Ukraine Demo

MHP "Ukraine", **DBFZ** & **EE** "Germany"

Thessaloniki, 19.06.24

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innovations in the BIOMETHAne uniVERSE

In-situ biological methanation (IBM)

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Objectives

Demonstration of an innovative in-situ biological methanation pathway using a gas recirculation system, as well as the construction and implementation of a similar system and technology at a biogas plant in Ladyzhyn, Ukraine

New implementation of the container-type DEMO installation will allow conducting research and testing on existing biogas installations in Ukraine and Europe

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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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A.1. Demonstration of IBM in 50 L lab-scale reactors

Task 1.1. Preparing the laboratory setup

Task 1.2. Establishing a stable anaerobic digestion (AD) proces

Task 1.3. Establishing a stable IBM process

Task 1.4. Determining process parameters

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A.1. Demonstration of IBM in 50 L lab-scale reactors

➢ Laboratory setup

© Daniel N. Dzofou (DBFZ)

1: AD reactor
2: Mass flow controller
3: H_2 tank
4: Gas meter
5: Gas pump
6: Stirrer
7: Monitor
8: Water trap

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A.1. Demonstration of IBM in 50 L lab-scale reactors

➢ Operating parameters

Operating Parameters	Unit	MHP	DBFZ
Working volume of reactors	g	40,000	40,000
Temperature	°C	39 ± 3	40 ± 2
Hydraulic Retention Time	days	60 – 80	50 – 70
Organic loading rate	(g_{VS}/L day^{-1})	3 ± 0.2	4 ± 0.2
daily feed (g FM)		**390 – 550**	**672 – 770**
Cow manure		✗	✓
Chicken manure		✓	✓
Corn sillage		✓	✓
Water		✓	✗

	Unit	Effluent		Cow manure		Chicken manure		Corn sillage	
		MHP	DBFZ	MHP	DBFZ	MHP	DBFZ	MHP	DBFZ
pH		8.50 ± 0.10	7.78 ± 0.13	-	7.23 ± 0.34	-	-	-	-
FOS/TAC	g_{FOS}/g_{CaCO3}	0.16 ± 0.03	0.19 ± 0.06	-	0.86 ± 0.35	-	2.33 ± 1.07	-	-
NH_4-N	$g.L^{-1}$	4.10 ± 0.63	3.40 ± 0.60	-	1.91 ± 0.21	6.68 ± 1.19	5.85 ± 5.16	-	-
TS	%	5.79 ± 0.4	8.63 ± 1.54	-	9.47 ± 0.95	48.9 ± 0.68	32.86 ± 1.48	31.15 ± 7.20	30.07 ± 3.76
VS	$\%_{TS}$	81.0 ± 8.15	73.93 ± 7.75	-	75.79 ± 1.35	78.20 ± 2.25	70.18 ± 5.20	95.19 ± 1.28	96.48 ± 0.74

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A.1. Demonstration of IBM in 50 L lab-scale reactors

- **Establishing a stable IBM process**
  - **H_2 addition & determination of optimal process**

DBFZ				
	Volume	Ratio	**40 °C**	**42 °C**
H_2 flow rate	**3.5** mL.min^{-1}	~ **4.6** %	2W	
	7 mL.min^{-1}	~ **9.3** %	4W	
	10.5 mL.min^{-1}	~ **14** %	3W	3W

*W: week

MHP				
	Volume	Ratio	**39 °C**	**42 °C**
H_2 flow rate	**0.6** mL.min^{-1}	~ **1.4** %	1W	
	0.6 mL.min^{-1}	~ **1.6** %	3W	1W
	1.0 mL.min^{-1}	~ **2.6** %		2W

  - **Bioaugmentation**

Aim: Increase the hydrogenotrophic methanogen community in DBFZ reactors by daily addition of ~7.5 mL.$L_{reactor}^{-1}$.d^{-1} of *Methanobacterium formicicum* for at least 1 month

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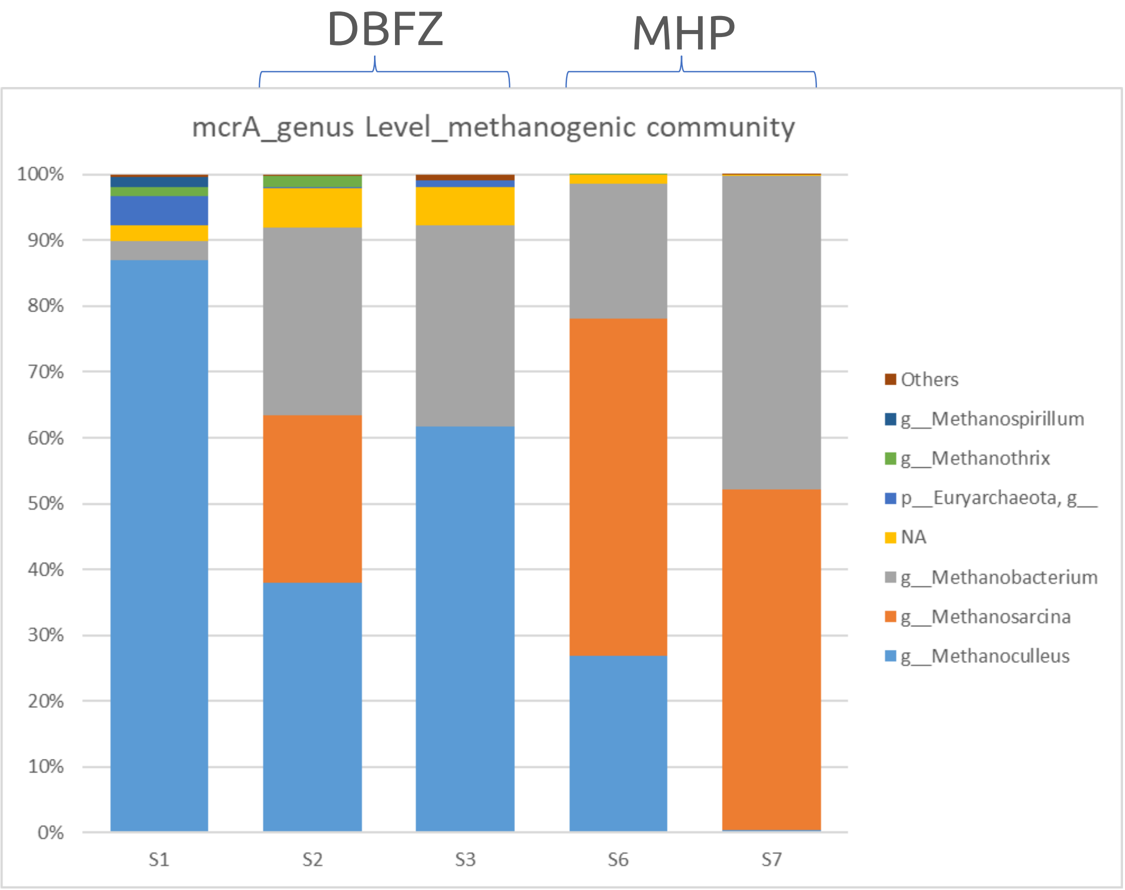
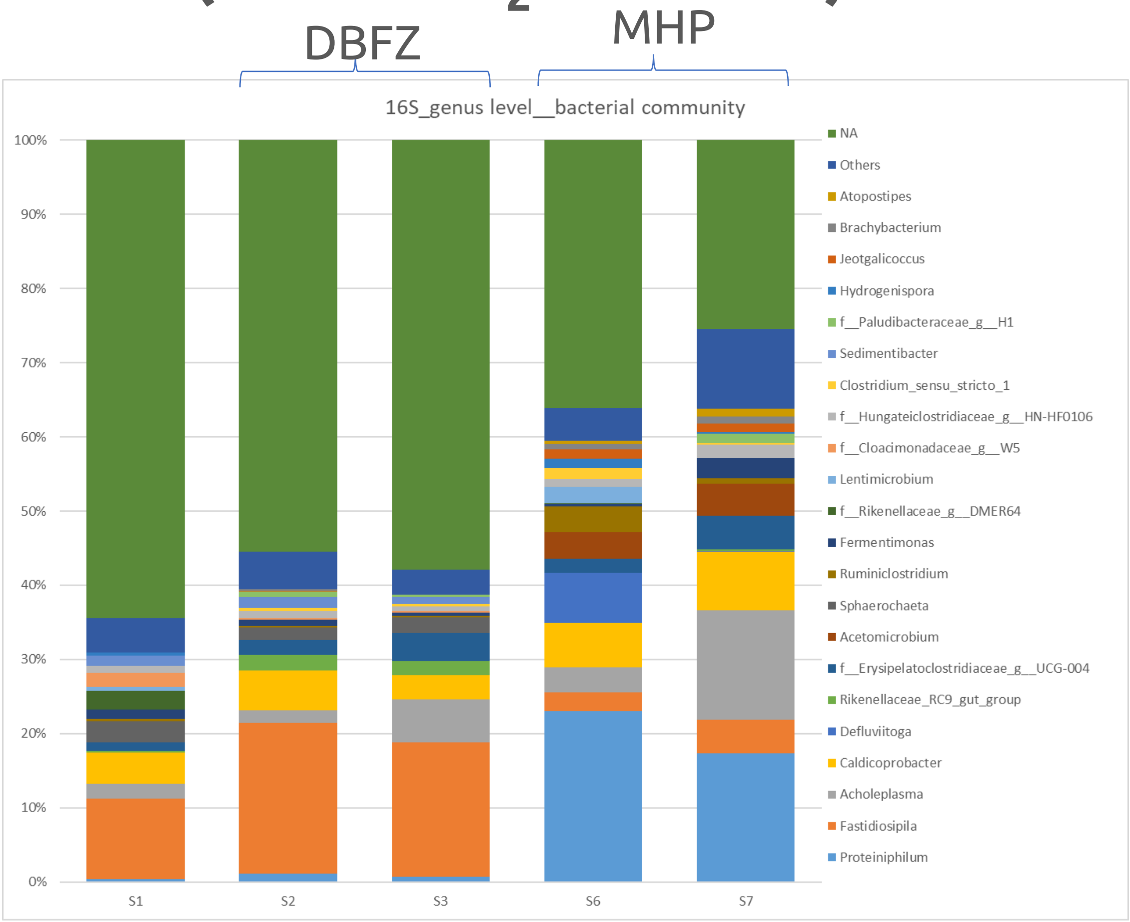
A.1. Demonstration of IBM in 50 L lab-scale reactors

➢ Establishing a stable IBM process

- **Screening of the microbial consortia (before H_2 addition)**





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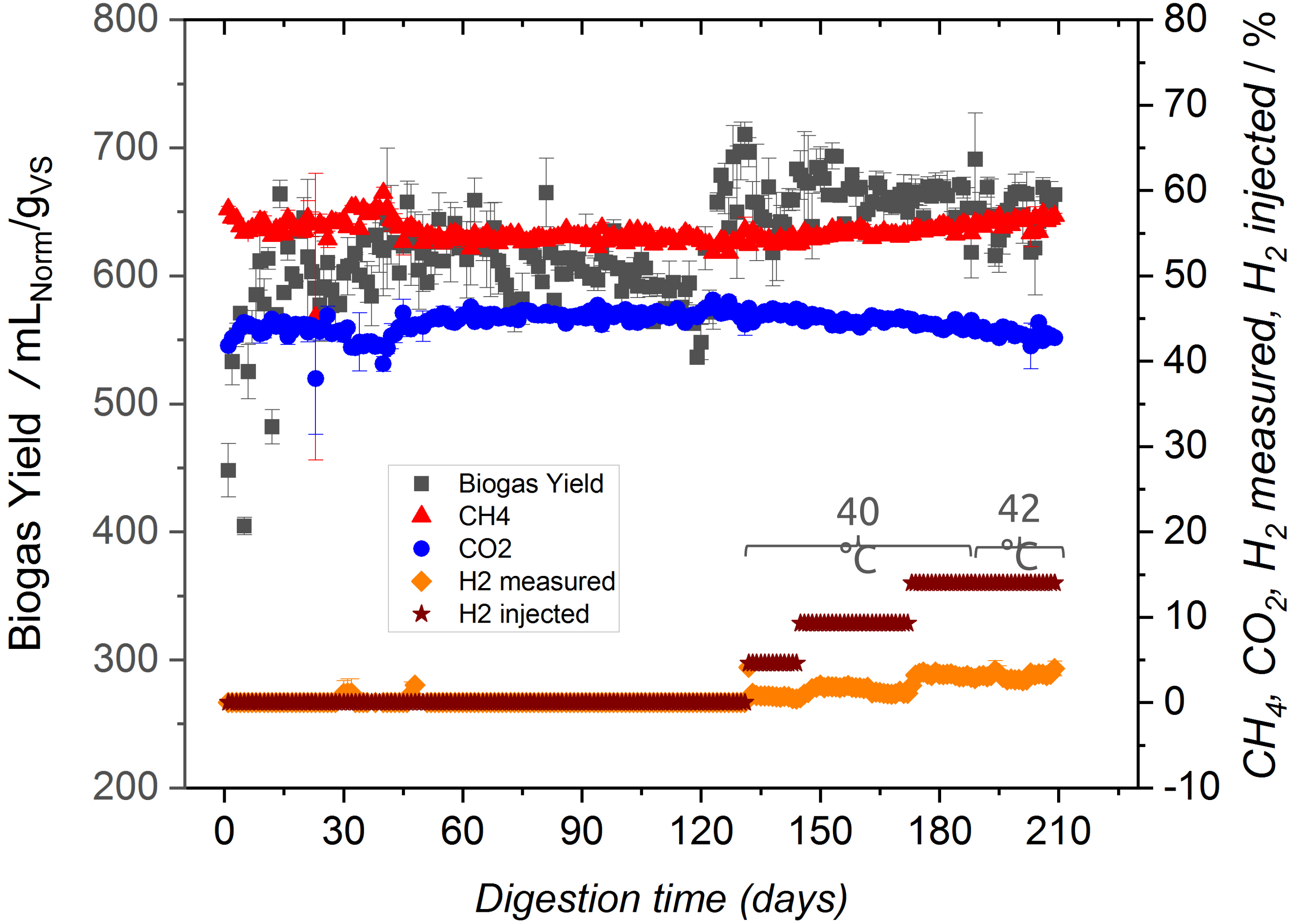
A.1. Demonstration of IBM in 50 L lab-scale reactors

Result to date: Specific biogas production, H_2, CO_2 and CH_4 content in biogas

DBFZ reactors



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A.2. Construction of an IBM demo reactor 10 m³

Ellmann Engineering
process solutions

▪ MHP Demo – Tasks

- Task 2.1 Definition of the Technical Task ✓
- Task 2.2 Concept design ✓
- Task 2.3 Detailed technical Design ✓
- Task 2.4 Design of Controls and Instruments ✓
- Task 2.5 Equipment List ✓
- HAZOP ✓
- Task 2.6 Installation of the Demo Plant
- Task 2.7 Commissioning of the Demo Plant

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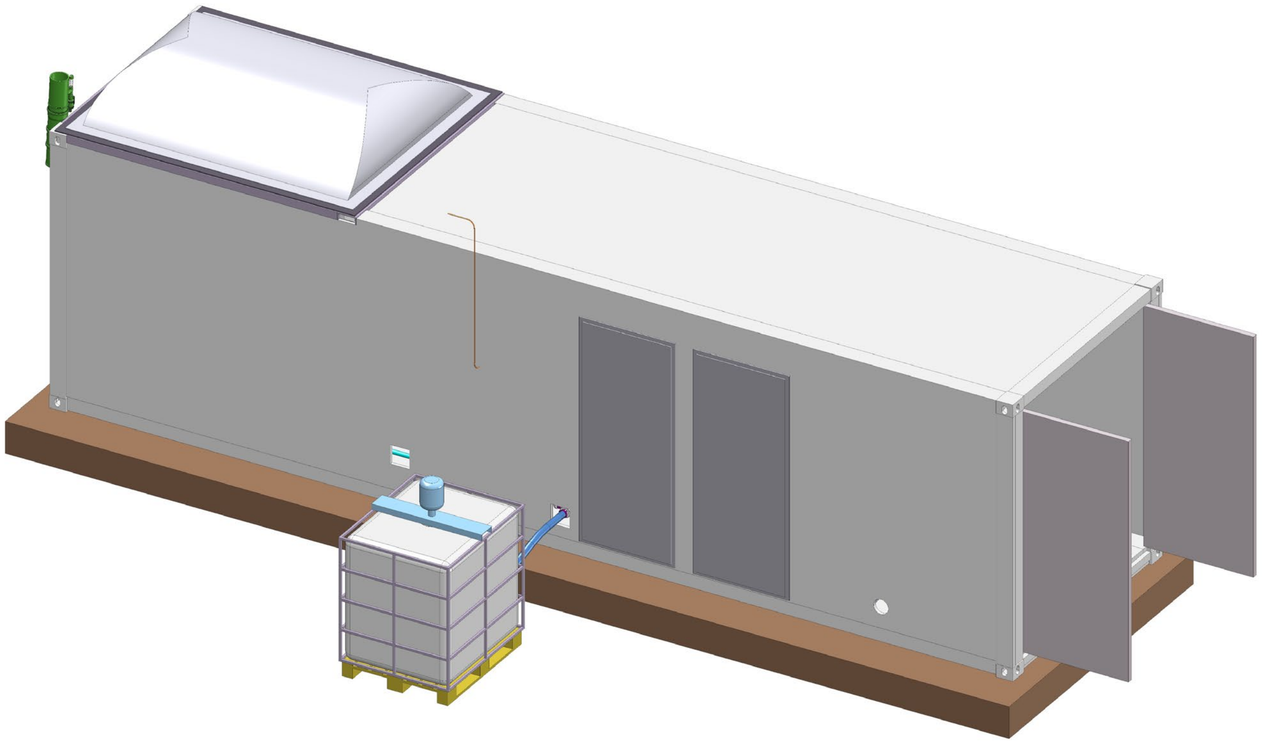
A.2. Construction of an IBM demo reactor 10 m³

▪ Main Structure of the Plant

Ellmann Engineering
process solutions

- Standard sea container as a basis structure
- The system should be able to be transported using standard container trailers.
- The container is divided into the following separate sectors:
  - SCADA and control room
  - Electrolysis room
  - machine room
  - Digester

Containerized In situ Demo Plant Ukraine



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A.2. Construction of an IBM demo reactor 10 m³

▪ Technical Detailed Design

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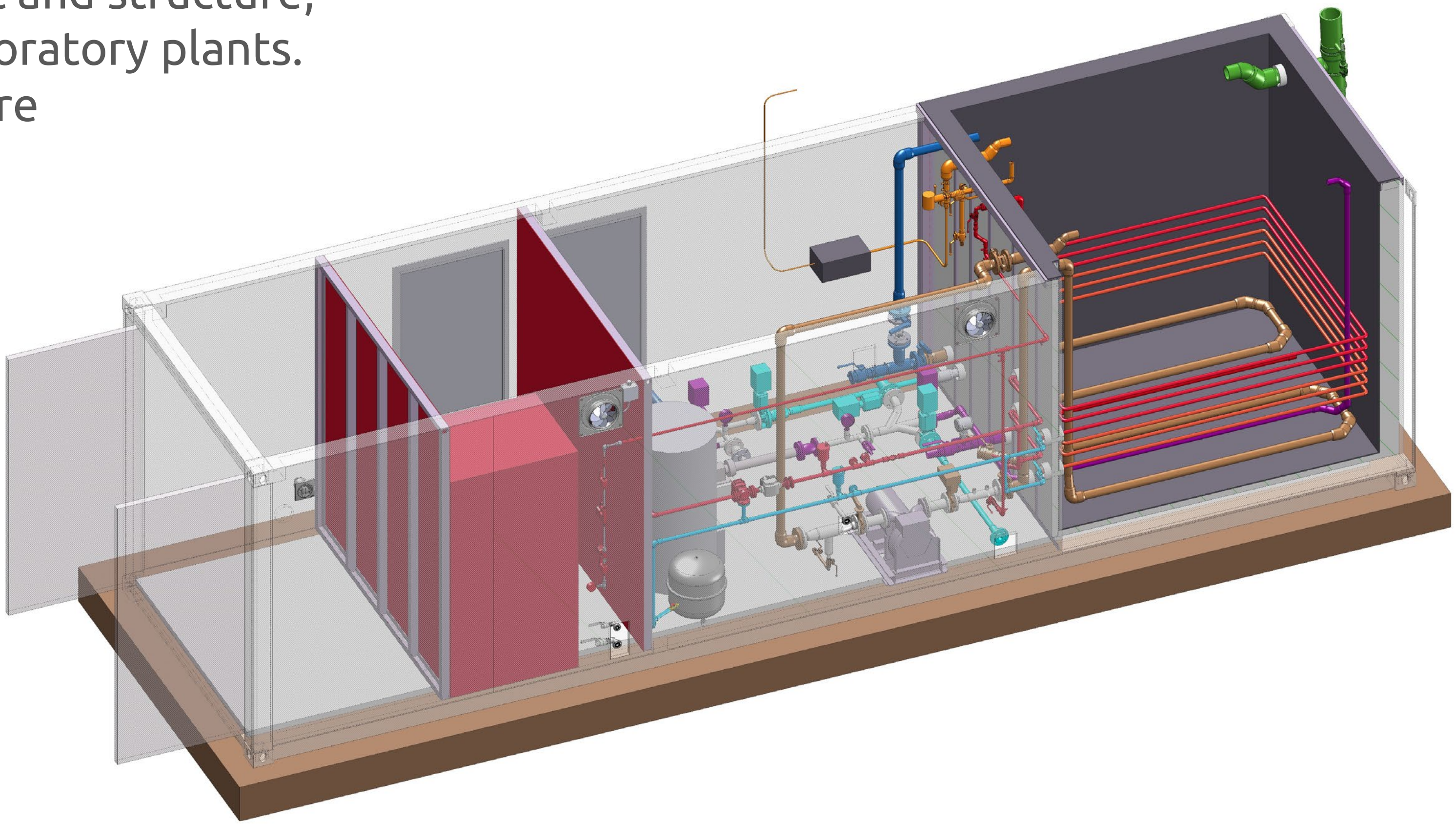
Containerized In situ Demo Plant Ukraine



The pilot plant must have the essential characteristics of a conventional biogas plant in its equipment and structure, as well as mirroring the processes in the laboratory plants. The following priorities therefore took centre stage in the design:

- Mesophilic process with temperatures between 37 - 45°C
- Gas circulation system in the fermenter, which corresponds to that of a large scale plant
- Integration of hydrogen distribution and injection into the gas circulation system.

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Deviations

- Purchased and installed 2 containers for demo installation
- Container 1 - fermenter 10m3 and container 2 - electrolyzer
- Equipment for production of hydrogen in container 2 was purchased
- Installation of equipment in container 2 has begun
- Equipment for container 1 (biogas production) was purchased
- Work on the development of a fermenter 10m3 has begun
- Delivery of the main equipment - end of June 2024

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