# IBM Demo Plant Ukraine

## In-Sito Hydrogenothrophic Methanogenesis

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MHP Ukraine

UABIO, DBFZ, Ellmann Engineering

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innovations in the BIOMETHAne uniVERSE

# Objectives

- **Demonstration of an innovative In-Situ biological methanation (IBM) pathway**

- **Construction and implementation of IBM at biogas plants in Ukraine**



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# Biological Methanation (IBM) in Ukraine: Locations for technology testing

- Main location


**MHP: LADYZHIN, VYNNITSIA REGION**

**Feedstock:** 300 t/d of chicken manure and agricultural residues

**Capacity:** **12 MW**
**Biogas 44 000 000 м3**

- Additional locations in Ukraine

**MHP: DNIPRO, DNIPRO REGION**

**Feedstock:**
120t/d chicken manure and agricultural residues

**Capacity:** **5,5 MW**
**Biogas 22 000 000 м3**

- Potential locations in Ukraine / Europe

**UKRAINE / EUROPE**

**Feedstock:**
agricultural residues

**Capacity:** **1 - 26 MW**



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# Construction and installation of IBM demo reactor (10 $m^3$)

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## ▪ MHP Demo – Achievements

- 1: IBM Demo Plant concept is developed and approved; modeling is made
- 2: Main technological equipment is completed and procured;
- 3: Demonstration plant in the process of construction and installation



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# Transportable IBM Pilot Plant

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- **Transportable solution that can be moved with standard truck and can be integrated with existing biogas complexes is developed**

- **Main Parameters for the IBM Pilot Plant:**

➢ Digester 10 $m^3$ and section for machinery integrated in a 20 ft. standard Container
➢ Mixing / Hydrolysis tank 1 $m^3$ extern for 48 hours substrate buffer
➢ Gasholder as membrane storage on top for gas 5 $m^3$
➢ Automatic operation mode
➢ Self-sufficient operation possible for 48 h



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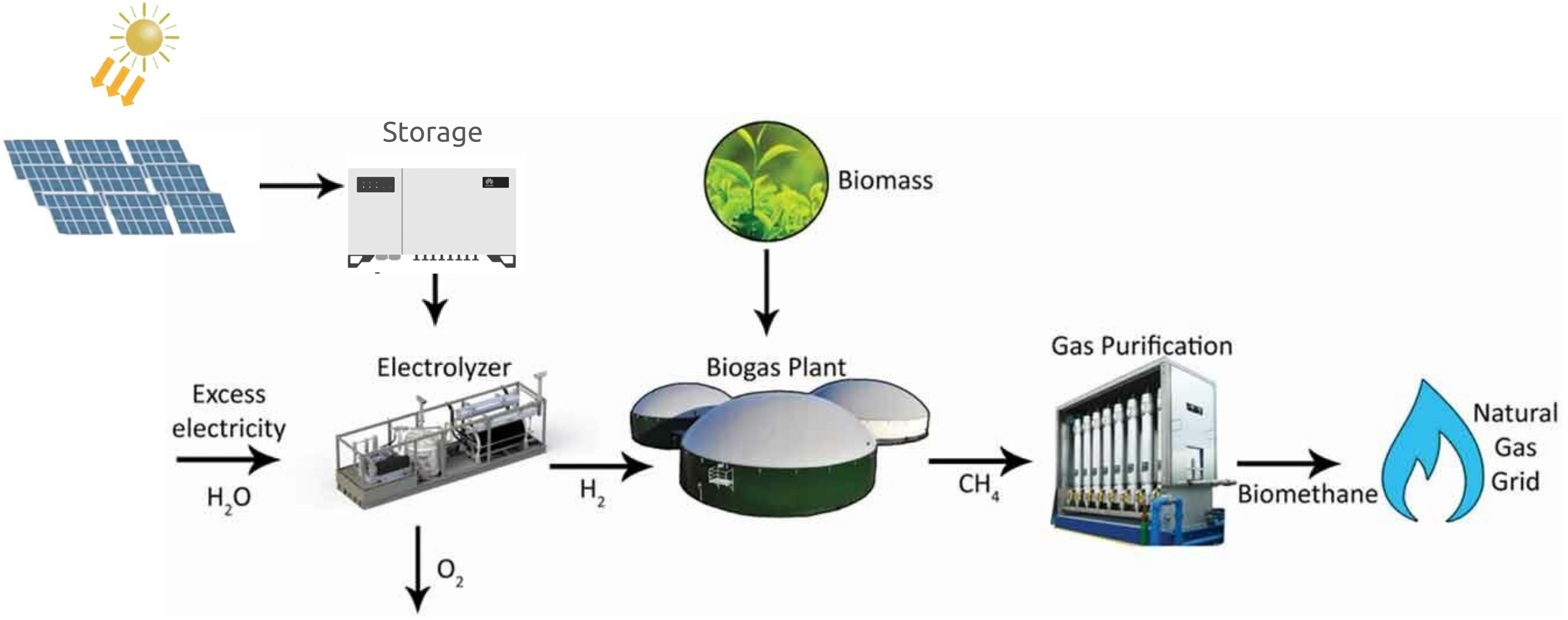
# Technology description




- In situ methanation using green hydrogen increases the methane concentration in the biogas up to ~85%
- It is still necessary to remove $H_2S$, $CO_2$ and $H_2O$ from the biogas



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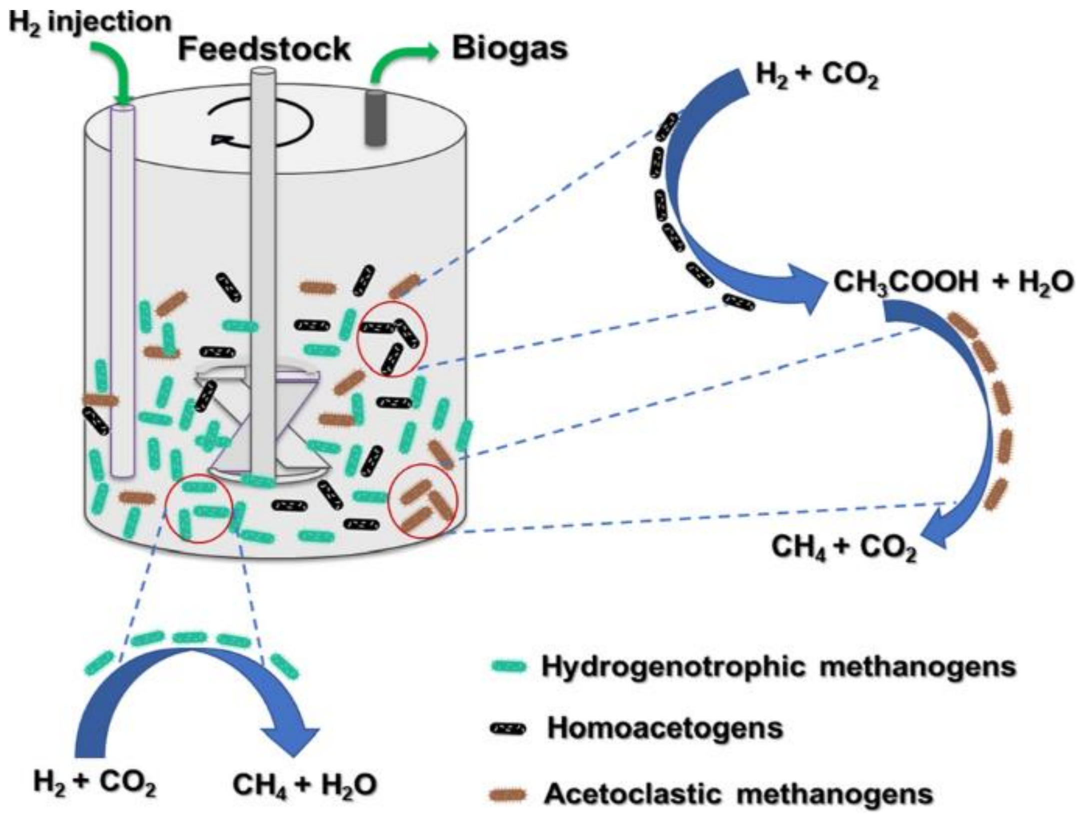
# Technology description

- Supply of additional hydrogen to the running AD reactor
- Increased synthesis of methane via increased *hydrogenotrophic methanogenesis*
- Increased biogas production via intensified *homoacetogenesis* (acetate production from $CO_2$ and $H_2$)



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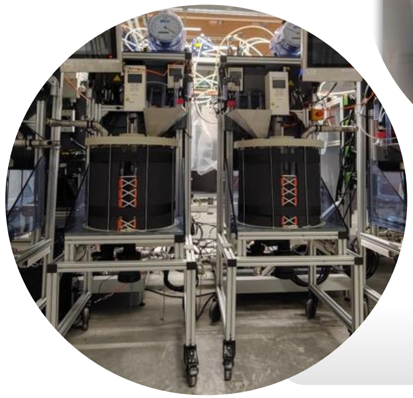
# Activities

1. Evaluation and optimisation of in situ methanation in 50 L scale at DBFZ and MHP
2. Planning and construction of a pilot reactor with V ~10m$^3$
3. Installation, start up and operation of the demo reactor at MHP
4. Evaluation of the pilot reactor performance
5. Development of a full scale concept for in situ methanation at the biogas plant in Ladyzhin

Operational biogas plant in Ladyzchyn

IBM Demo plant (transportable)



Lab scale reactor



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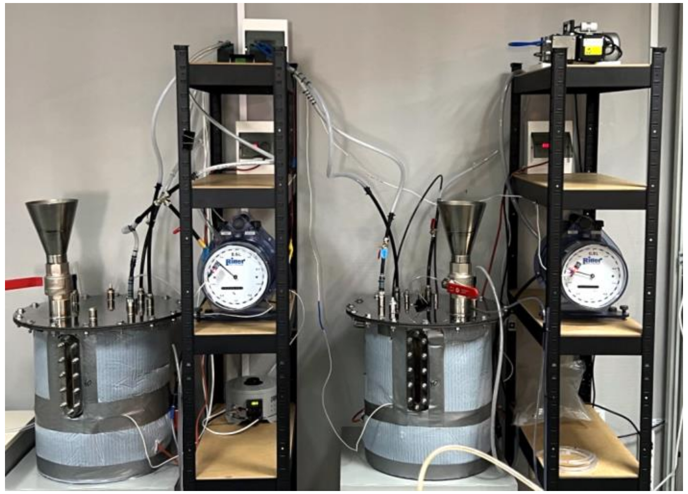
# IBM in 50 L lab-scale reactors

## Preparing the laboratory setup

**Aim:** Construct and set up 50 L AD reactors for IBM at the laboratories of DBFZ (2 reactors), MHP (2 reactors) and EE (1 Reactor)


*© Daniel N. Dzofou (DBFZ)*



*© Mariana Potapova (MHP)*

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# IBM demo reactor - Flow chart

## ▪ Concept Design

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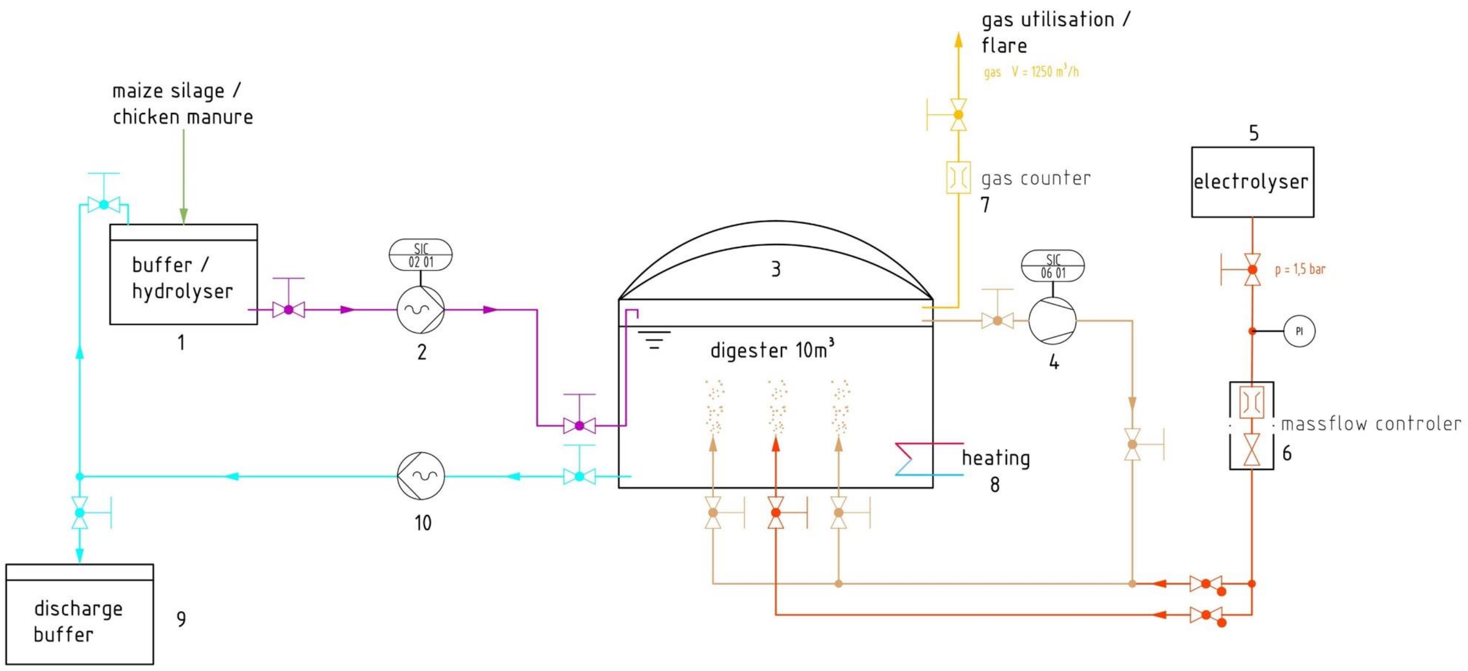
Hydrogenotrophic community is developed in parallel with the main anaerobic digestion process. The process is divided into two main stages: hydrolysis and the main fermenter. The hydrogen for the hydrogenotrophic biology is generated via an electrolyzer and fed to the fermenter.

*Flow Chart Pilot Plant Ukraine*

Hydrogenotropic Methanogenesis Methaverse




legend

| | | | |
|---|---|---|---|
| 1 | buffer/hydolyser | 6 | massflow controler |
| 2 | filling pump | 7 | gas counter |
| 3 | digester | 8 | heating |
| 4 | blower | 9 | discharge buffer |
| 5 | electrolyser | 10 | discharge pump |



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# Construction and installation of IBM demo reactor (10 m³) at a biogas plant

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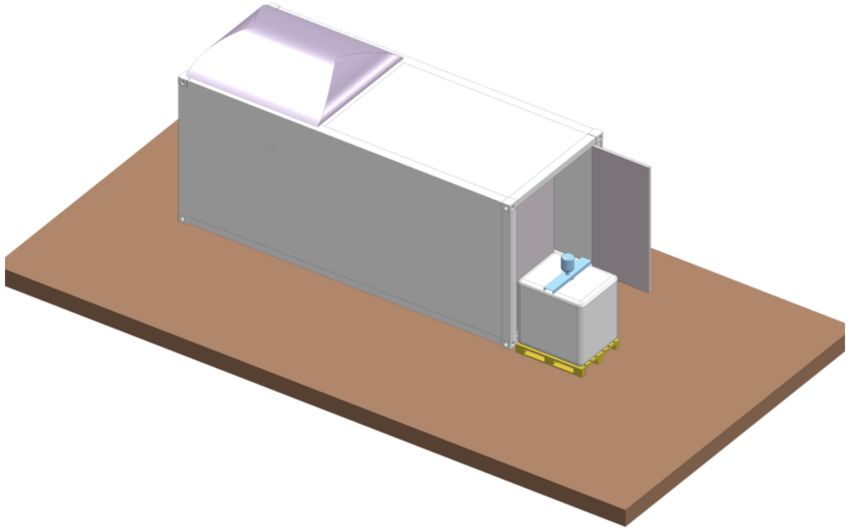
- ## Concept of the Facility

The 20 ft. Container will be divided into a digester section and a machine room for pumps, blowers, controls, etc. The aim is to ensure the highest possible mobility to be able to test the plant at several locations and to make it safer with regard to the war.

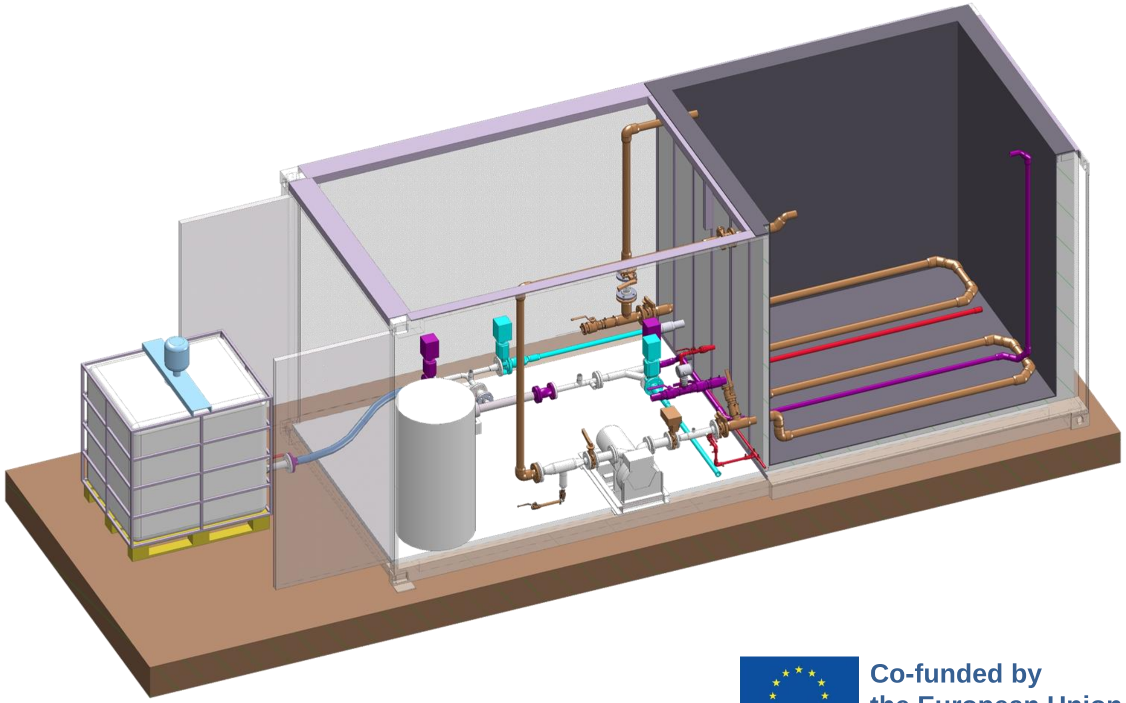
*Containerized In situ Demo Plant Ukraine*



- ## Technical Detailed Design

The container is divided into two section, the digester section and a room for the technical equipment (pumps, blowers, etc.)

*Containerized In situ Demo Plant Ukraine*





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# IBM demo reactor - View from above

- **Technical Detailed Design**

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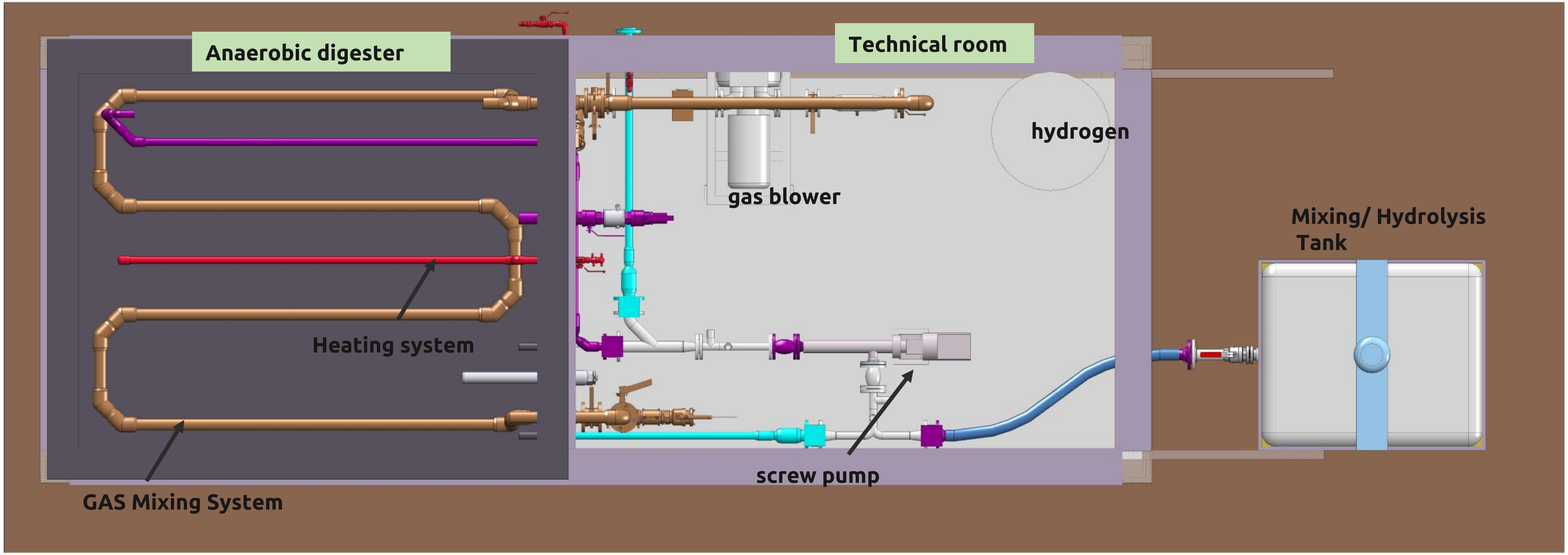




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# Challenges for in situ methanation

**Specific challenges:**

Russian act of aggression threaten project realization causing various every-day challenges in stability, planning, logistics, construction, safety etc.

**Major constraints:**

1. Lab Tests are not finished and in an early stage. For this reason, only a few results and experiences from the laboratory plants can be transferred to the pilot plant at the moment.
2. influencing metabolic pathways in AD by adding $H_2$ (i.e. hydrogentotrophic methanogenesis and homoacetogenesis) can lead to process disturbances
3. low solubility of $H_2$ in aqueous solutions (also relevant for ex-situ systems)
4. $H_2$ diffusion from AD reactors

**Approach:**

1. The pilot plant must be designed flexibly so that future findings from the laboratory plants can still be taken into account.
2. Identification of optimal dosing of hydrogen, control of its assimilation and residues in the final biomethane;
3. Correct distribution of hydrogen in the system for its maximum assimilation by hydrogenotrophs;
4. Achieving stable biological indicators of the system, which is the key to a constant yield of biomethane



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