Italy Demo Case

Ex-situ BioMethanation

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Barcelona, 29th November 2024

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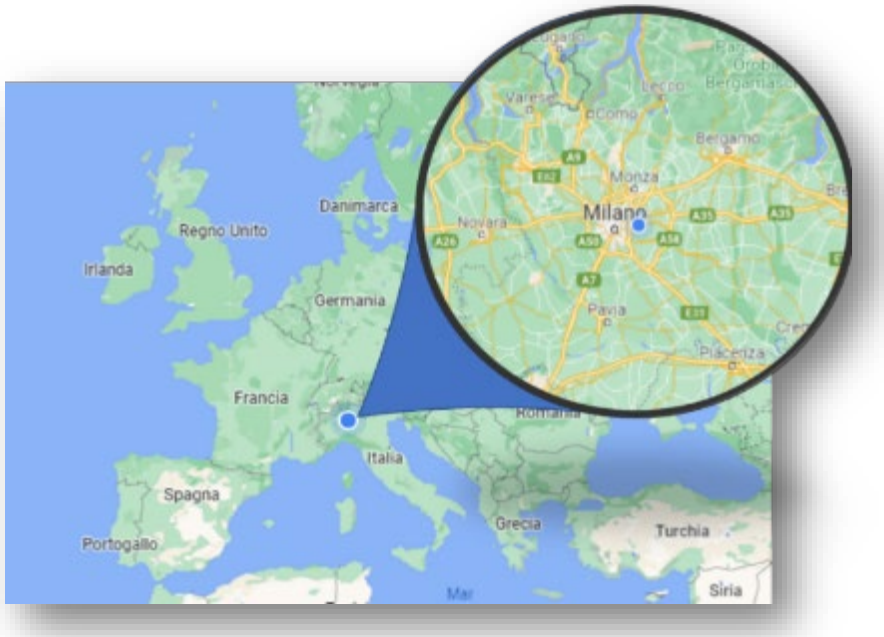
innovations in the BIOMETHANE uniVERSE

Brief description of the site



Experimental site for the Italian case is in the Wastewater treatment plant of Bresso-Niguarda, which is located in the city of Milan 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.

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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**.

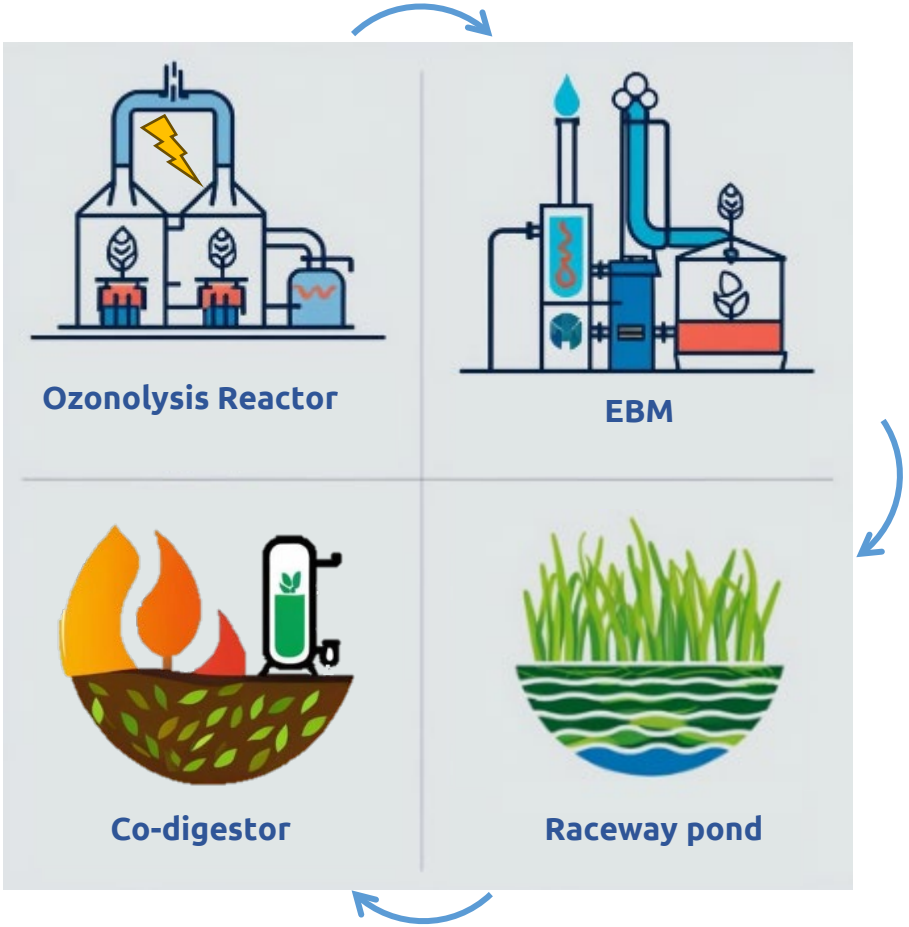
The project aims to highlight the positive outcomes of the **integrated model**, utilizing synergies to maximize **environmental benefits** and secure **economic sustainability**.

Two main units:

- The feedstock pre-treatment via ozonisation allows to increase the biogas yield from sewage sludge
- The upgrading unit (EBM) converts produced biogas into biomethane via an ex-situ hydrogen promoted biological upgrading process.

Two auxiliary units:

- The raceway pond where microalgae cultivation treats nutrients and pollutants from a wastewater stream providing new biomass
- The biomass is co-digested with sewage sludge, increasing bio-gas production.



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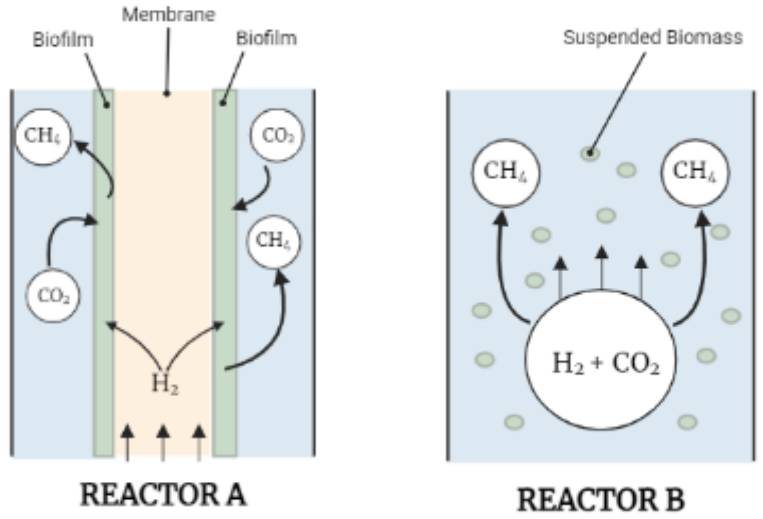
Challenges and criticalities of technology

Pre-treatment via ozonolysis
Avoid ineffective transfer yields and malfunctions related to clogging problems

Ex-situ biological upgrading
Increase the efficiency of H_2 mass-transfer and the process yield under variable feed flow

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.

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



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What done so far

Ozonolysis

•Initial laboratory tests: optimal ozone dosage, protein solubilization, TSS reduction, mineralization,…
•Then, ozonolysis contact reactor was designed
•Safety measures and electrical designs were implemented
•Construction phase: 12 m3 oxygen tank, the ozone generator and the contact reactor.
•Integration into the existing WWTP with the support of plant technicians.
•Safety inspections and successful trials using regular water
► **Full-scale treatment of wastewater sludge was initiated.**

EBM

•Membrane selection and inoculation of 1 membrane unit, Gas Transfer Membrane (GTM) testing in feed/dead-end flow
•Laboratory-scale tests: biofilm hydrogen conversion rates and nutrient uptake.
► **The EBM pilot plant was installed in LIA lab in Polimi,** tested in blank and put into operation once completed the installation of all security devices.
•Modelling of start up conditions for suspended biomass bubble column reactor completed (column on the right).
•Modelling of membrane biofilm reactor (ongoing)

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What done so far

Co-digestion

•Lab test: Anaerobic degradability of sludge, microalgae, and their mixtures was evaluated.

•Batch BMP tests were conducted on various mixed matrices to assess their biogas production potential.

•Semi-continuous co-digestion at a laboratory scale.

► **Existing co-digestion pilot plant was revamped.** Finally, the equipment was transported and under installation at the Bresso WWTP
(operation will start in spring 2024 when algae will be available)

Microalgae Cultivation

•During 2023 and 2024 (352 days of operation), **verification of productivities and nutrient removal** → according to the expected values

Site Preparation

•Completed basement structural design and construction

•Revamped conventional membrane upgrading unit

•Configured piping systems

•Assessment to ensure compliance with safety certifications (CPI, ATEX)

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Future activities

Full-scale ozonolysis:

a) Achieve full-scale ozonolysis of sludge in a continuous process.

b) On-line data monitoring and analytical campaigns.

EBM:

a) Completion of pilot scale testing and optimization of EBM reactor in Polimi laboratory

b) 1-D Biofilm and Gas-liquid transfer model finalization.

Microalgae cultivation:

Pilot-scale production of microalgae biomass for co-digestion pilot tasting (from spring 2025)

Co-digestion:

a) Lab-scale co-digestion tests with ozonated algae (on going)

b) Pilot-scale start up expected in spring when algae biomass will be available

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