

# LIFE 20 CCM/GR/001642

## CO<sub>2</sub>toCH<sub>4</sub>: Demonstration of a mobile unit for hybrid energy storage based on CO<sub>2</sub> capture and renewable energy sources



PPC  
Renewables



ARISTOTLE  
UNIVERSITY  
OF THESSALONIKI



LIFE20 CCM/GR/001642

LIFE CO<sub>2</sub>toCH<sub>4</sub> Launching Event

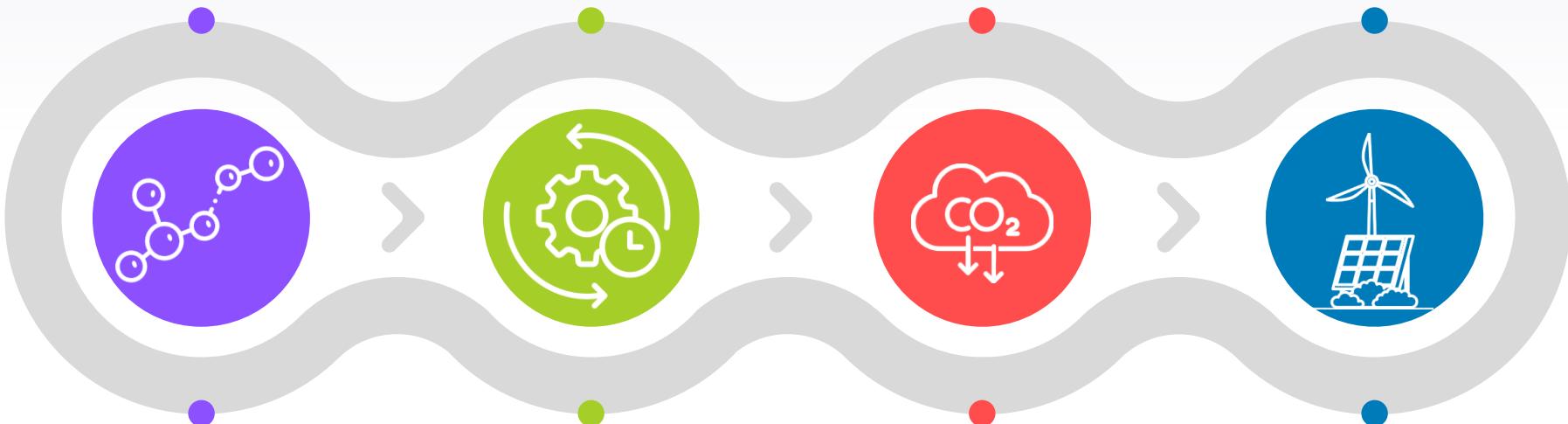


“ What is the biological  
CO<sub>2</sub> hydrogenation  
technology? ”

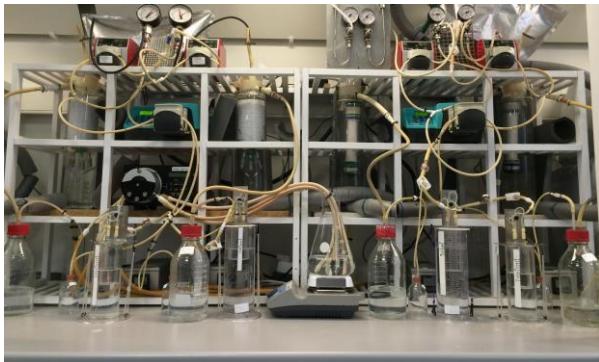
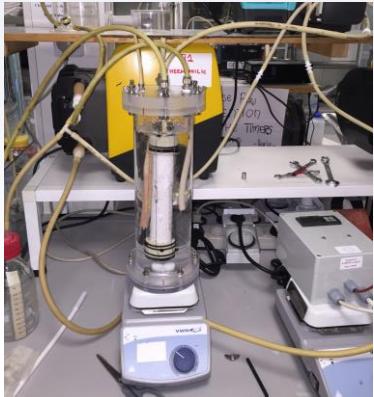


# Technology Background on Methanation System

Reaction	Method	CCUS	RES synergy
$4\text{H}_2 + \text{CO}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$	Thermocatalytical (300-400°C, ~30bar, catalyst) or biological (30-60°C, methanogens)	Emerging technologies for carbon capture and utilisation	Exploitation of surplus RES for green H <sub>2</sub> production

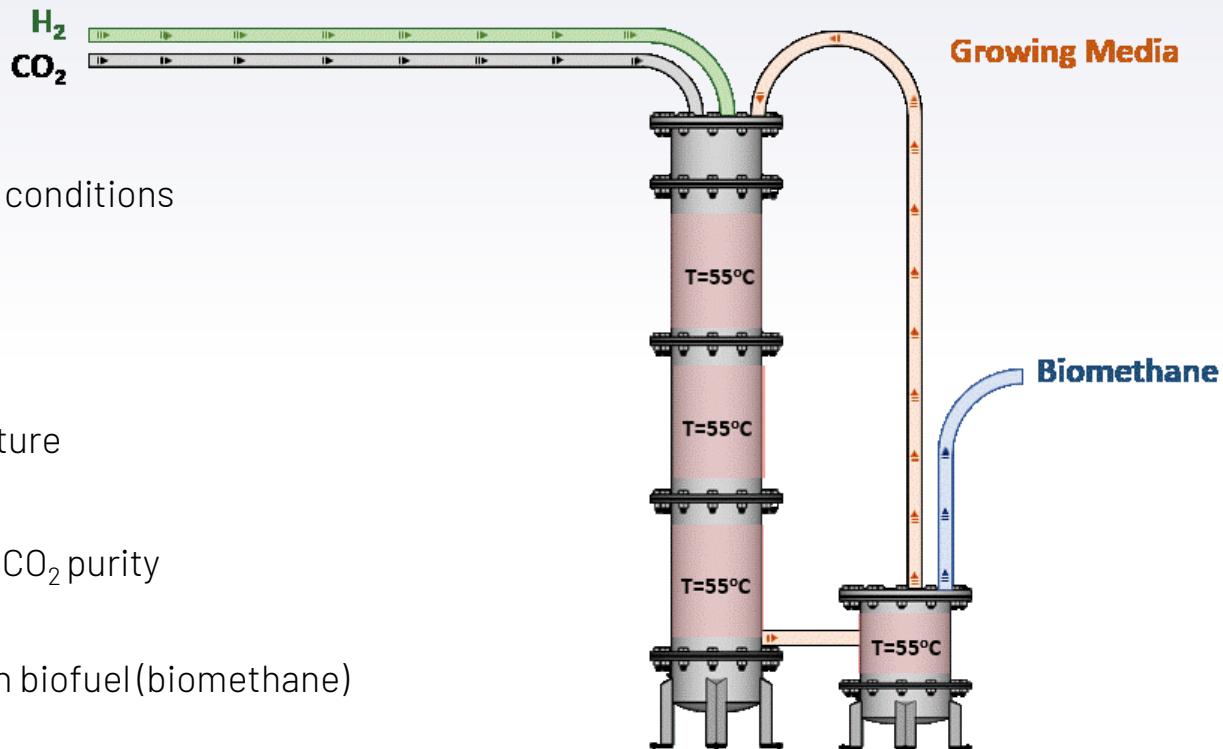


# Capitalizing on previous experience (TRL 2-4)



# ...moving from TRL 5 in LIFE CO<sub>2</sub>toCH<sub>4</sub>

- Operation in mild temperature conditions
- Operation in ambient pressure
- No need for pure microbial culture
- Process is not affected by the CO<sub>2</sub> purity
- Transformation of CO<sub>2</sub> to 3-gen biofuel(biomethane)



“ Where can this technology be applied? ”



# Examples of application



**Biogas Plants**



**CO<sub>2</sub> intensive industries**

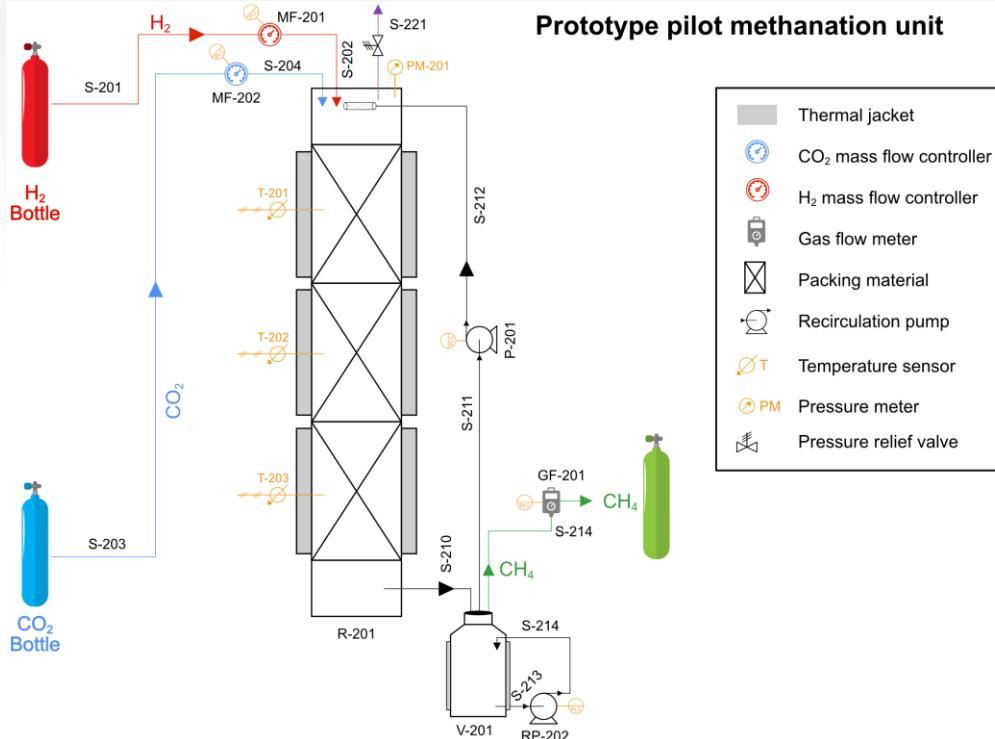


**Other CO<sub>2</sub> emitting  
applications (e.g. pyrolysis)**

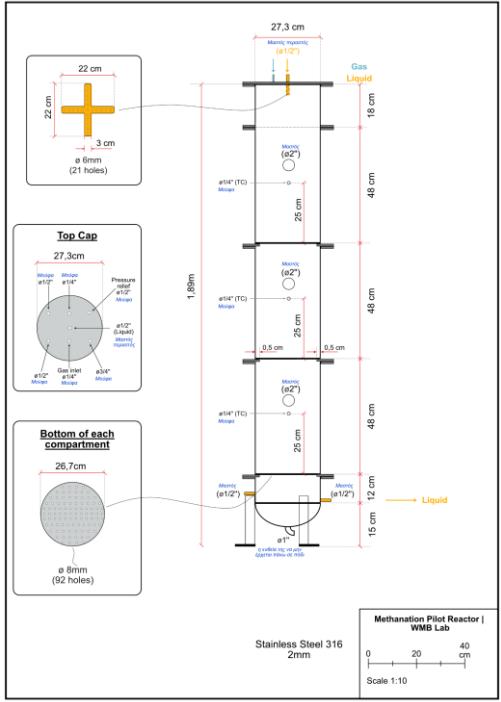
“ What we have been taught from the first year of reactor operation?



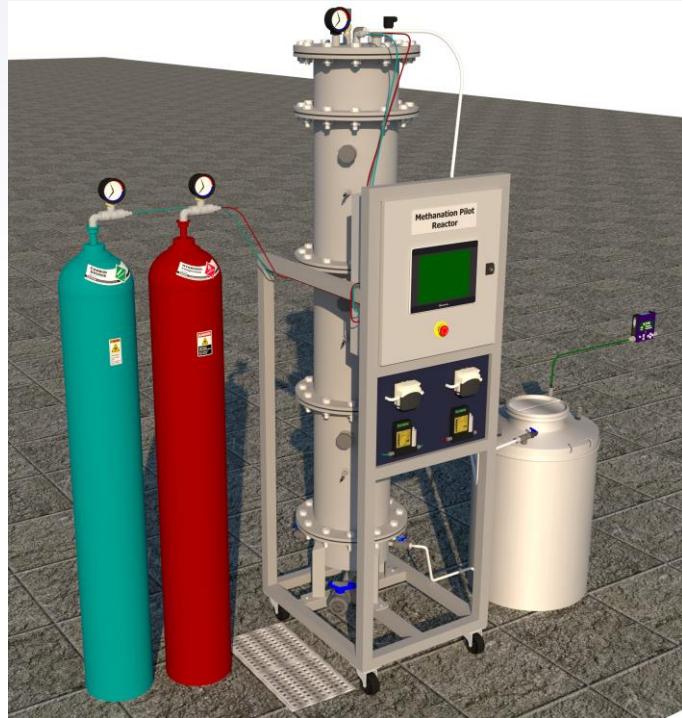
# Design and operation of a prototype pilot methanation unit



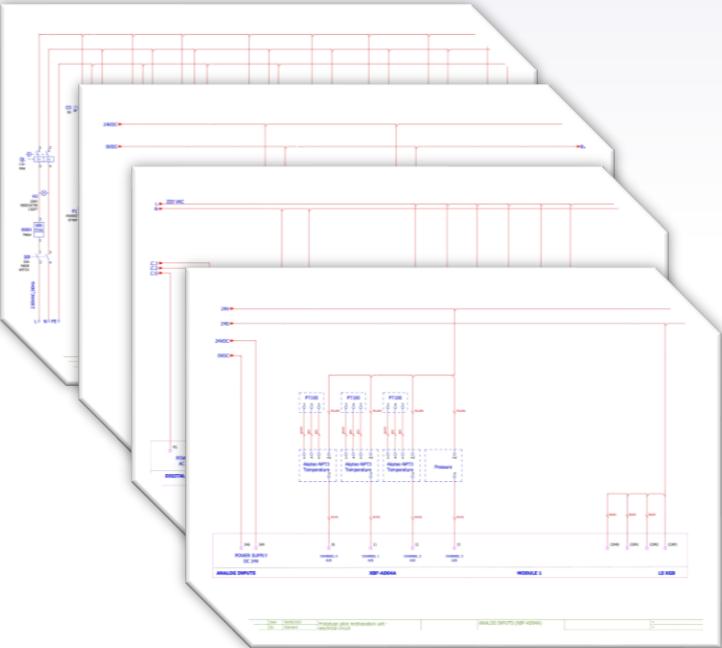
## STEP 2: Design of reactor unit



## STEP 3: Design of methanation model



## STEP 4: Construction & assembly



## STEP 5: Installation & Safety

# Design and operation of a prototype pilot methanation unit



Standard Operating Procedure | Pilot Units Container Checklist (v1.0)

Pilot Units Container Daily Checklist  
Instructions and safety measurements for working in the pilot units' container

Date: \_\_\_\_\_

**Opening Container**

Checklist	Comment
<input type="checkbox"/> Carefully open container door	
<input type="checkbox"/> Turn on ventilation for 5 minutes	
<input type="checkbox"/> Check for any leakage	
<input type="checkbox"/> Enter container after an initial 5 minutes of ventilation	
<input type="checkbox"/> Check for any liquid leakage	
<input type="checkbox"/> Check for any unusual odors	
<input type="checkbox"/> Check for any unusual operating sounds	

**Other comments**

Operator: \_\_\_\_\_ Signature: \_\_\_\_\_

**Closing Container**

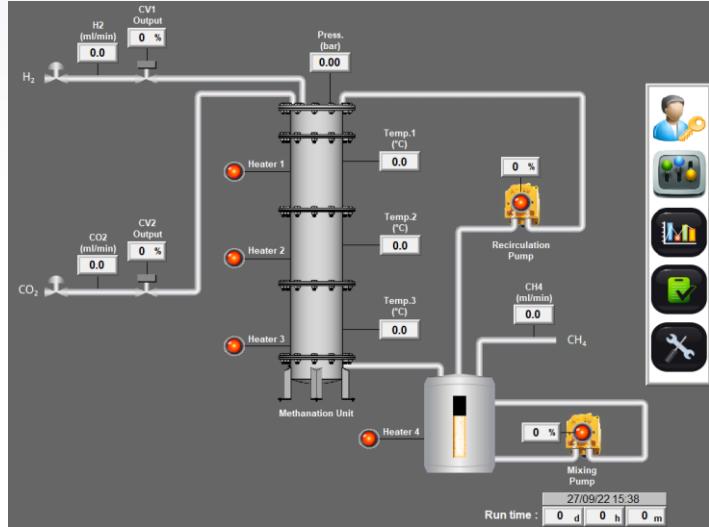
Checklist	Comment
<input type="checkbox"/> Check for any unusual operating sounds	
<input type="checkbox"/> Check pressure of gas tanks	
<input type="checkbox"/> Check for any liquid leakage	
<input type="checkbox"/> Check for any unusual odors	
<input type="checkbox"/> Turn off ventilation	
<input type="checkbox"/> Turn off the lights	
<input type="checkbox"/> Lock the container	

**Other comments**

Operator: \_\_\_\_\_ Signature: \_\_\_\_\_

In case you observe any leakage, unusual odor, sound or anything beyond the standard operation of the pilot units, contact Lab Manager (Dr. Kostas Karayannidis) (697194846)

## STEP 6: Test operation



## STEP 7: Unit ready to operate



## STEP 8: Training of the operators



# Design and operation of a prototype pilot methanation unit

# Operation of a prototype pilot methanation unit



## Operation Strategy

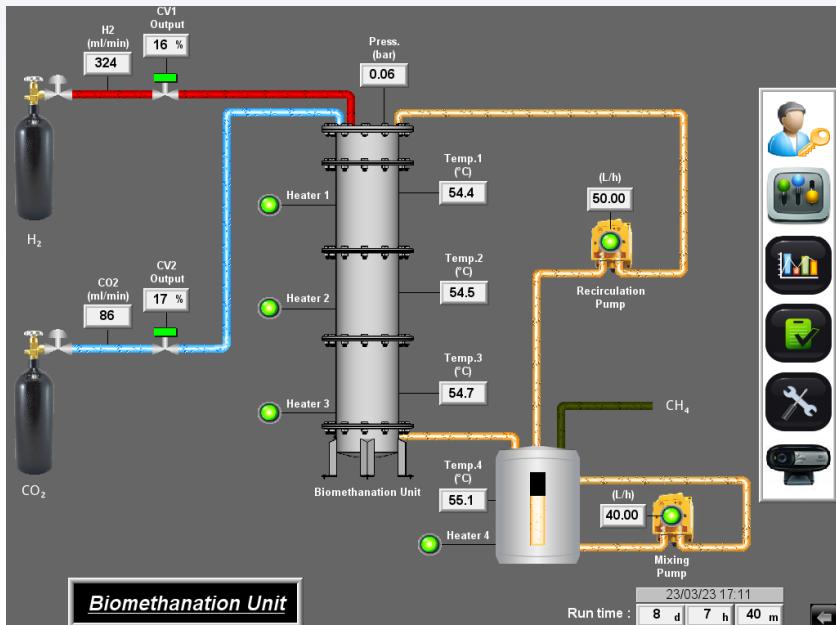
	4	3	2	1	0.5
Gas (L/h)	25.3	33.7	50.5	101.1	202.1
H <sub>2</sub> (L/h)	20.2	26.9	40.4	80.8	161.7
CO <sub>2</sub> (L/h)	5.1	6.7	10.1	20.2	40.4
CO <sub>2</sub> (L/day)	121.3	161.7	242.5	485.1	970.1
CO <sub>2</sub> (kg/day)	0.2	0.3	0.4	0.9	1.7
max kg CO <sub>2</sub> /m <sup>3</sup> reactor	2.2	2.9	4.3	8.6	17.3
actual kg CO <sub>2</sub> /m <sup>3</sup> 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<sub>2</sub>: 320mL/min | CO<sub>2</sub>: 80mL/min
- ✓ TARGET: >90% CO<sub>2</sub> conversion

# Operation of a prototype pilot methanation unit



✓ Fully automated operation

✓ Online monitoring

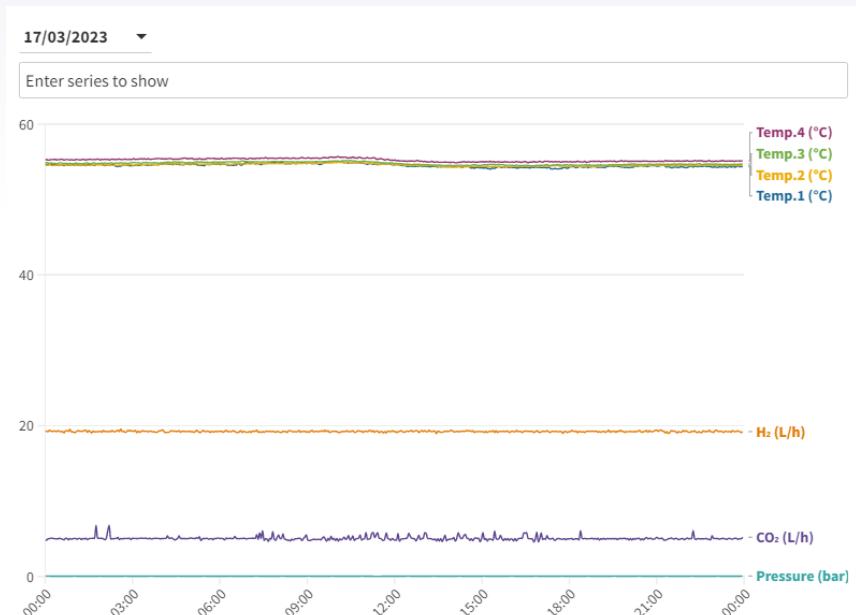
✓ Data logging

# Operation of a prototype pilot methanation unit

**Input TOTAL**

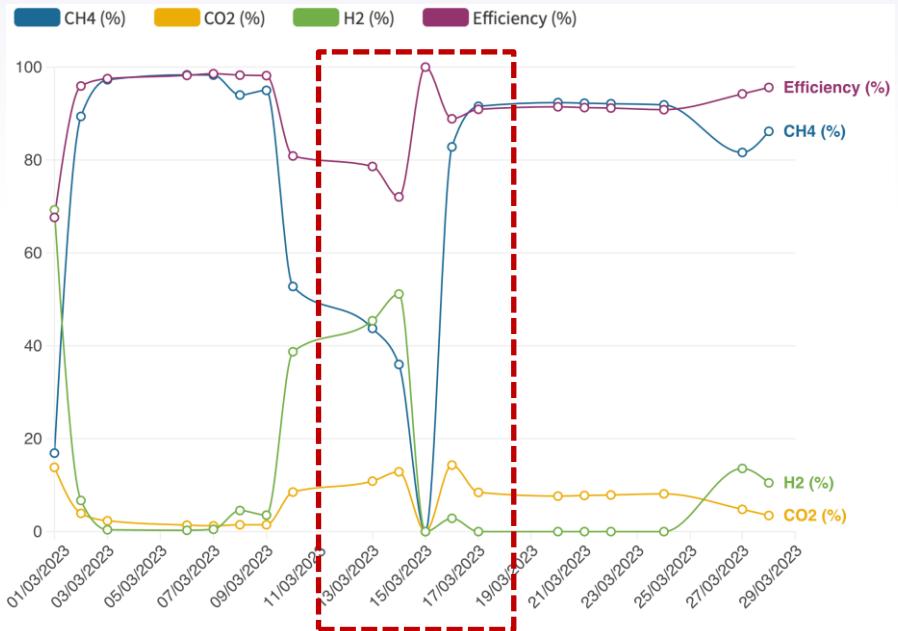


**Input DAILY**

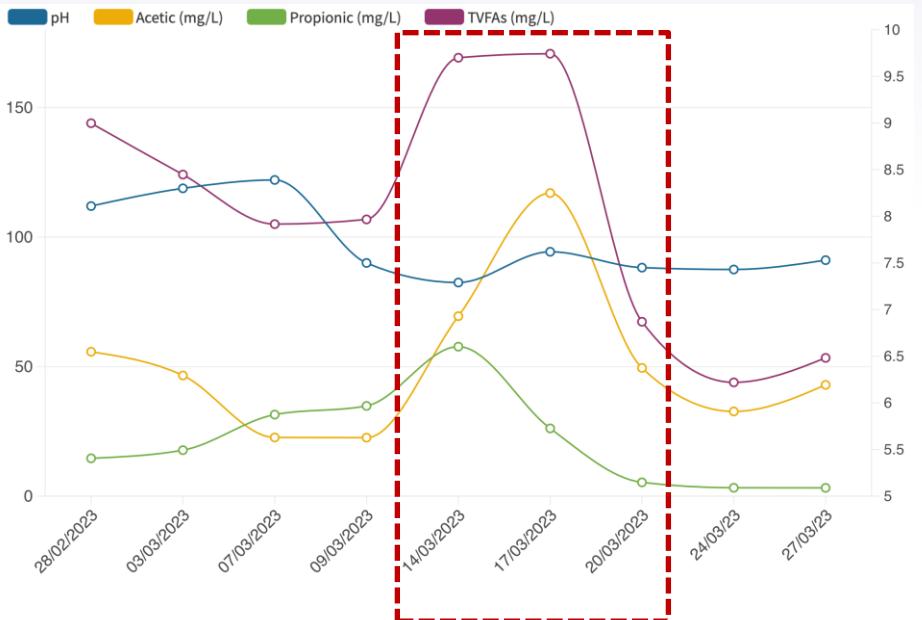


# Operation of a prototype pilot methanation unit

## Process Efficiency



## Total and Individual VFA



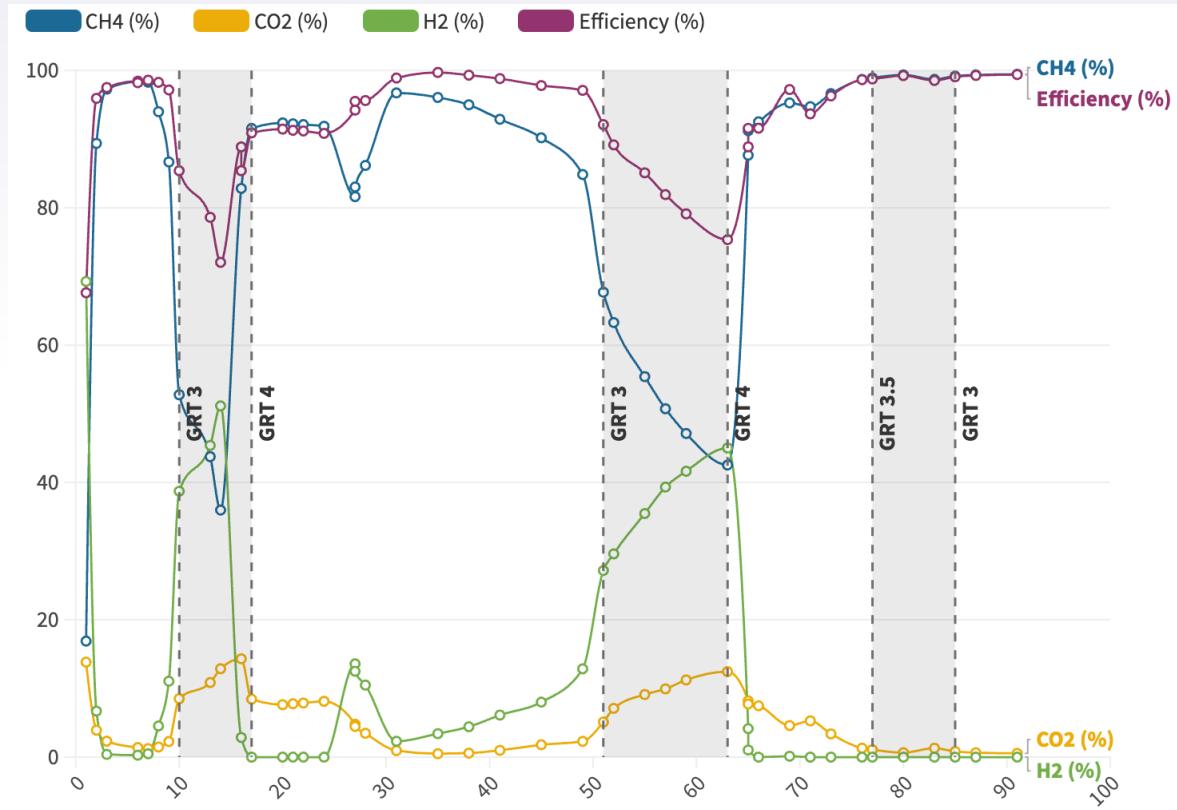
# Operation of a prototype pilot methanation unit



## 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



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