Biomethaverse Italian Demo

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Milano

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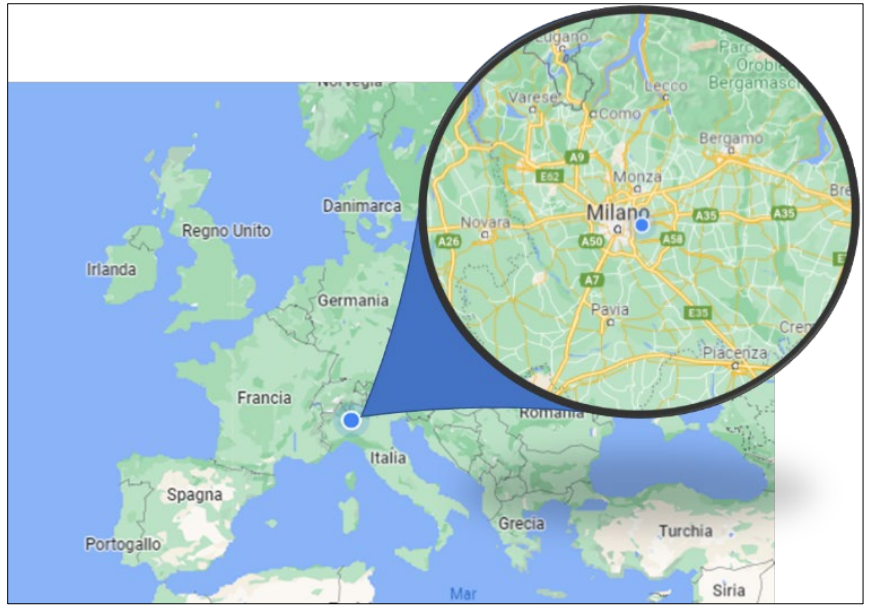
innovations in the BIOMETHANE uniVERSE

Brief description of the site



Experimental site for the Italian case will be the Wastewater treatment plant of Bresso-Niguarda, which is located in the city of Milano and managed by CAP.

It is a 320.000 P.E. urban wastewater treatment plant, with two parallel anaerobic digestion lines for sludge treatment and valorization to biogas.

In 2018 in the Bresso-Niguarda WWTP was installed the first biogas upgrading plant to obtain biomethane from sewage sludge-produced biogas.

Currently, the plant produces about **600.000 m³ per year** that are injected to the national distribution grid.

Description of innovative technology

CAP, in collaboration with partners Politecnico di Milano, SIAD and CIC, will implement an **integrated demo plant**, to achieve a **more sustainable biomethane production.**

The pilot consists of **two main units**: the feedstock **pre-treatment via ozonisation** and the **ex-situ biological upgrading**. Furthermore, **two auxiliary units**, the **micro-algae reactor and the co-digestion unit** complement the two main units. The pre-treatment unit allows to increase the biogas yield from sewage sludge, the upgrading unit converts produced biogas into biomethane via an ex-situ hydrogen promoted biological upgrading process.

The model is planned in order to consider pre-treatment unit and the upgrading unit **integrated** considering that hydrogen for the biological upgrading and oxygen for the ozone production would be obtained from a single water electrolyser. Furthermore, unconverted carbon dioxide would be used to the algal pond to evaluate its recovery by means of biomass growth. Finally, co-digestion of sludge with microalgae, integrated with process modelling will be demonstrated as a technological approach for increasing the biogas yield and its CO2 content optimization, by controlling the effective mixing of two or more co-substrates and operating conditions

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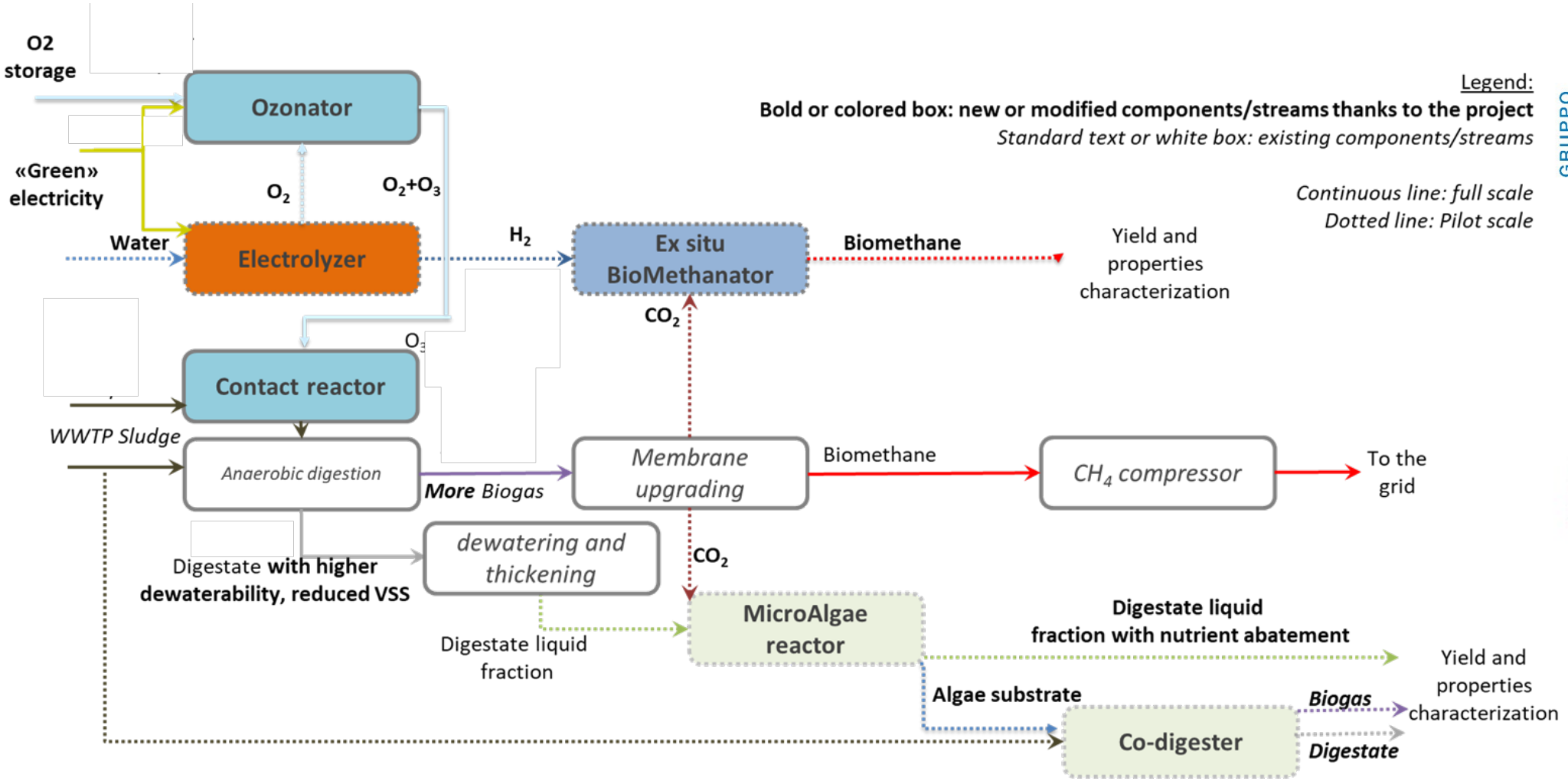
Description of innovative technology

The integrated model, to achieve a **more sustainable biomethane production.**



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Objectives and first results

The project aims to demonstrate the positive value of the synergies enabled by the integrated model maximizing the environmental impacts and guaranteeing the economic viability. In particular:

- The ozonolisys pre treatment aims to produce from 20% to 40% more biogas and decrease the amount of sludges to be dispose of by 10-15%
- The EBM aims to produces grid quality biomethane under variable H_2 loads
- The algae reactor aims to validate the feasibility of biomass production (10g/m^2/d) under variable CO_2 availability
- The codigester aims to evaluate the optimum feed in mixture and operative condition to enhance the biogas production.

Overall the project objective is to demonstrate how the integrated pilots if implemented at full scale, could achieve a +60-70% of biomethane production at Bresso WWTP

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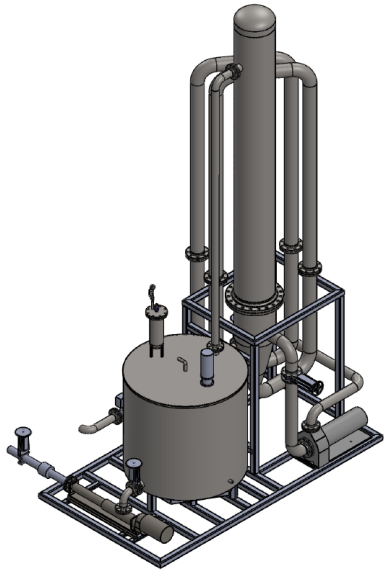
Objectives and first results

A1 Feedstock pre-treatment via ozonolysis

- Preliminary ozone **lab-scale tests** on digestate sludge
- Container with **ozone generator installation**
- Completed the **P&ID** and the **constructive design** of the contact reactor
- **Procurement and acquisition** of apparatus needed for the contact reactor (end of 2023)
- Completed procedures (safety authorization practices and design) for **oxygen tank installation** (end of 2023)



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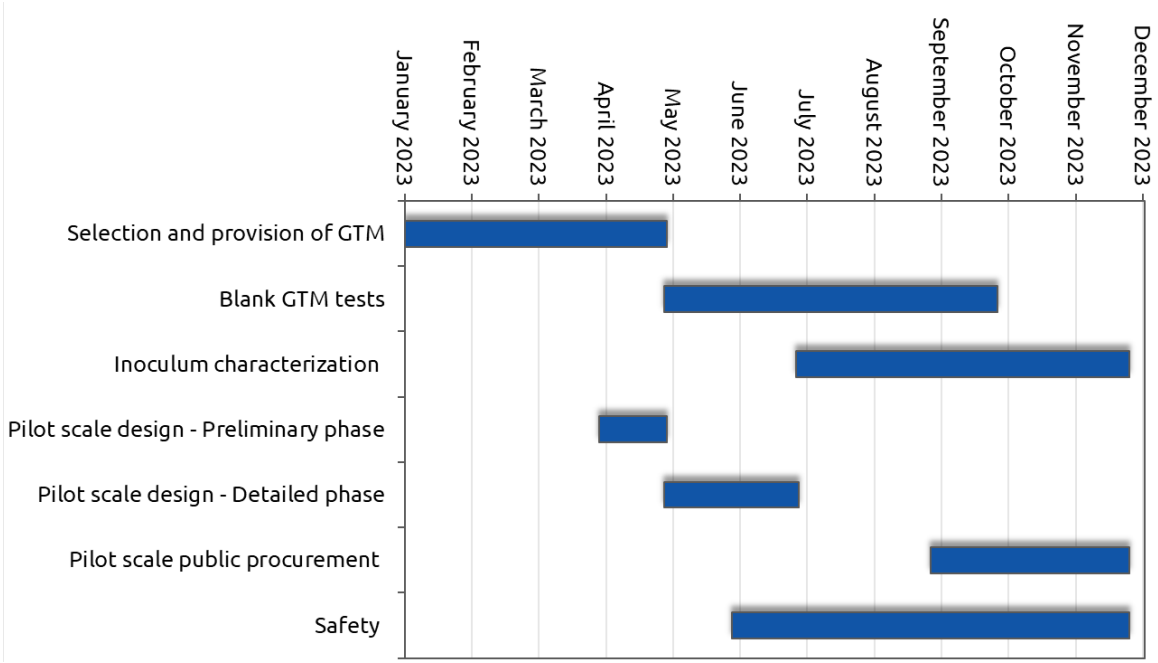
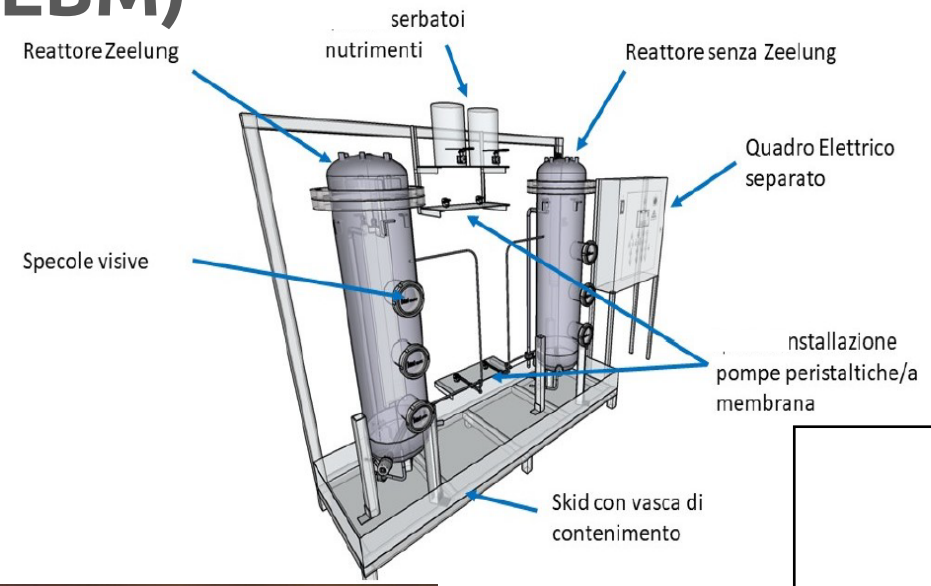
Objectives and first results

A 2 - Ex situ Biological upgrading (EBM)

2023 activities





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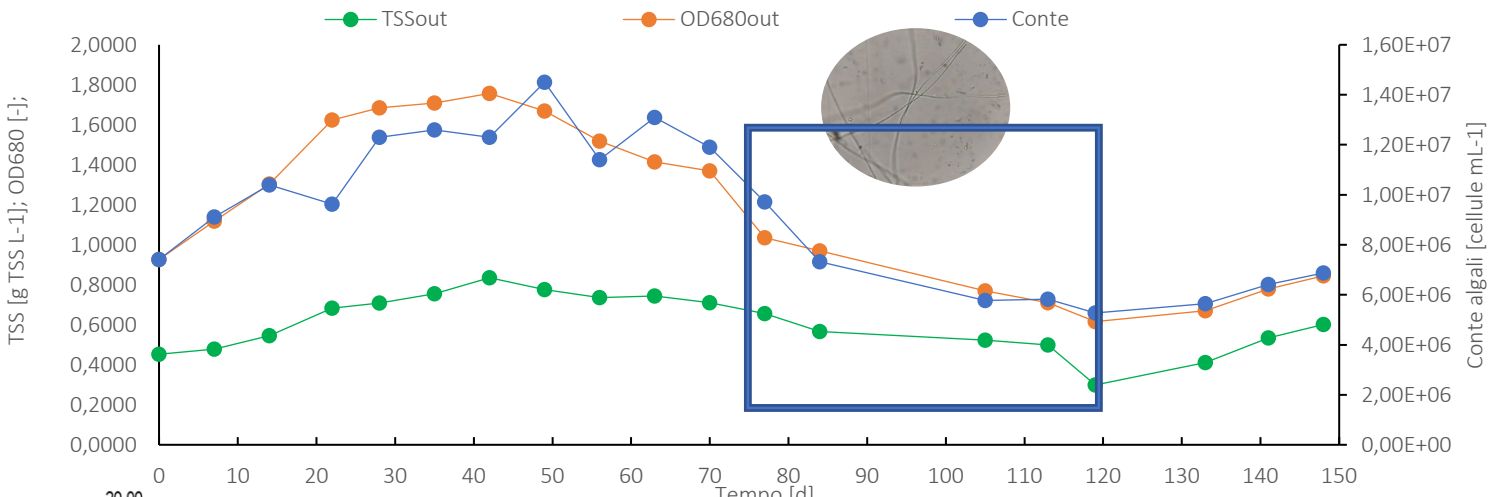
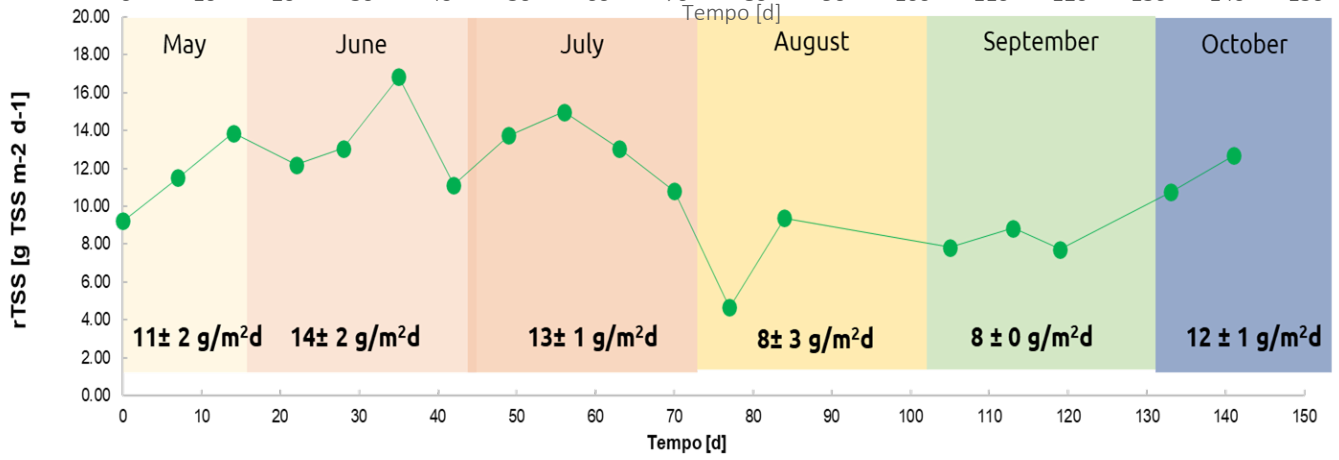
Objectives and first results

A 3 - Pilot scale microalgae operation – Biomass productivity





CO2

Calendar:
April: Inoculum preparation in PBR from mixed *Scenedesmus* spp. *Chlorella* spp., *Arthrospira platensis)*
May: RWP start-up, continuous operation from 17/05

NITROGEN:

- N-NH_4 removal **90 ± 10 %**
- Partial nitrification from Day 22 (8 June)
- N-NO_2 follows influent NH_4-N trend

PHOSPHORUS:

- P-PO_4 removal more variable: **53 ± 21%**

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Challenges and criticalities of technology

Technical Challenges:

a1) Feedstock pre-treatment via ozonolysis:

The main challenge for the full-scale ozonolysis application is related to the design configuration of the contact reactor to avoid ineffective transfer yields and malfunctions related to clogging problems and to the degassing unit of the ozonated sludge to avoid inhibition phenomenon of the AD process linked to the oxygen presence.

a2) Ex-situ biological upgrading

Ex-situ hydrogen promoted biological upgrading efficiency is highly influenced by the mass-transfer of hydrogen into the medium

a4) Co-digestion pilot

Fast and reliable analytical tools for supporting of digester modelling are currently one of the main bottlenecks for process modelling integration at real scale facilities.

Managerial challenge:

Develop a comprehensive framework to evaluate the synergies between pilots optimizing the aggregated impacts

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Economic viability/ Initial Business Perspective

Main Leverages

Externals:
- **Electricity cost**
- **Gas price**
- **Incentives framework**
- **Sludge disposal cost**

Internals:
- **EBM transfer efficiencies and yields**
- **Ozonolysis biogas increase yield**
- **Ozonolysis sludge volume reduction**

A first economic evaluation were carried out by CAP before 2022 showing that the integration of the different pilots optimizing their synergies could bring to a reduction of the biomethane production cost along with an increase in its production.

An implementation of a strong evaluation framework that could optimize the synergies between the pilots is needed and should be planned along with the experimental design in order to collect all the needed data and formulate different scenarios to increase the flexibility and improve economics

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