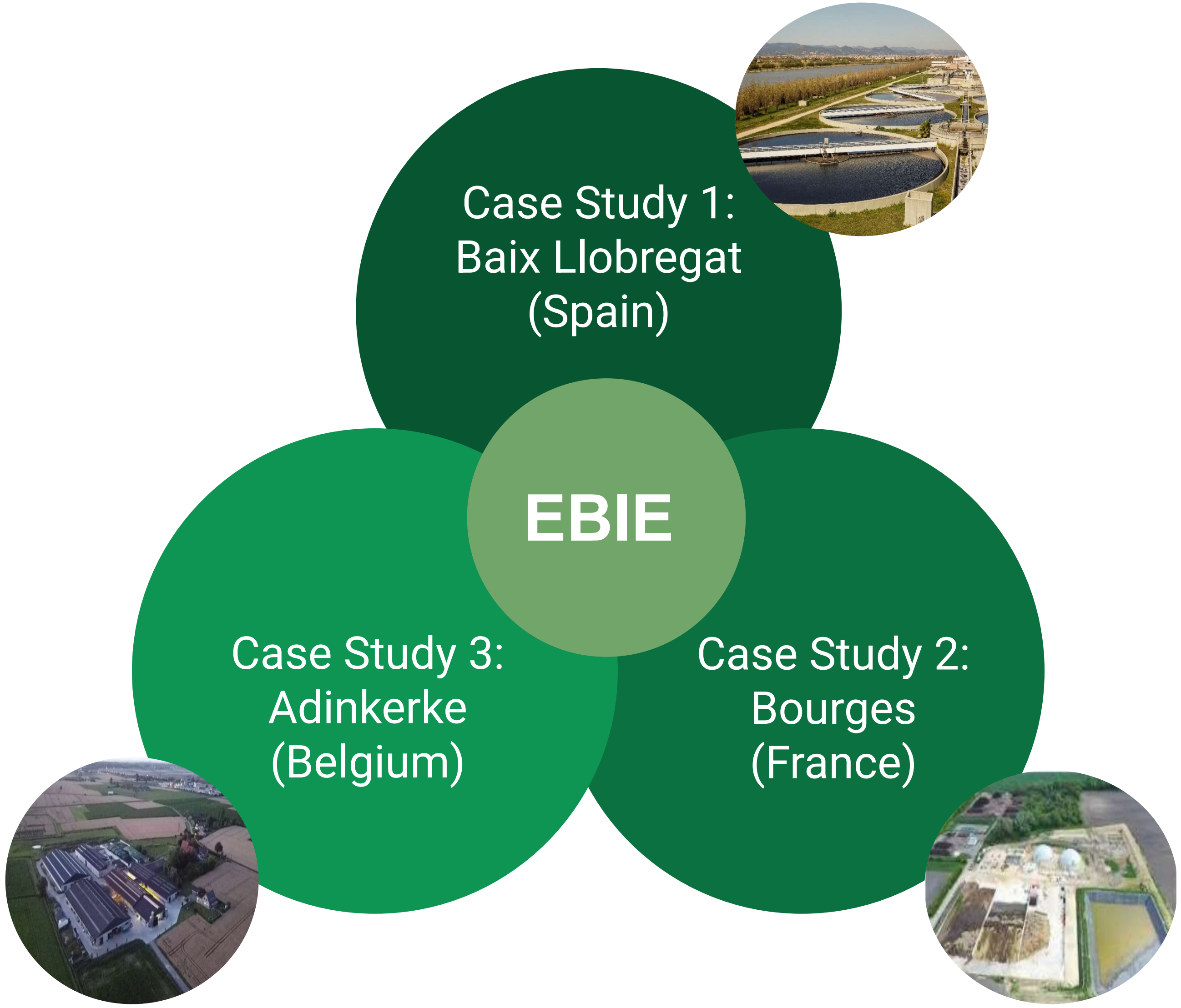


2040 Thermal gasification feedstock



Funded by the European Union

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



European Biomethane Innovation Ecosystem

Funded by
the European Union

Case Study I: Baix Llobregat (Spain)

CO_2 biomethanation

Wastewater

Electrolysis

CS1

CNG for public transportation

Anaerobic digestion

Raw Biogas

CH_4
CO_2
H_2S
VOCs
Siloxanes

Pretreatment

Clean biogas

65% CH_4
35% CO_2

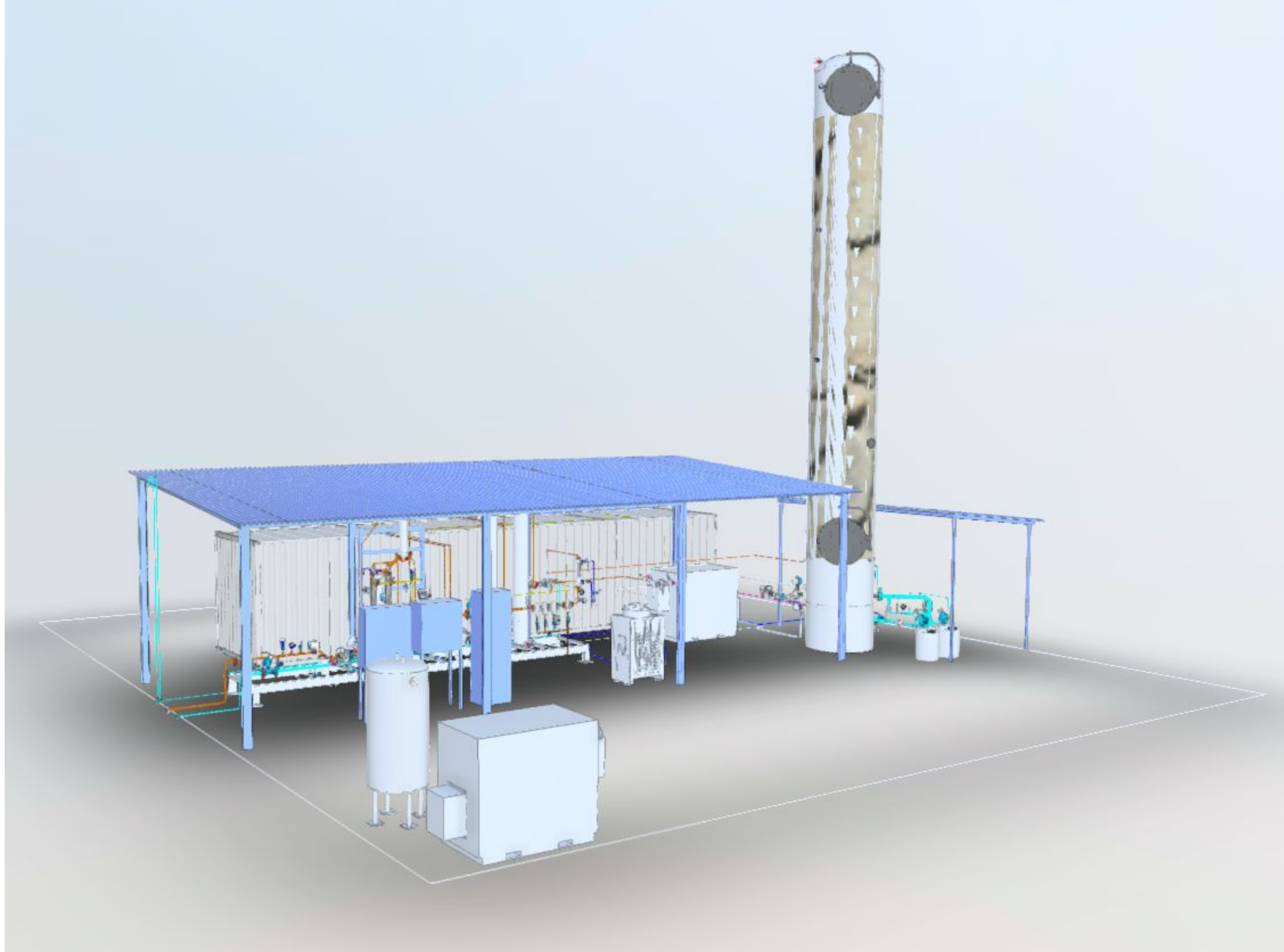
Biomethane

>95% CH_4
<2.5% CO_2
<2% H_2
<1% O_2
<5 ppm H_2S
<0.1 ppm Siloxanes

Funded by the European Union

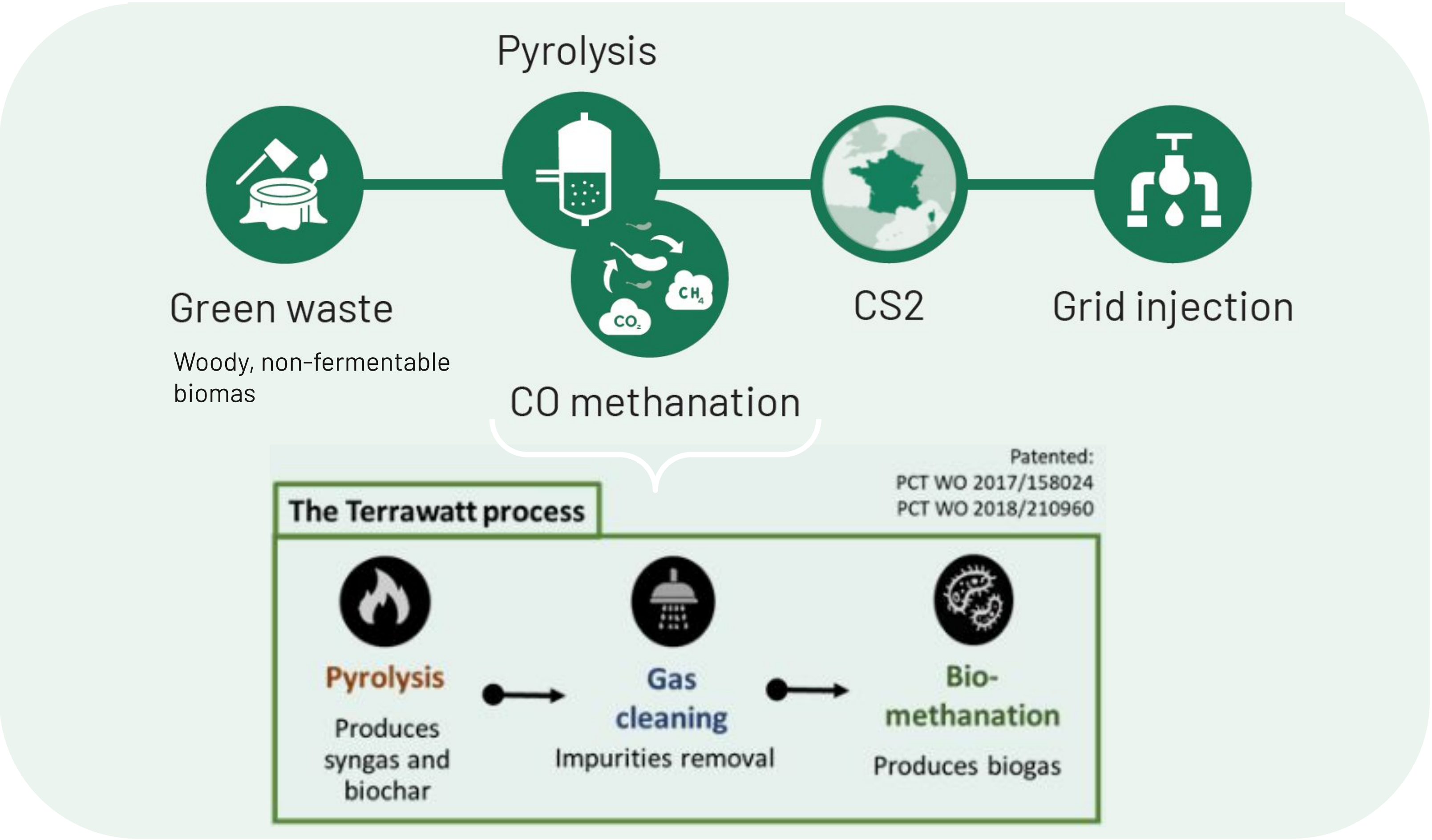
Status of Case Study I: Under construction

Aigües de Barcelona



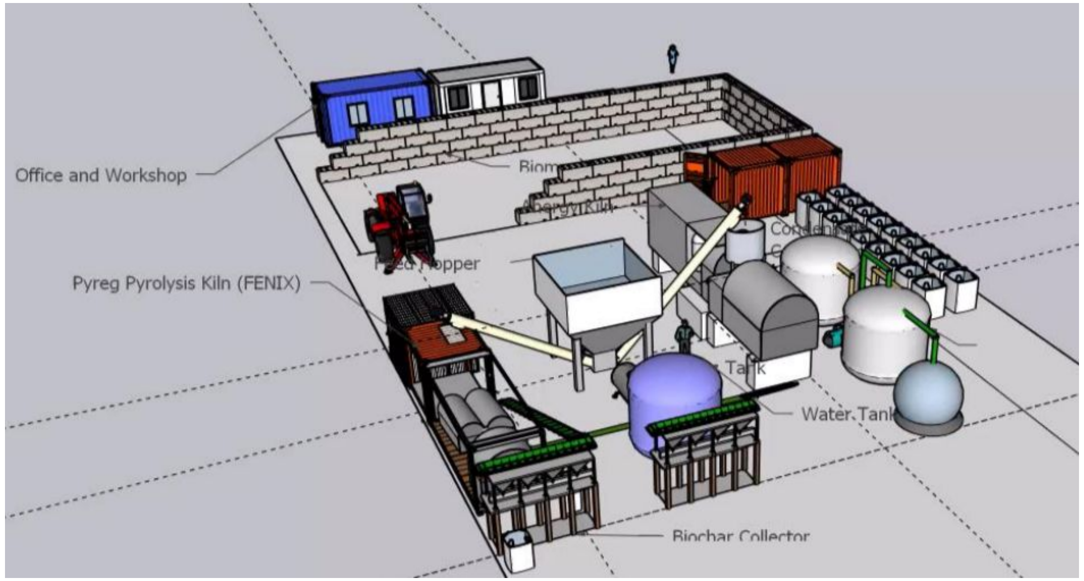
Funded by the European Union

Case Study 2: Bourges (France)



Funded by
the European Union

Status of Case Study 2: Under construction

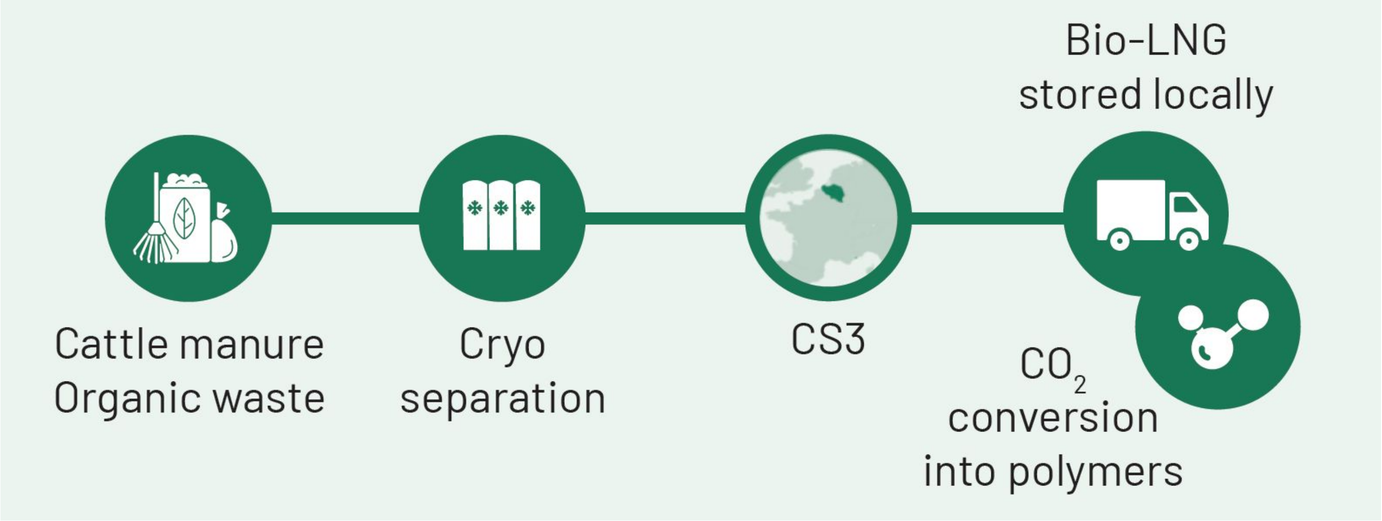


VEOLIA

Funded by
the European Union

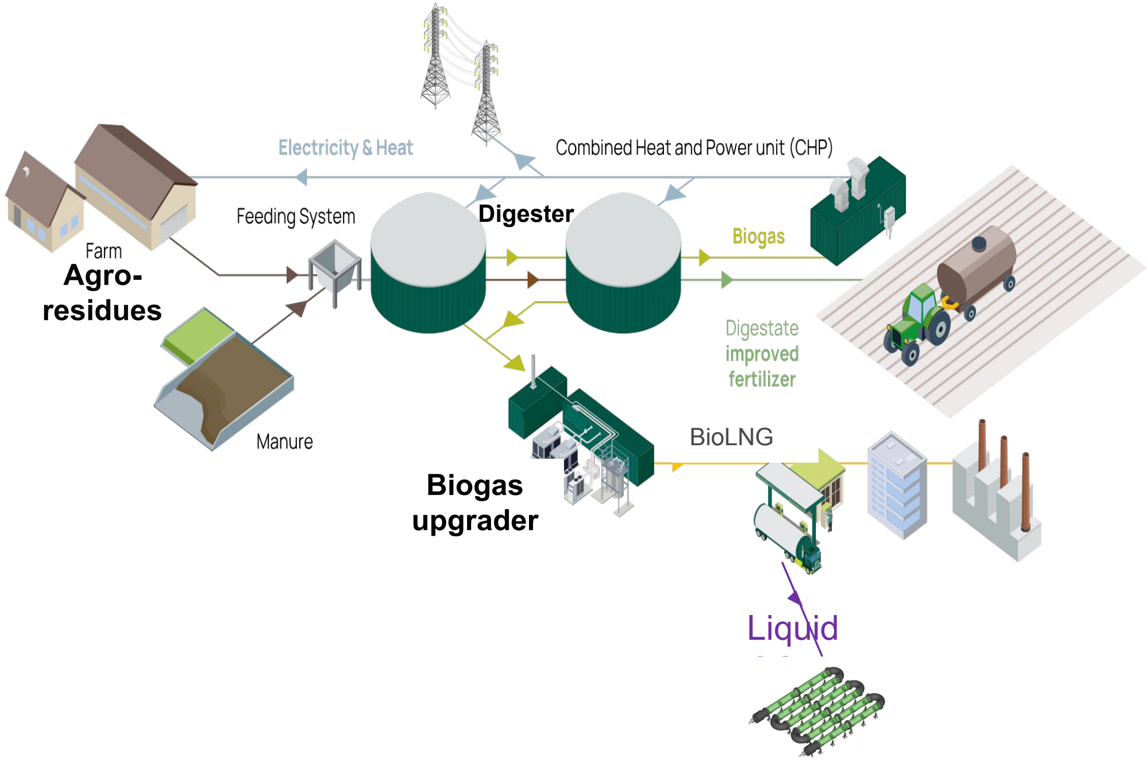
terrawatt DBFZ DTU SINTEF

Case Study 3: Adinkerke (Belgium)



Funded by
the European Union

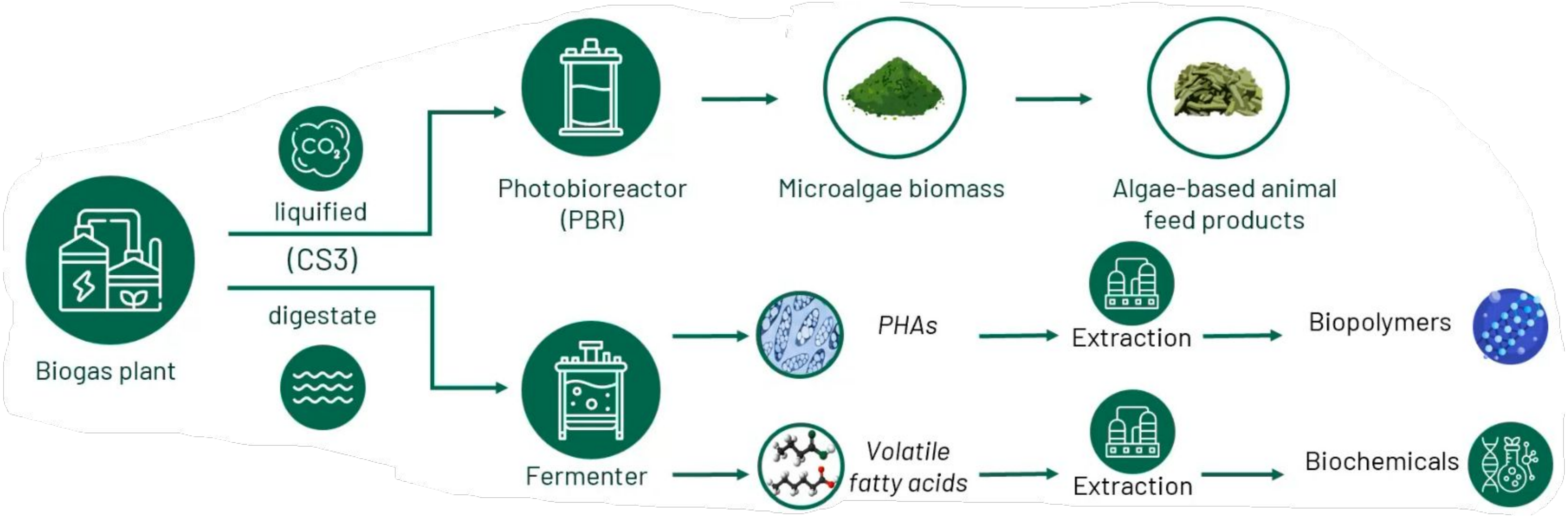
Status of Case Study 3: Construction finished and ready to operate



NV De Zwanebloem

Funded by the European Union

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



Funded by the European Union

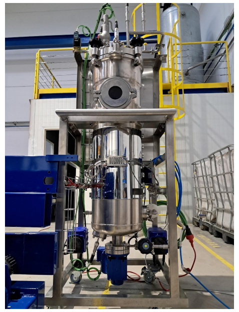
Advanced technologies for efficient valorization of CO2 from biogas/biomethane streams

Technical feasibility to produce potentially marketable biopolymers, biochemicals and alternative protein sources from CO_2 demonstrated.

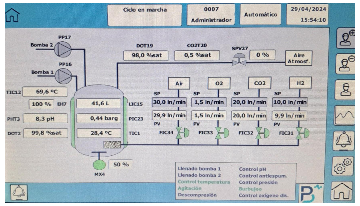
Fermentation process (biopolymers & biochemicals)

Lab Scale (0,5 - 5L)
Intermediate (1L)
Scale-up

Nutrient sources: Synthetic mineral medium vs. liquid fraction of digestate.



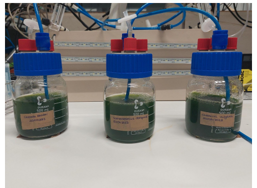
50L fermenter



PLC for control of the inlet gas mixture

Microalgae cultivation (alternative protein sources)

Lab Scale (0,5 - 5L)
Intermediate (10L)
Scale-up



Production of alternative protein sources for animal feed based on microalgae biomass: 40-50% (dry weight) of protein content.

Funded by the European Union

Beta Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària
UNIVERSITEIT GENT
DTU
Innolab
DBFZ
CRYO inox

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.

Funded by
the European Union

Case study I

David Checa Sánchez

Project Manager CETAQUA
CENTRO TECNOLÓGICO DEL AGUA

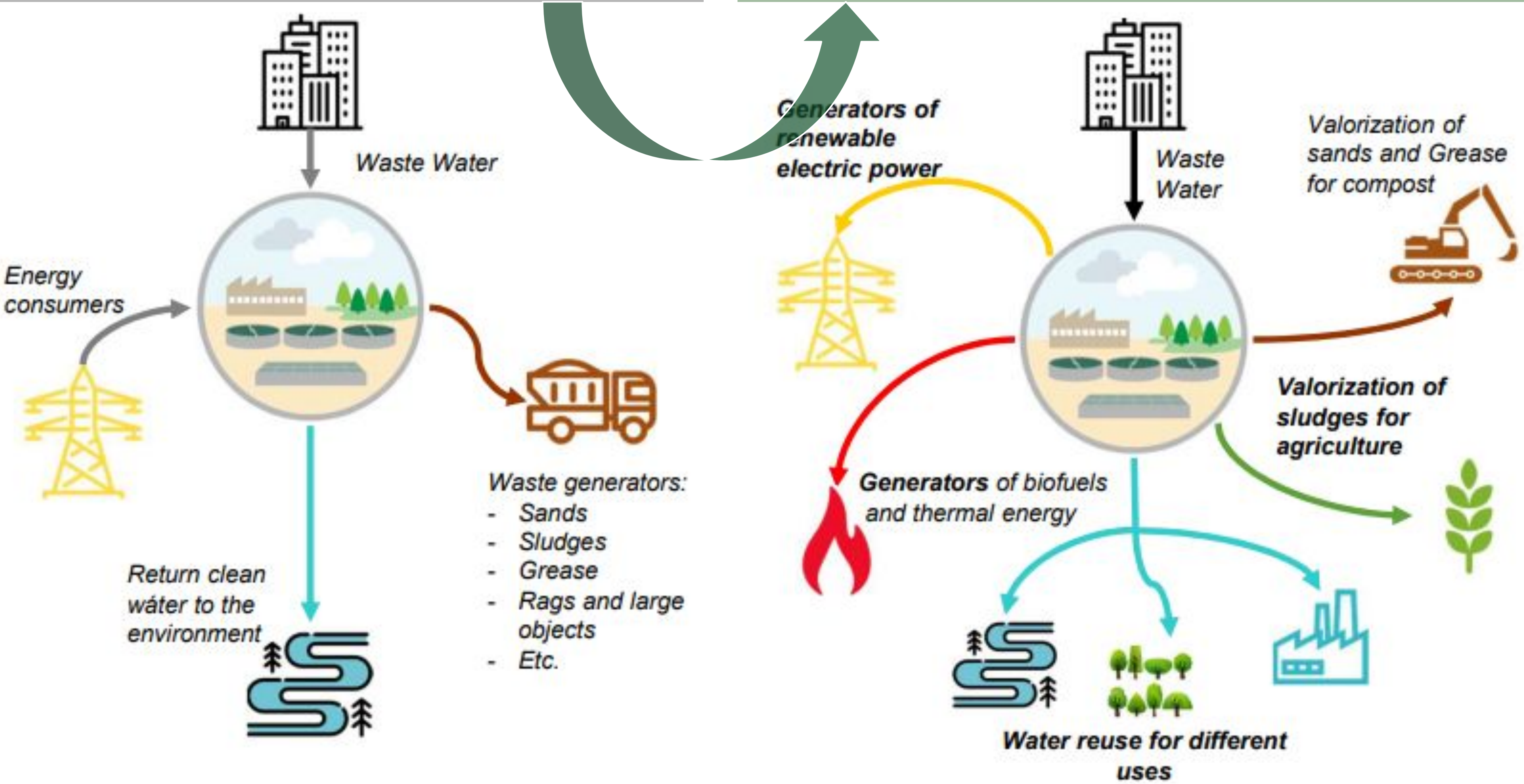
Funded by
the European Union

Case Study I: Baix Llobregat (Spain)

Aigües de Barcelona

Old Paradigm: Sewage Treatment Plant

New Paradigm: Biofactory



Funded by the European U

Case Study I: Baix Llobregat (Spain)

Wastewater → CO_2 biomethanation / Electrolysis → CS1 → CNG for public transportation

Anaerobic digestion

Raw Biogas

CH_4
CO_2
H_2S
VOCs
Siloxanes

Pretreatment

Clean biogas

65% CH_4
35% CO_2

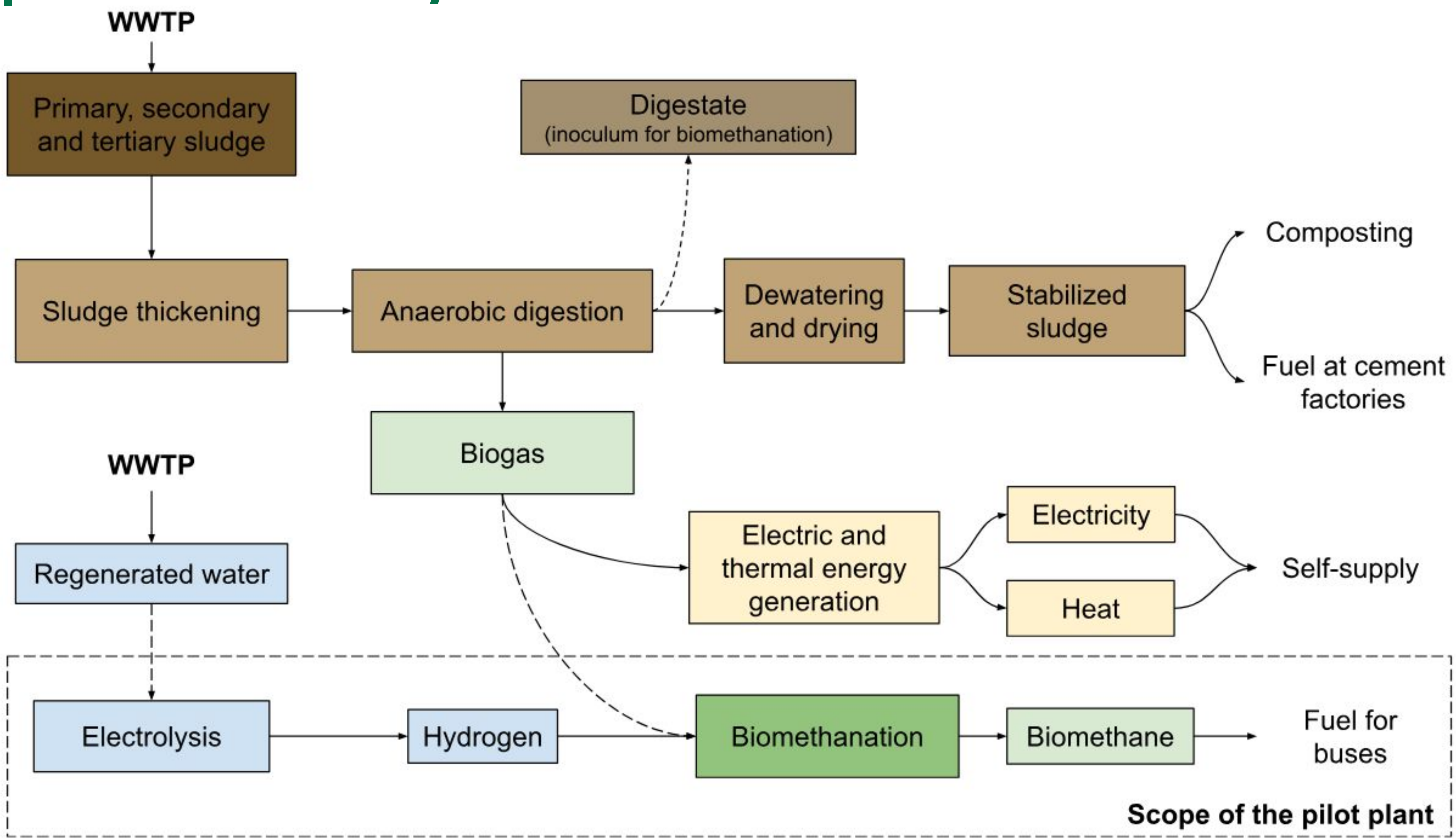
Biomethane

>95% CH_4
<2.5% CO_2
<2% H_2
<1% O_2
<5 ppm H_2S
<0.1 ppm Siloxanes

Funded by the European Union

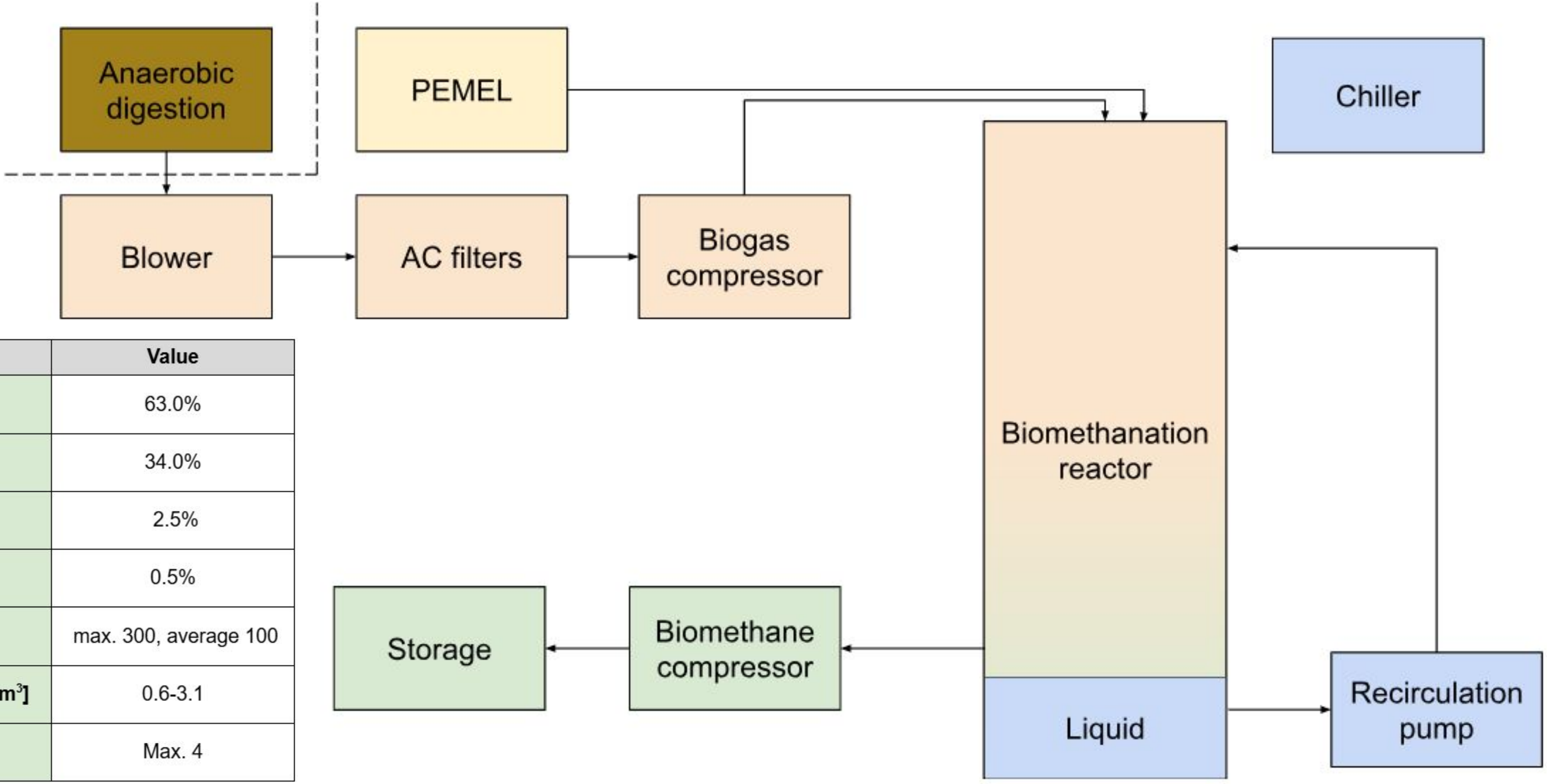
CETAQUA CENTRO TECNOLÓGICO DEL AGUA · Aigües de Barcelona · ProPuls · DTU · SINTEF · DBFZ · TMB · BIOTHANE by VEOLIA Water Technologies

Scope of Case Study I



Funded by
the European Union

Case Study I Process diagram



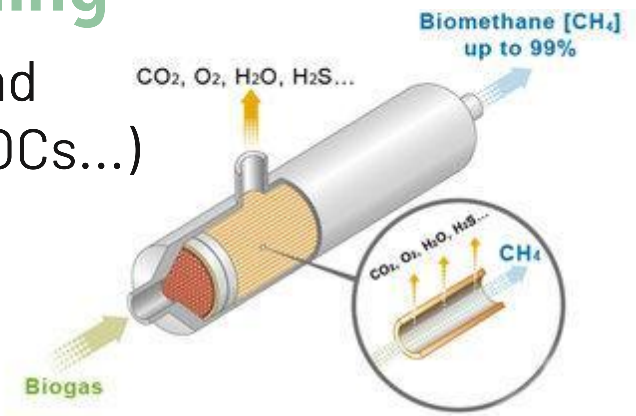
Component	Value
CH_4 [vol.%]	63.0%
CO_2 [vol.%]	34.0%
N_2 [vol.%]	2.5%
O_2 [vol.%]	0.5%
H_2S [ppmv]	max. 300, average 100
Siloxanes [mg Si/Nm^3]	0.6-3.1
VOCs [ppmv]	Max. 4

Funded by the European Union

Methanation vs Upgrading

Conventional upgrading

Separating CO_2 from CH_4 and purifying (H_2S, siloxanes, VOCs...)



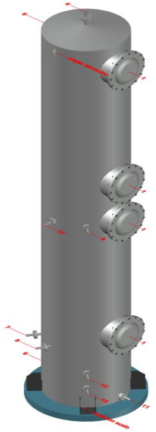
	WWTP Biogás [vol.%]	Biomethane for injection [vol.%]	Biomethane for mobility [vol.%]
CO_2 [vol.%]	**30-40%**	<2%	<5%*
CH_4 [vol.%]	**60-70%**	>90%	>90%*
H_2 [vol.%]	0%	<5%	<2%
H_2S [ppm]	5000-300	<3	<3

*For transport: $CO_2+N_2+O_2$ max. 5%, O_2 max. 1%, Methane number min. 70, Wobbe index below 41.9-49.0 MJ/Sm^3, LHV min. 44 MJ/kg

Methanation

Addition of H_2 to biogas to convert CO_2 to CH_4 through methanogens.

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

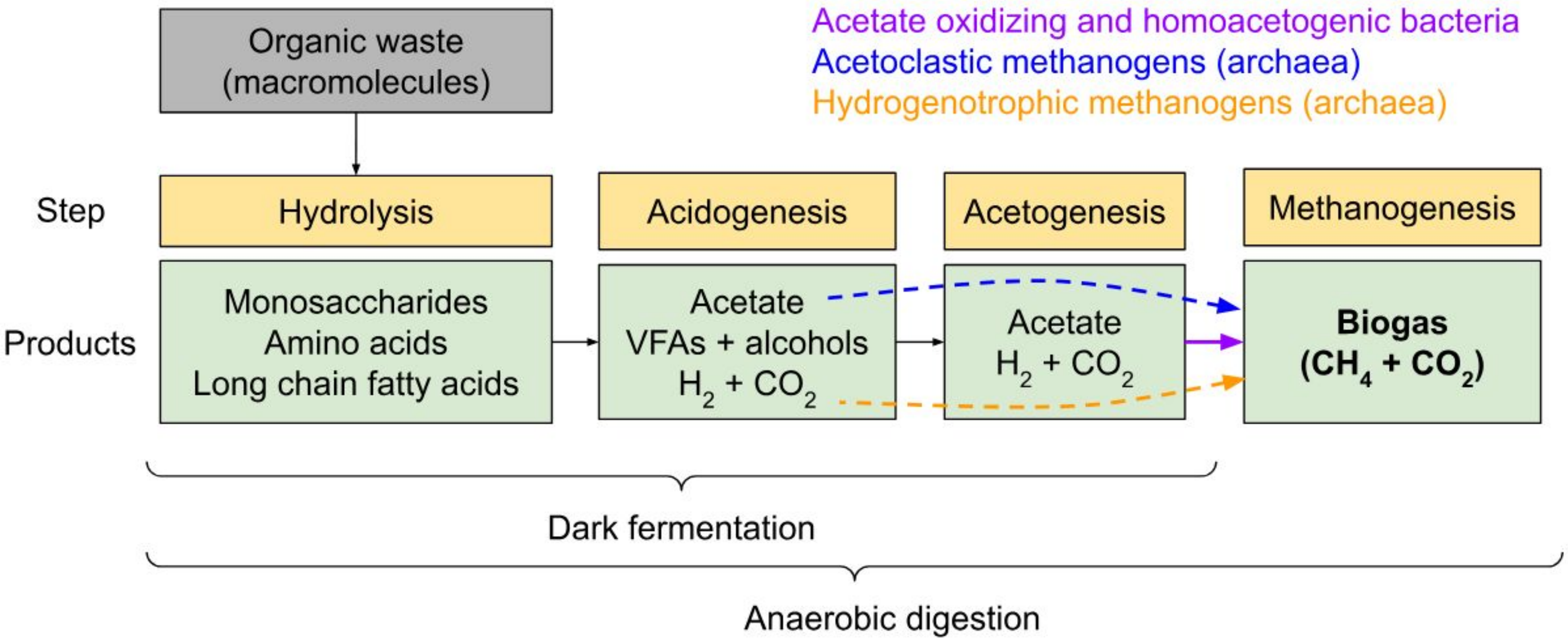


Increase of biomethane sales (all carbon is valorized).

High electrical consumption (H_2 generation) and CAPEX (electrolyzer).

Funded by the European Union

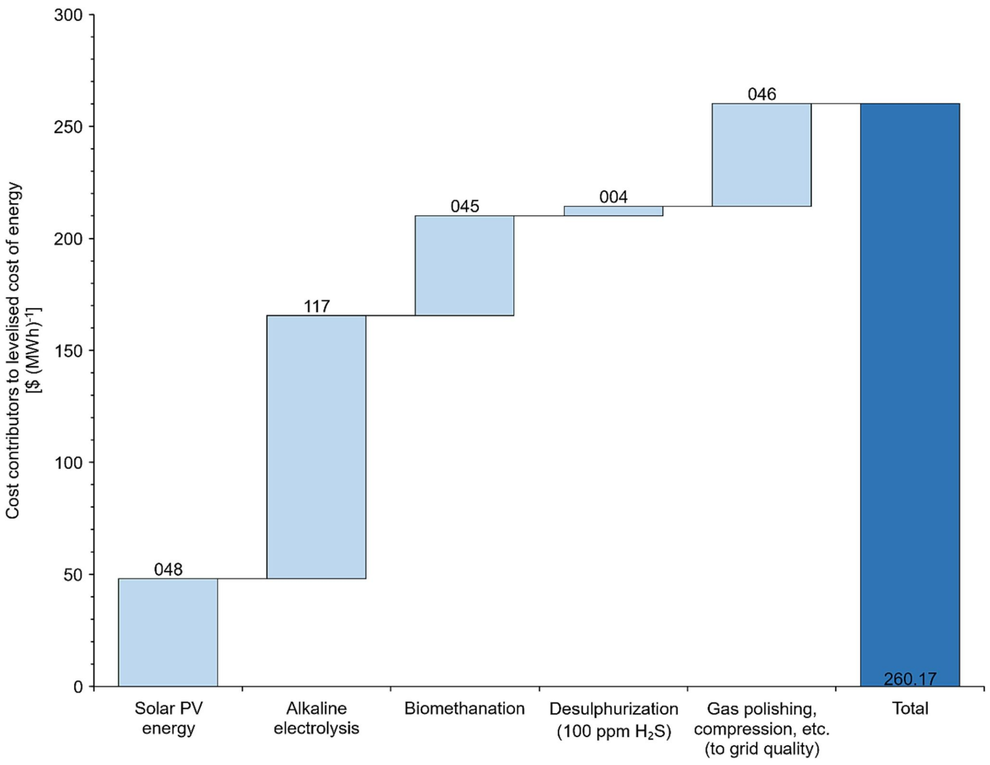
Anaerobic digestion



Funded by
the European Union

Methanation viability and potential

Lower electrolysis costs



(Sieborg et al. 2024)

Use of alternative water sources

Renewable water, seawater, atmospheric water

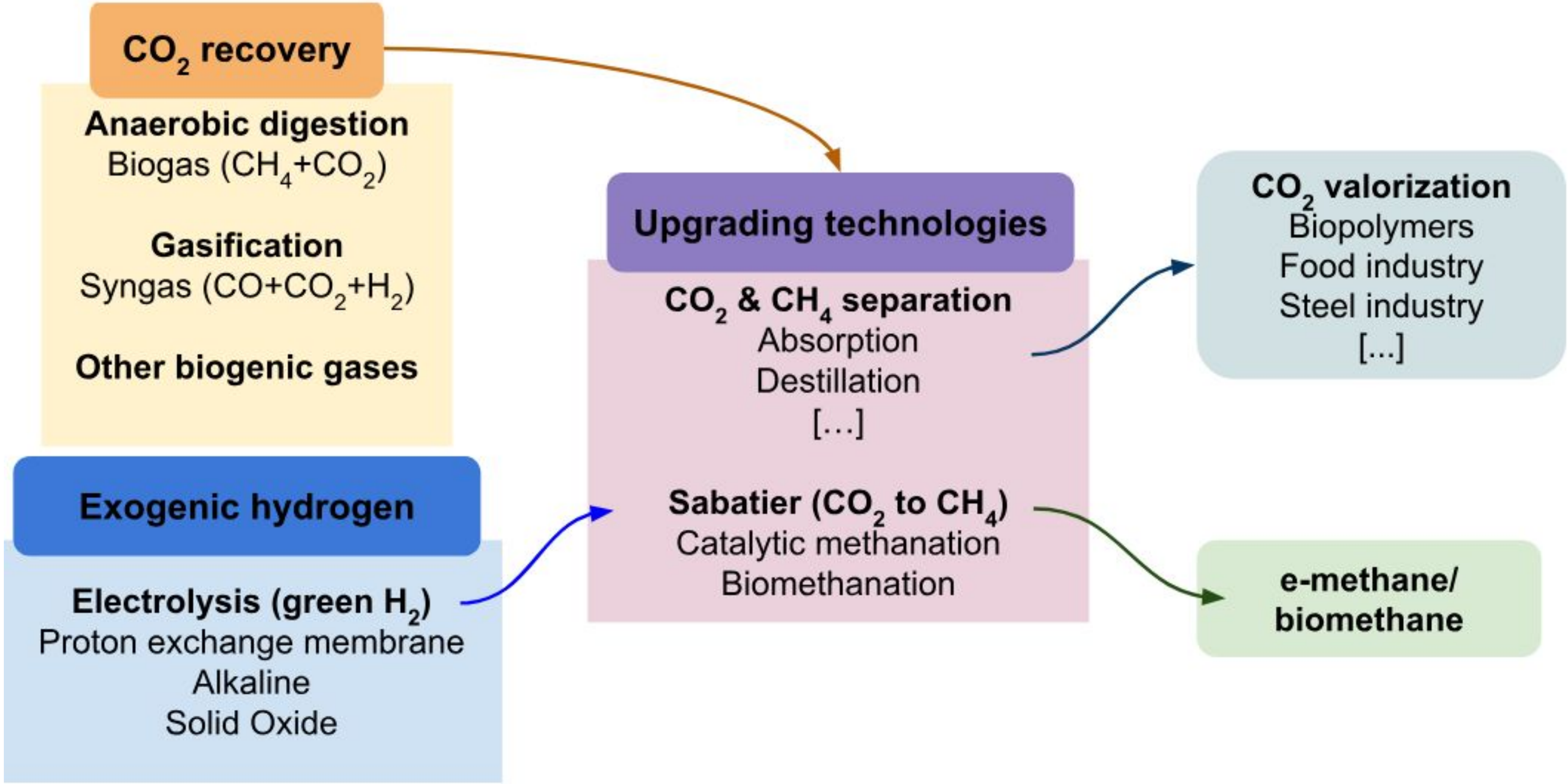
Renewable energy peaks storage

Otherwise, it is not competitive with other technologies

Different technologies adapt to different scenarios

Funded by the European Union

Biomethane production pathways



Funded by
the European Union

Case Study I: Under construction

Aigües de Barcelona

Funded by
the European Union

Thank you for your attention!

SEMPRE-BIO
@SEMPRE_BIO
SEMPRE-BIO PROJECT
INFO@SEMPRE-BIO.COM
WWW.SEMPRE-BIO.COM

CETAQUA
CENTRO TECNOLÓGICO DEL AGUA
Funded by
the European Union