LIFE 20 CCM/GR/001642
CO2toCH4: Demonstration of a mobile unit for hybrid energy storage based on CO2 capture and renewable energy sources

What is the biological CO_2 hydrogenation technology?

Technology Background on Methanation System

Reaction

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

Method

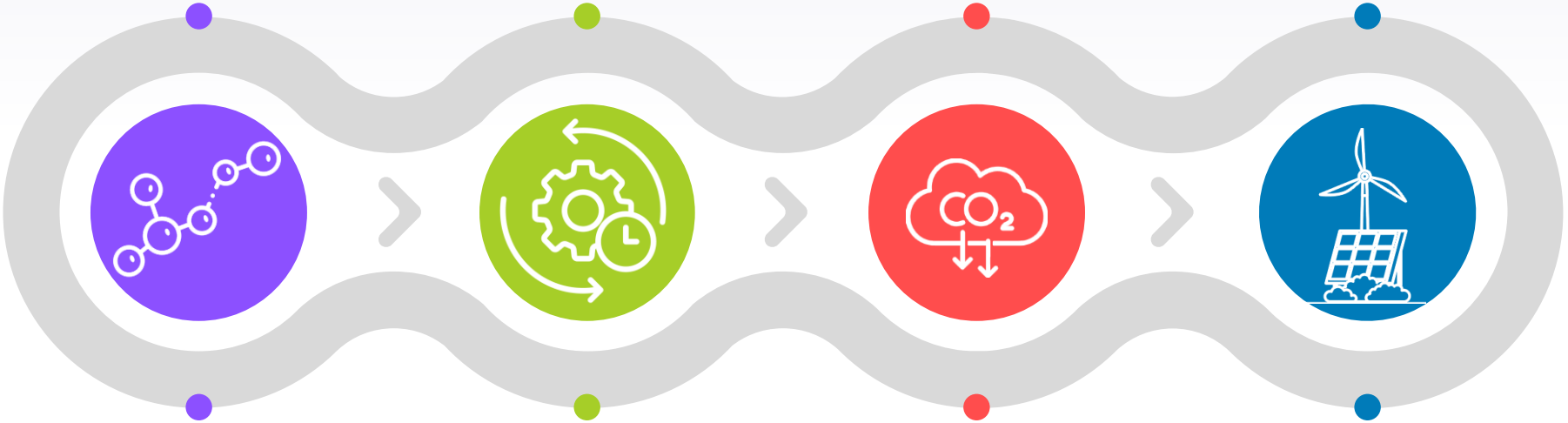
Themocatalytical (300-400ºC, ~30bar, catalyst) or biological (30-60ºC, methanogens)

CCUS

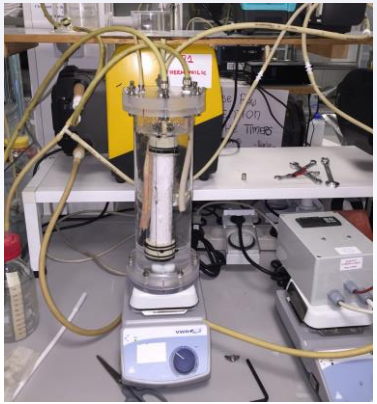
Emerging technologies for carbon capture and utilisation

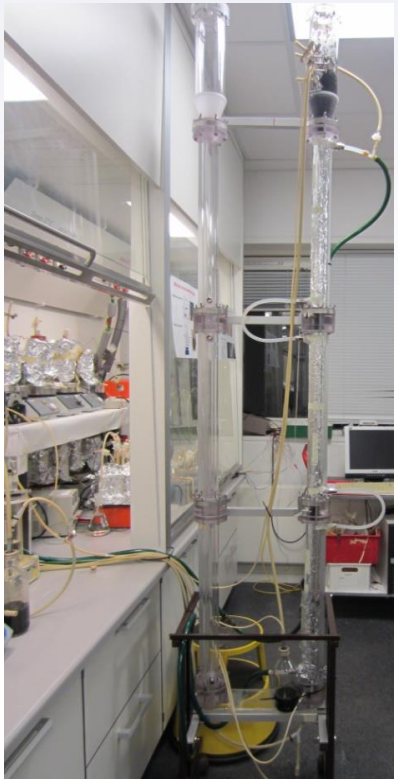
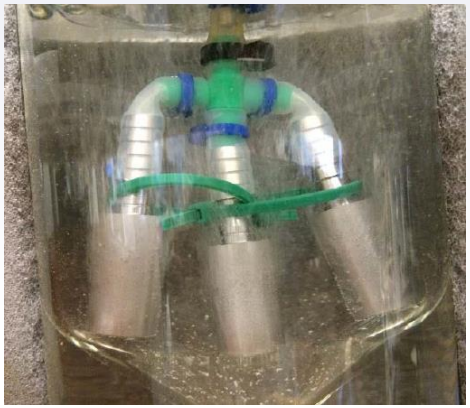
RES synergy

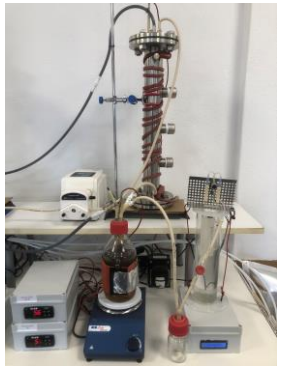
Exploitation of surplus RES for green H_2 production



Capitalizing on previous experience (TRL 2-4)

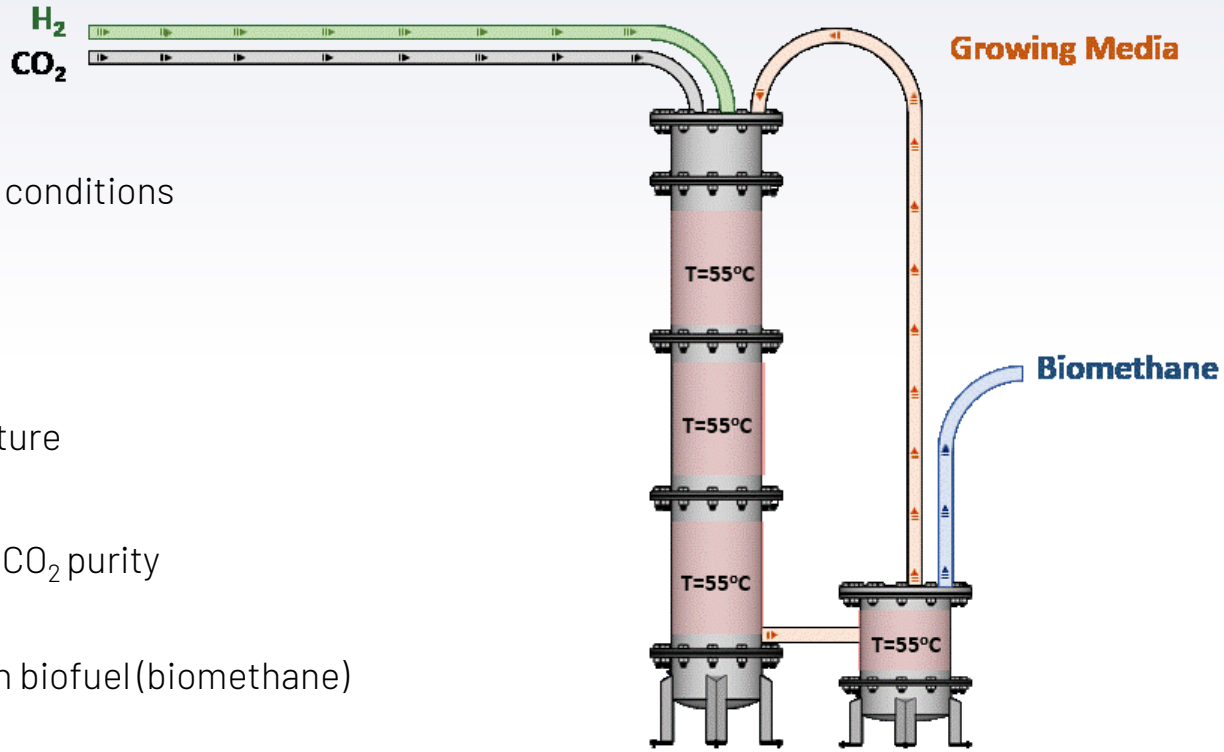


…moving from TRL 5 in LIFE CO2toCH4

- Operation in mild temperature conditions
- Operation in ambient pressure
- No need for pure microbial culture
- Process is not affected by the CO_2 purity
- Transformation of CO_2 to 3-gen biofuel (biomethane)



Where can this technology be applied?

Examples of application

Biogas Plants

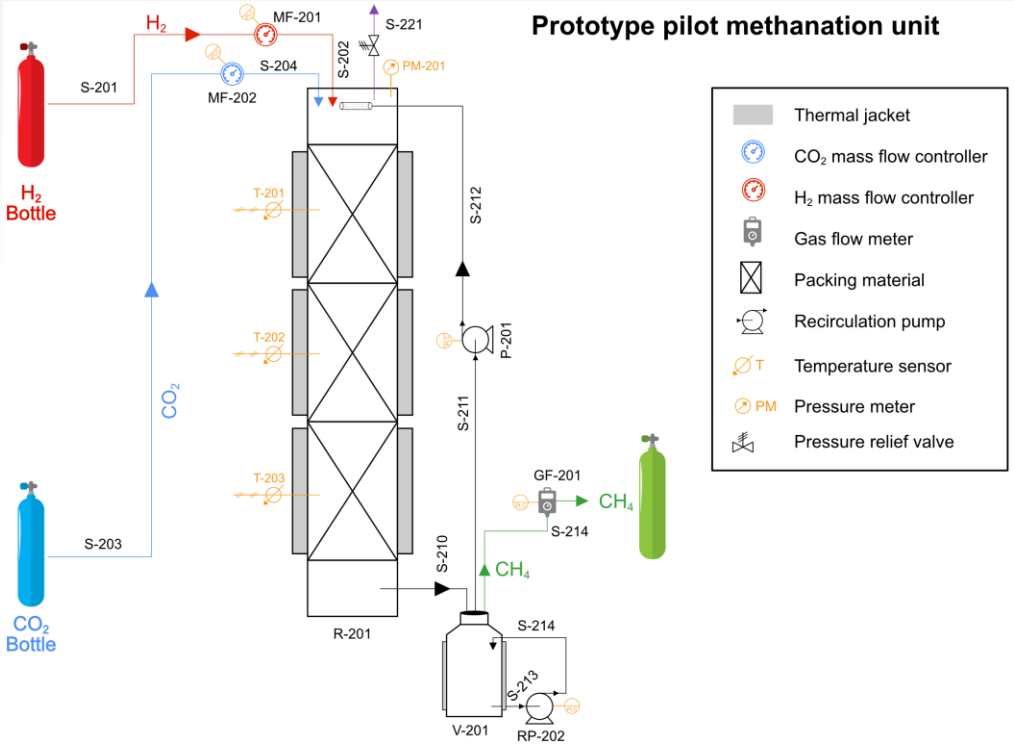
CO_2 intensive industries

Other CO_2 emitting applications (e.g. pyrolysis)

What we have been taught from the first year of reactor operation?

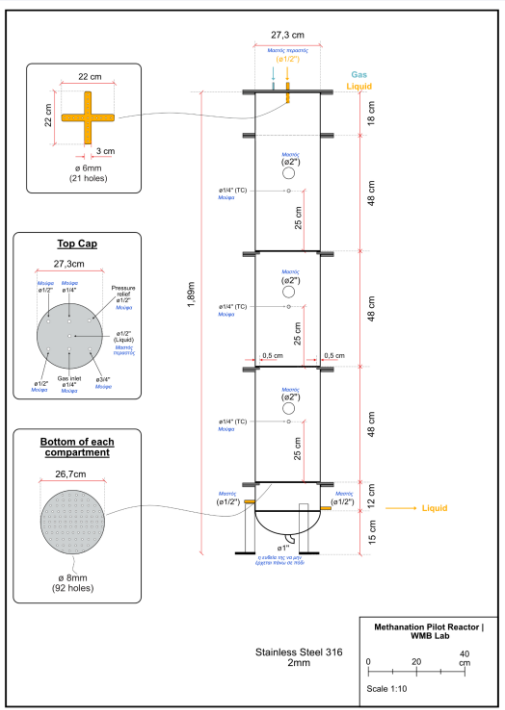
Design and operation of a prototype pilot methanation unit

STEP 1: Design of PI Diagram

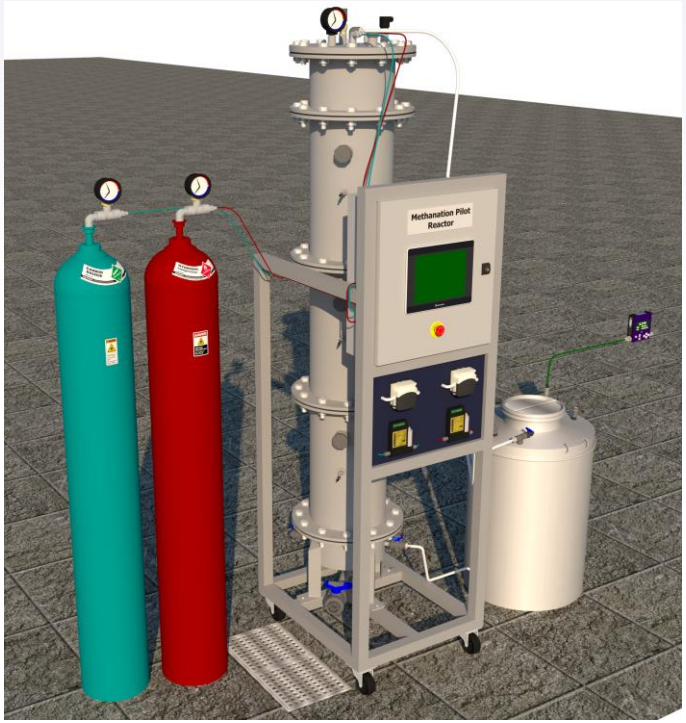


Design and operation of a prototype pilot methanation unit

STEP 2: Design of reactor unit

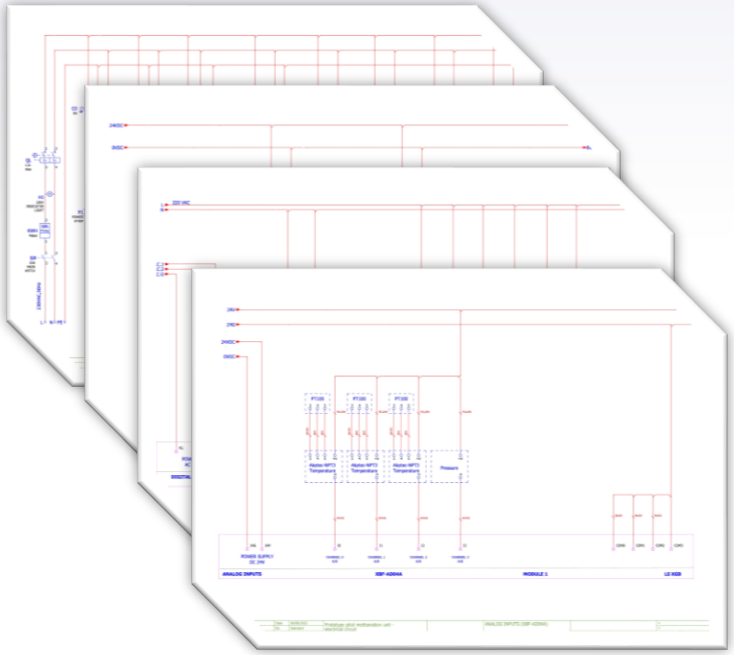


STEP 3: Design of methanation model



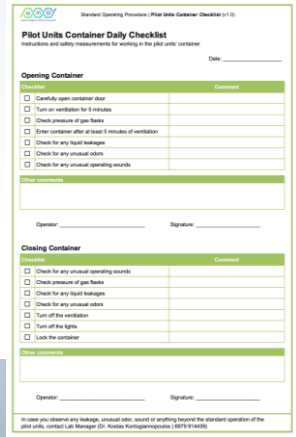
Design and operation of a prototype pilot methanation unit

STEP 4: Construction & assembly



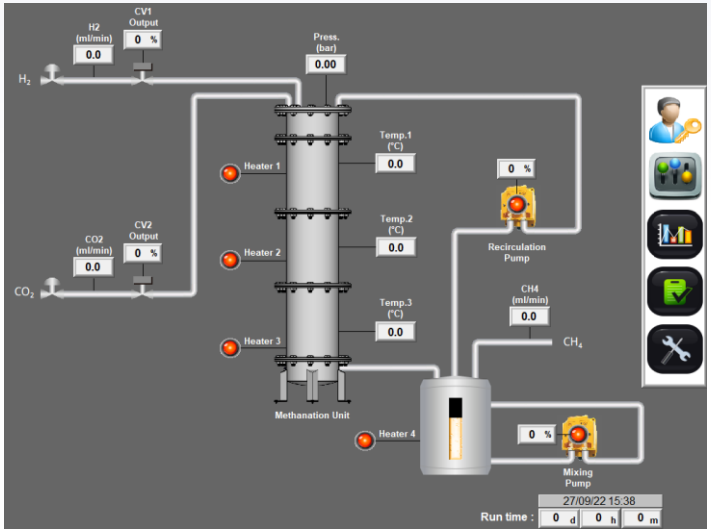
Design and operation of a prototype pilot methanation unit

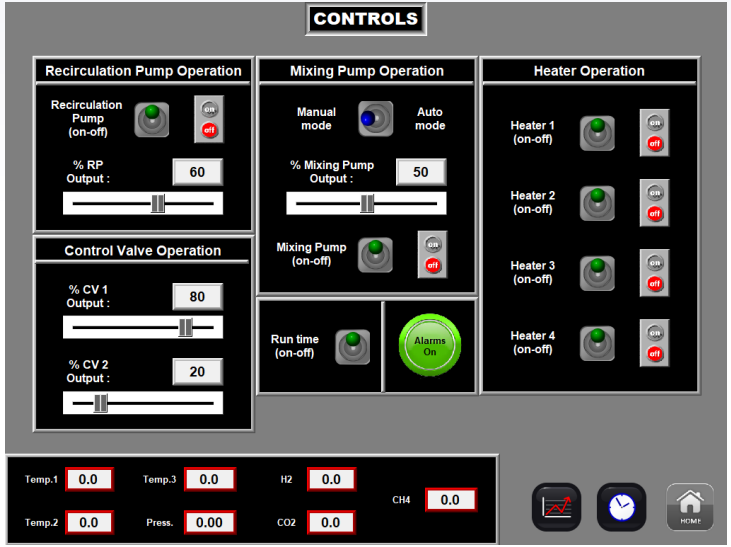
STEP 5: Installation & Safety



Design and operation of a prototype pilot methanation unit

STEP 6: Test operation





Design and operation of a prototype pilot methanation unit

STEP 7: Unit ready to operate

STEP 8: Training of the operators

Operation of a prototype pilot methanation unit

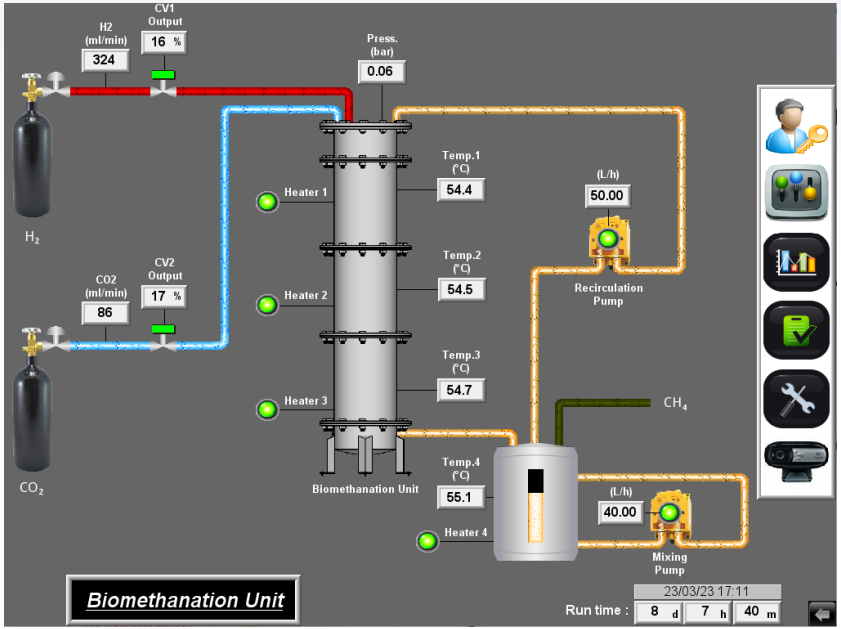
Operation Strategy

	4	3	2	1	0.5
Gas (L/h)	25.3	33.7	50.5	101.1	202.1
H_2 (L/h)	20.2	26.9	40.4	80.8	161.7
CO_2 (L/h)	5.1	6.7	10.1	20.2	40.4
CO_2 (L/day)	121.3	161.7	242.5	485.1	970.1
CO_2 (kg/day)	0.2	0.3	0.4	0.9	1.7
max kg CO_2/m^3 reactor	2.2	2.9	4.3	8.6	17.3
actual kg CO_2/m^3 reactor	1.9	2.6	3.9	7.8	15.6

Operation of a prototype pilot methanation unit

- Initial operation on 17.03.2023
- GRT 4h
- Feed H_2: 320mL/min | CO_2: 80mL/min
- TARGET: >90% CO_2 conversion

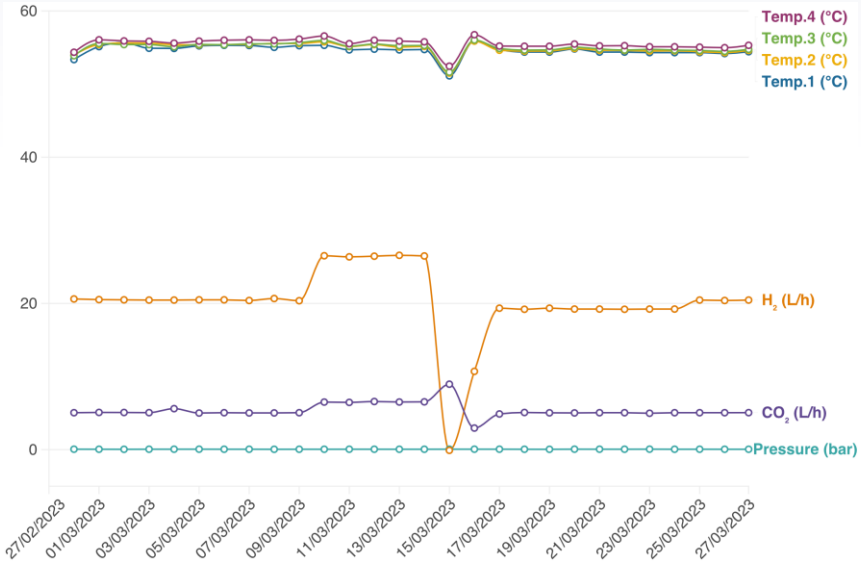
Operation of a prototype pilot methanation unit



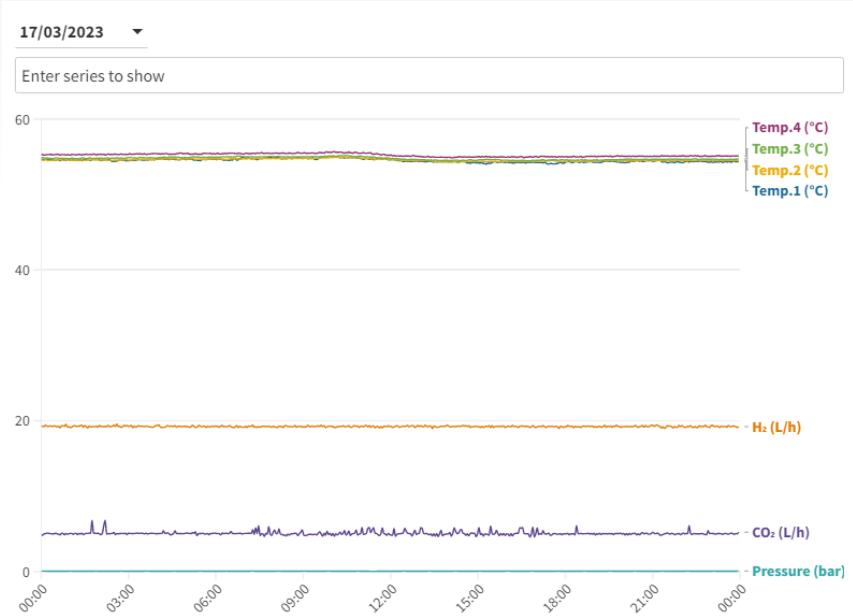
- ✓ Fully automated operation
- ✓ Online monitoring
- ✓ Data logging

Operation of a prototype pilot methanation unit

Input TOTAL

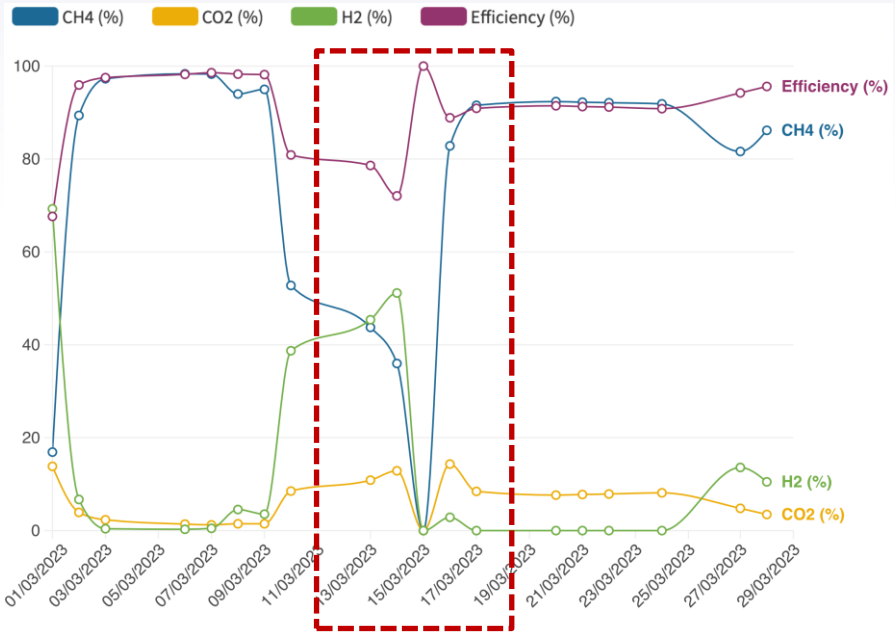


Input DAILY

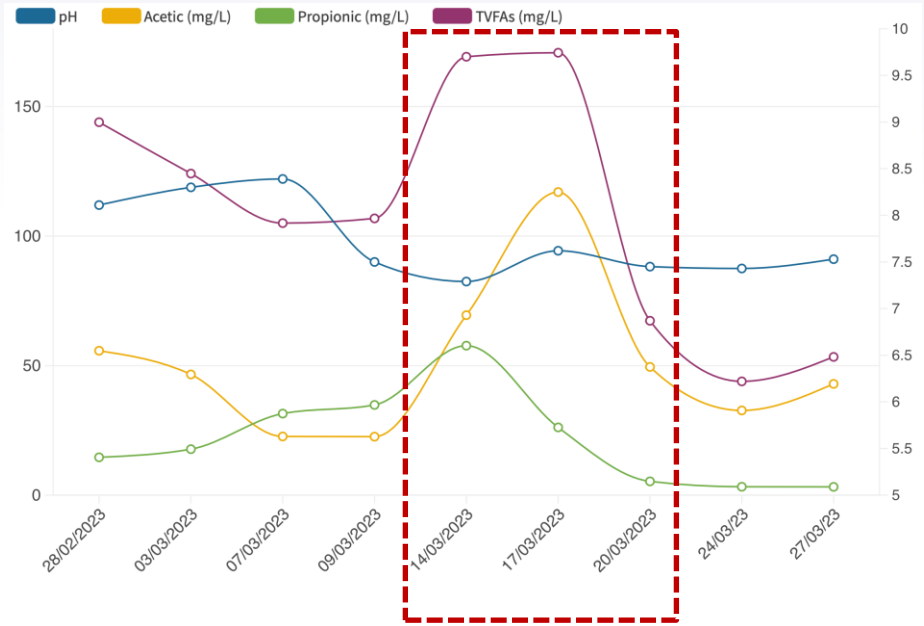


Operation of a prototype pilot methanation unit

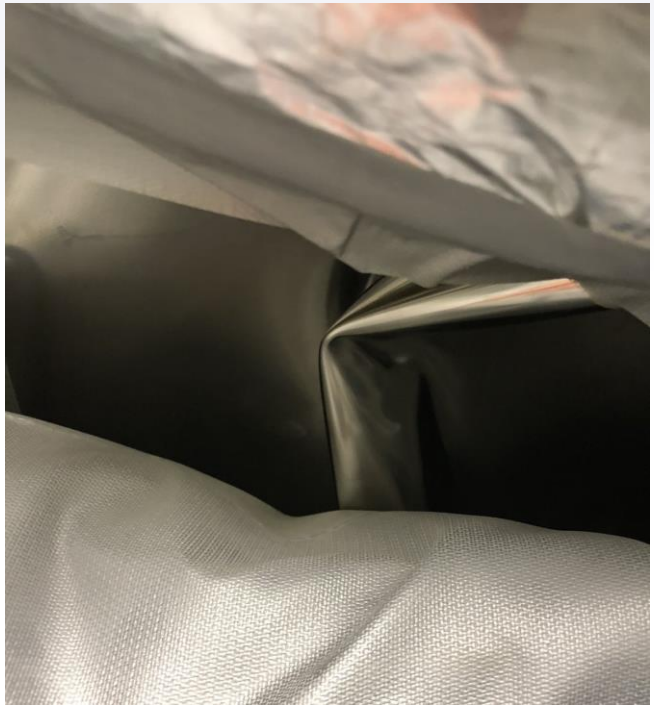
Process Efficiency



Total and Individual VFA



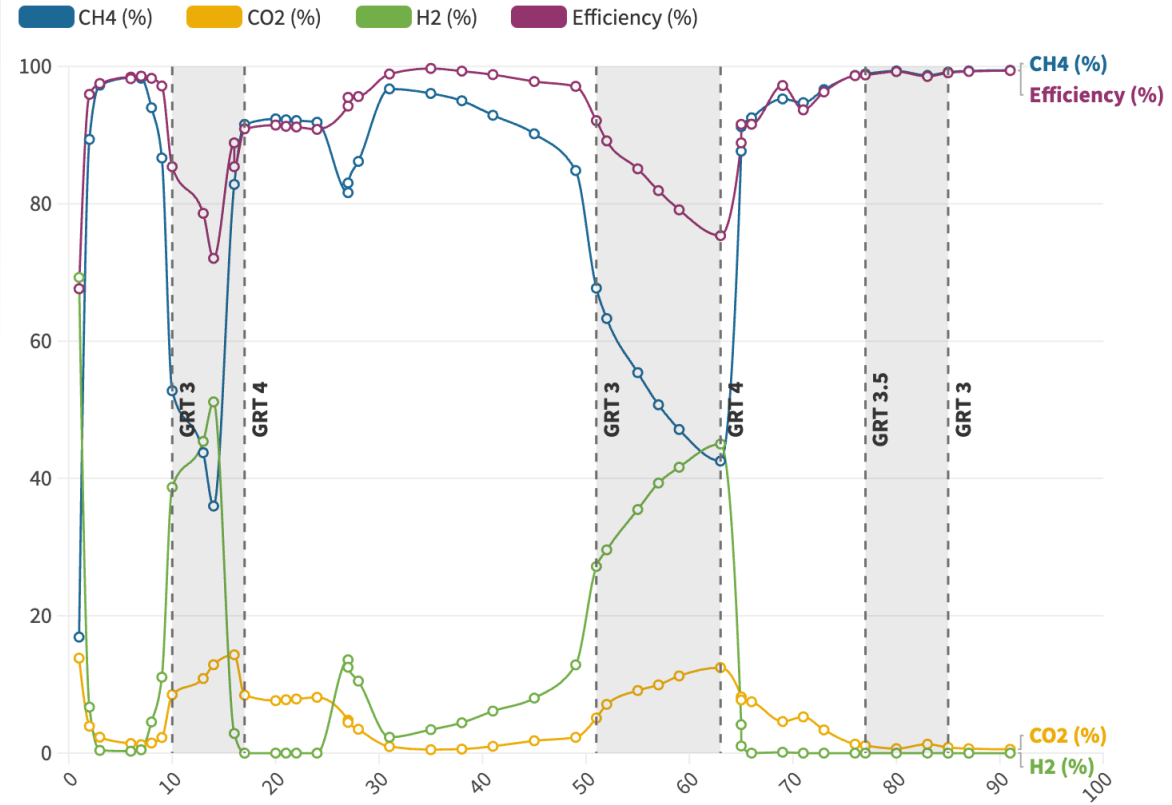
Operation of a prototype pilot methanation unit



Lessons learned during the last year..

- Difficulties in respect to increased prices of raw materials and equipment
  - Modify the design of the TBR/ save costs from e.g. flanges, thermal jackets, pumps etc
- Difficulties in respect to delays from suppliers
  - Need to plan procurement processes earlier than scheduled
- Risk from process perturbation
  - Need to closely monitor the operation of the methanation unit
  - Need to have well-trained operators to understand process disturbances
  - Need to understand/manipulate the microbial dynamics

Current status…



Thank you