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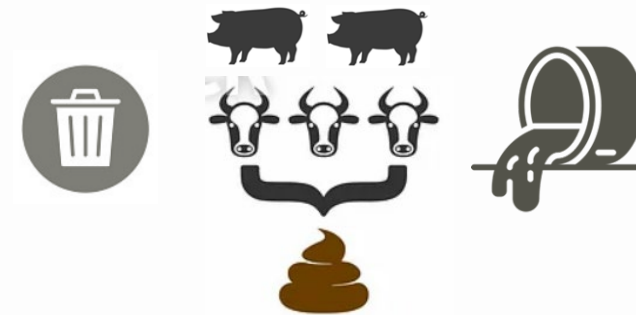
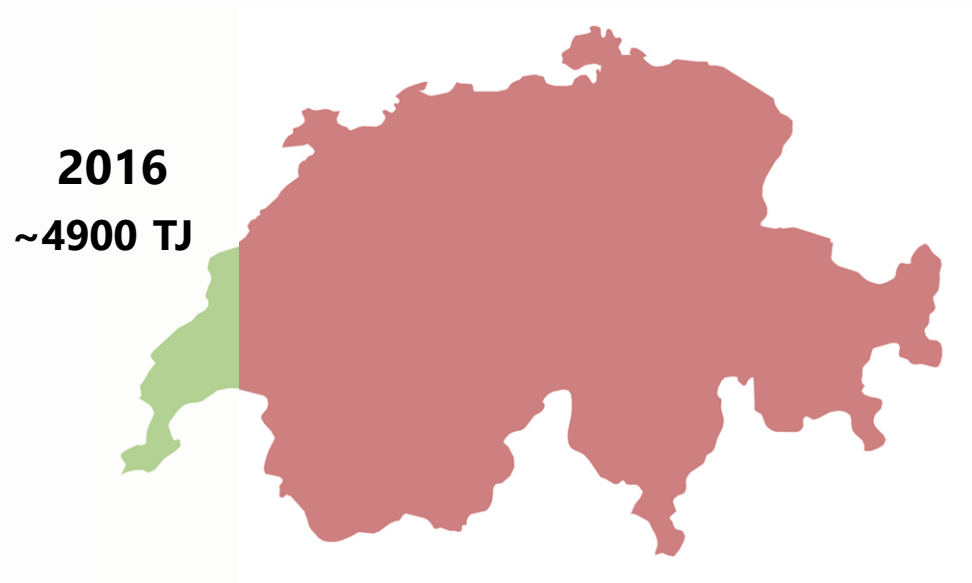
Sorption Enhanced Methanation: a novel Biogas upgrade concept

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Advanced Materials & Processes, UMTEC



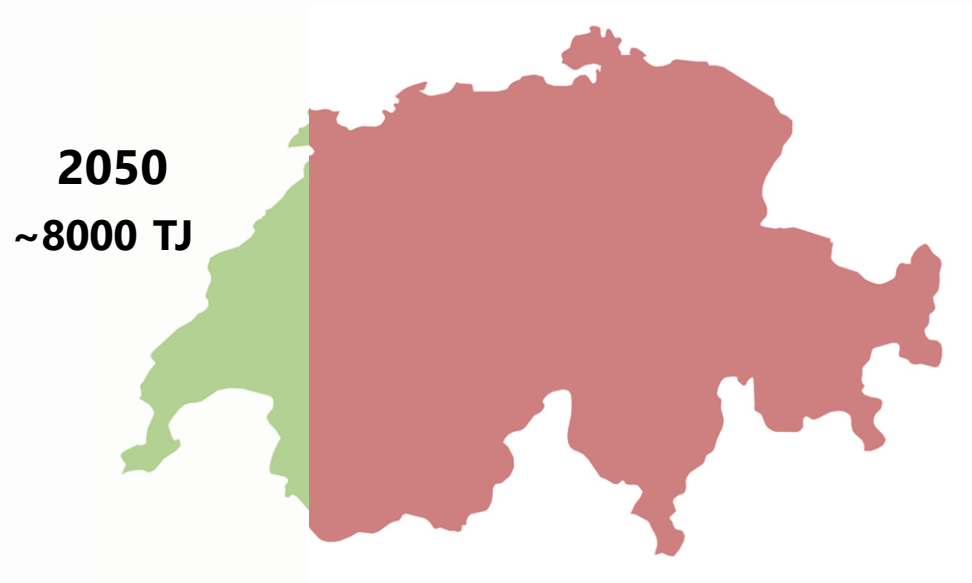
Biogas production in Switzerland:



Biogas produced from waste usage:

- **24 % - Electricity**
- **33 % - CHP / Industrial burners**
- **20 % - Upgraded to Biomethane**
- **23% handling/parasitic heat losses**

Biogas production in Switzerland:

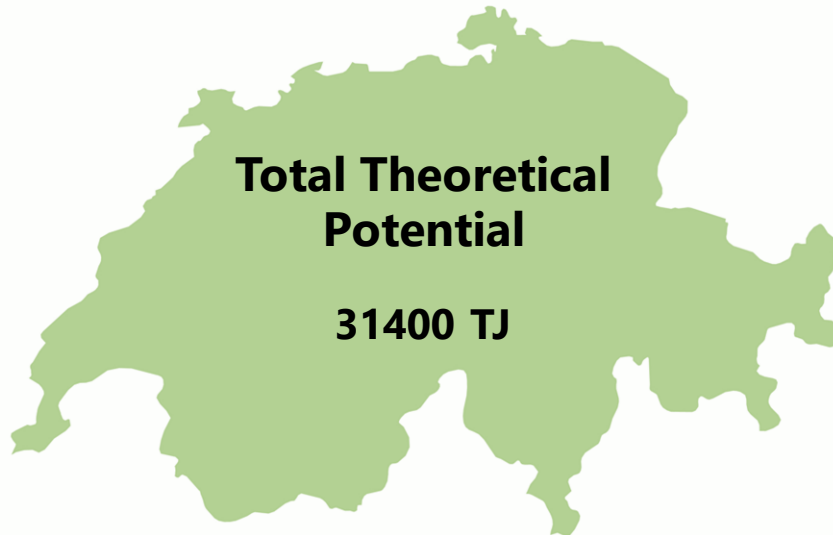


Is expected a production of ~8000 TJ by 2050

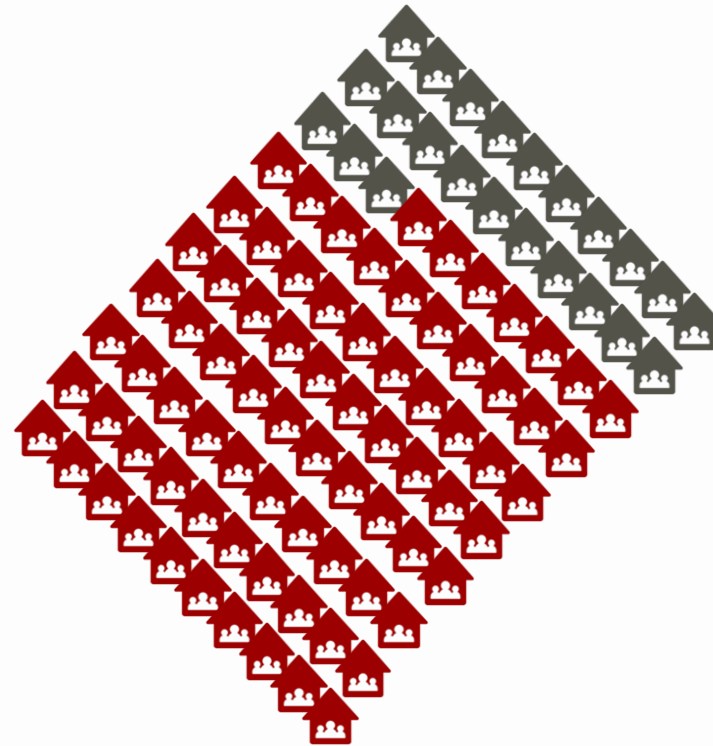
Swiss gas industry new goal: increase the use of renewable methane/biogas in the **heating market up to 30% in 2030**

How to achieve this goal?

Biogas production in Switzerland:

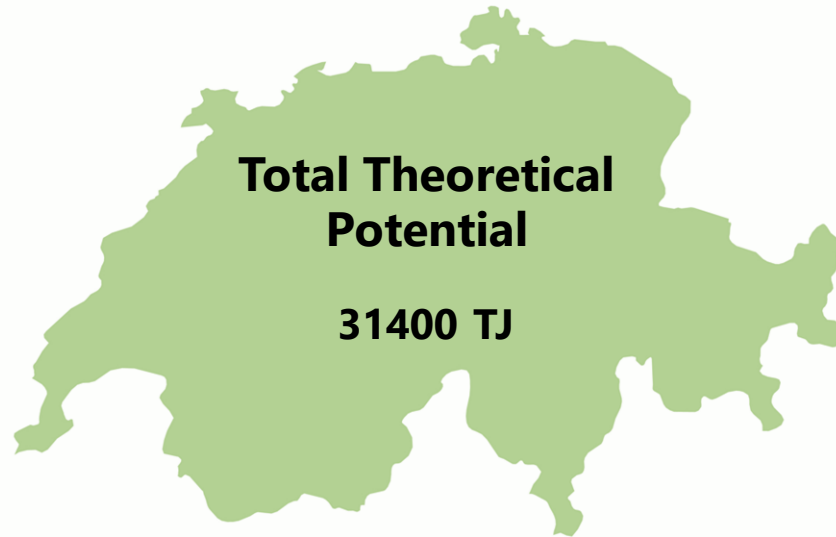


➤ **Losses could be about 7000 TJ !!!!**

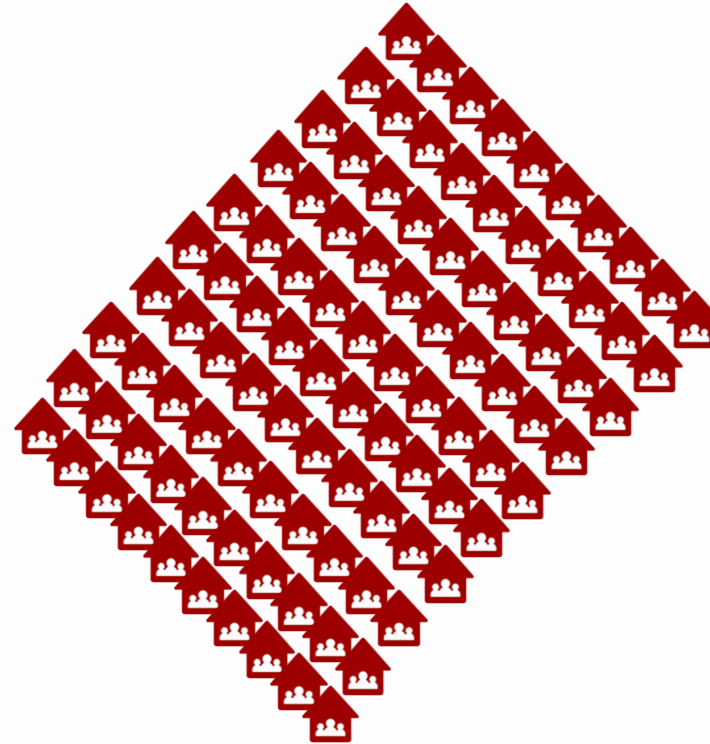


Energy wasted would be enough to supply 400000 Swiss households

Biogas production in Switzerland:



How to decrease the losses and expand biogas use in the heat market?

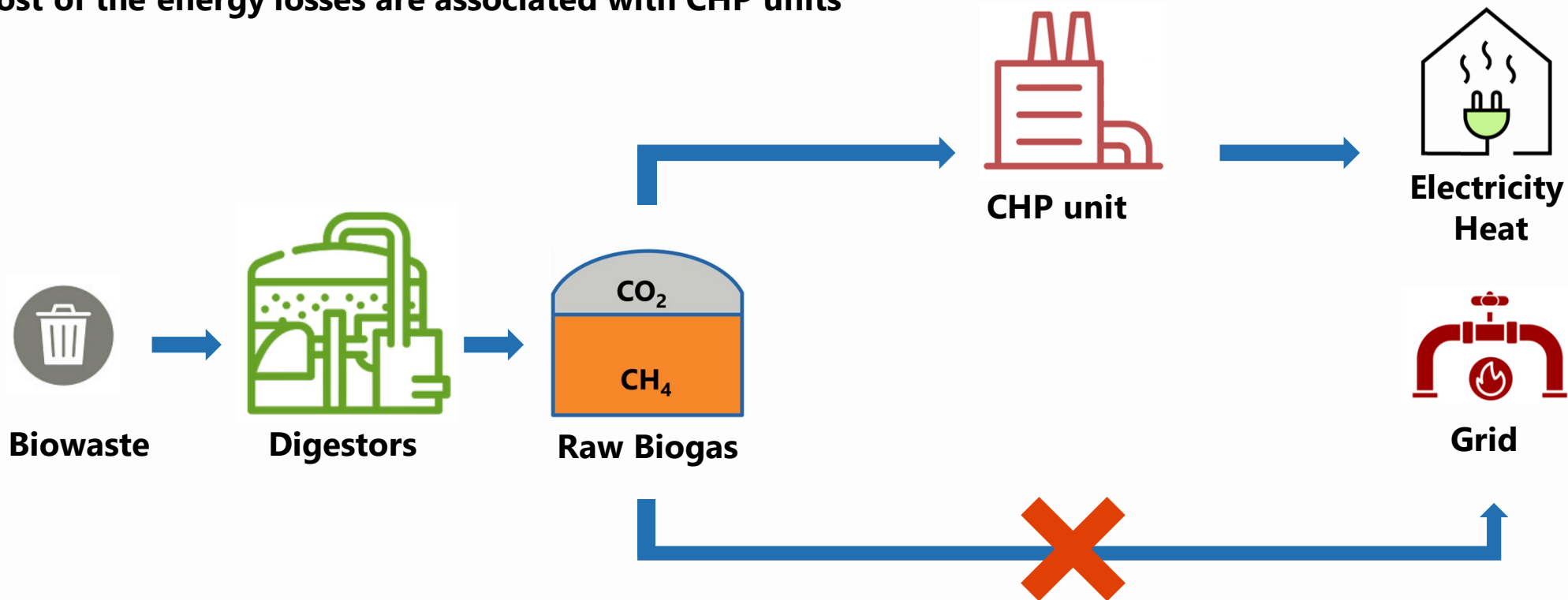


➤ **Losses could be about 7000 TJ !!!!**

Why upgrade biogas?

Raw biogas cannot be directly fed into the grid

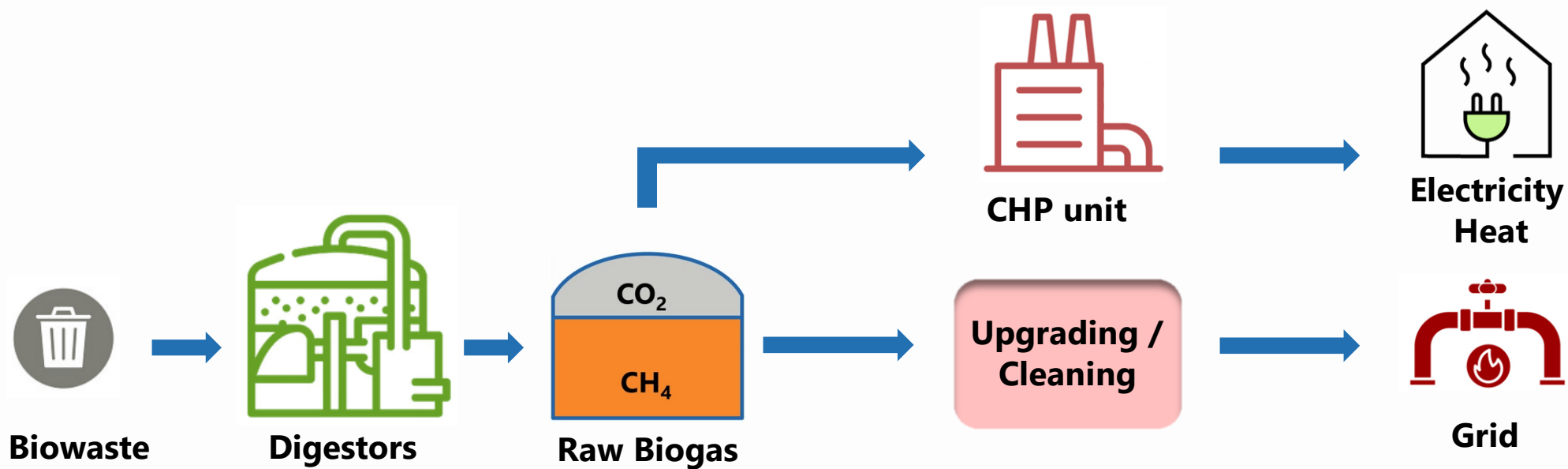
Most of the energy losses are associated with CHP units

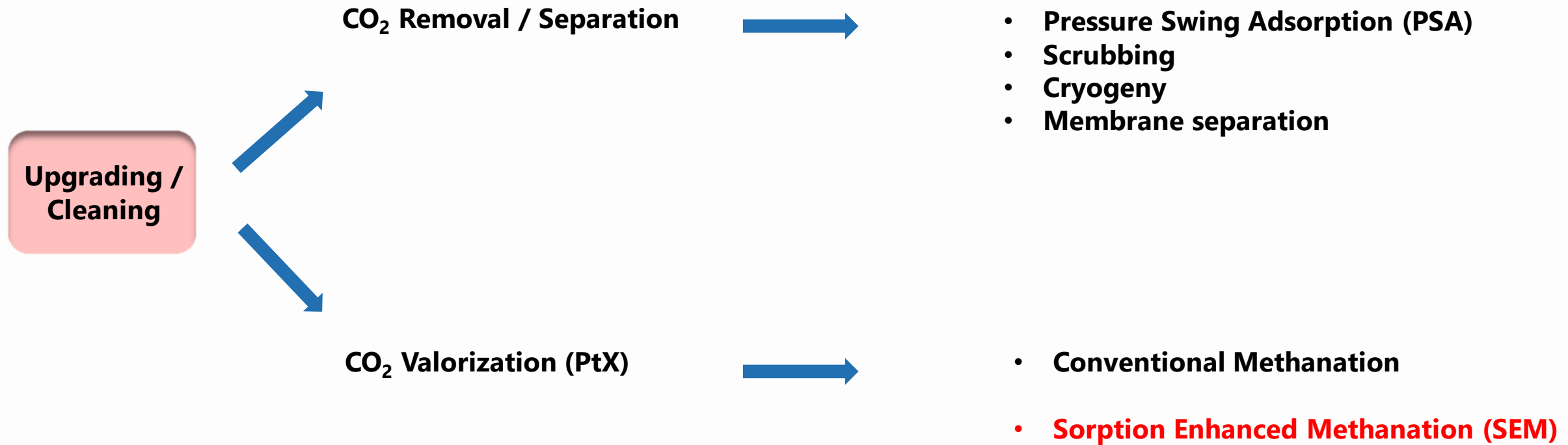


Why upgrade is needed?

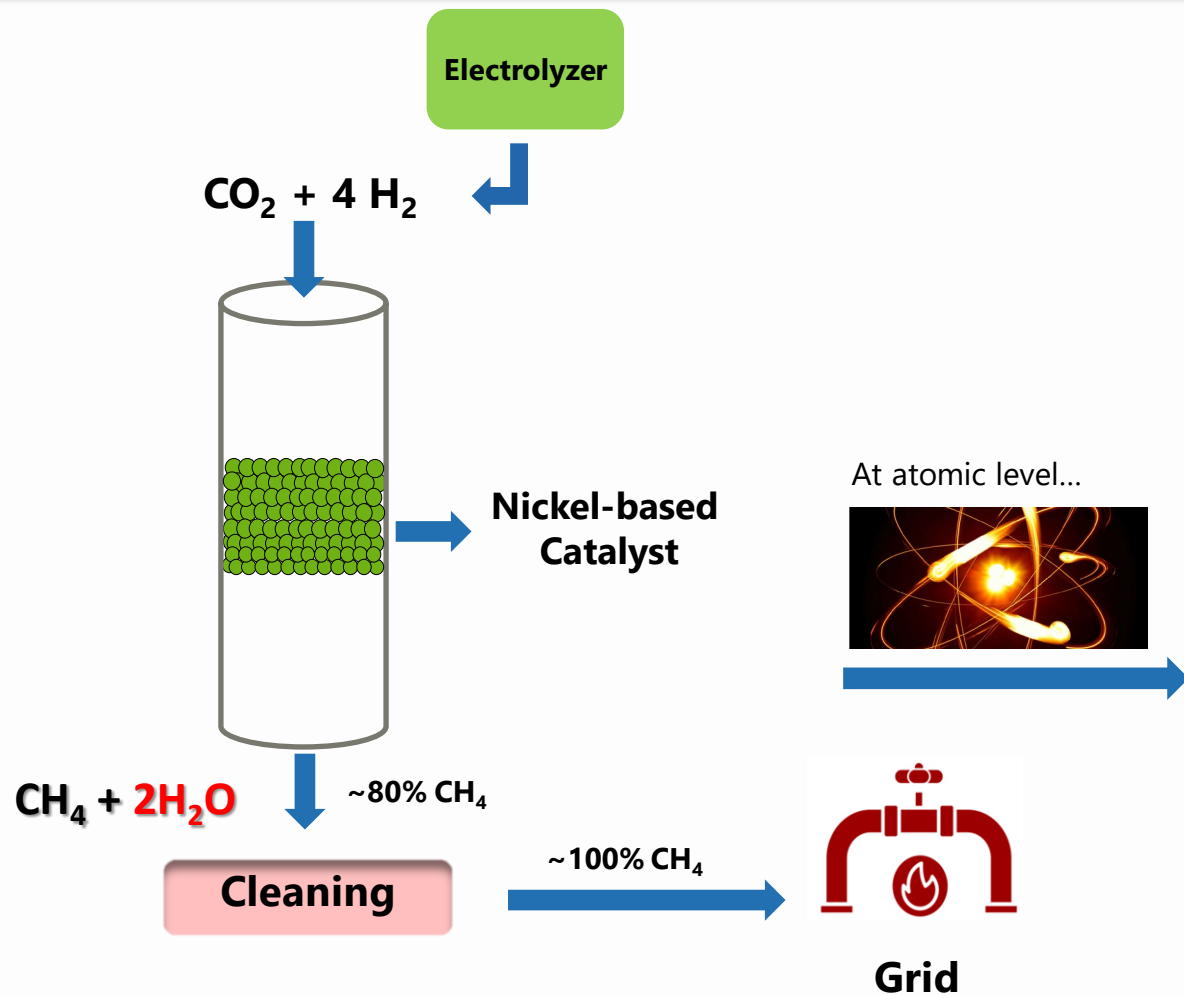
Expansion of biogas use in the domestic heat market

Investments in Upgrading/Cleaning are needed



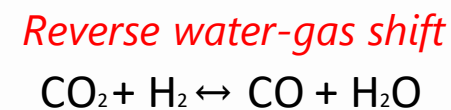
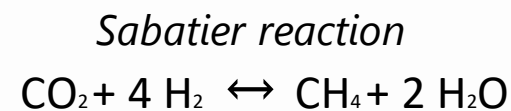
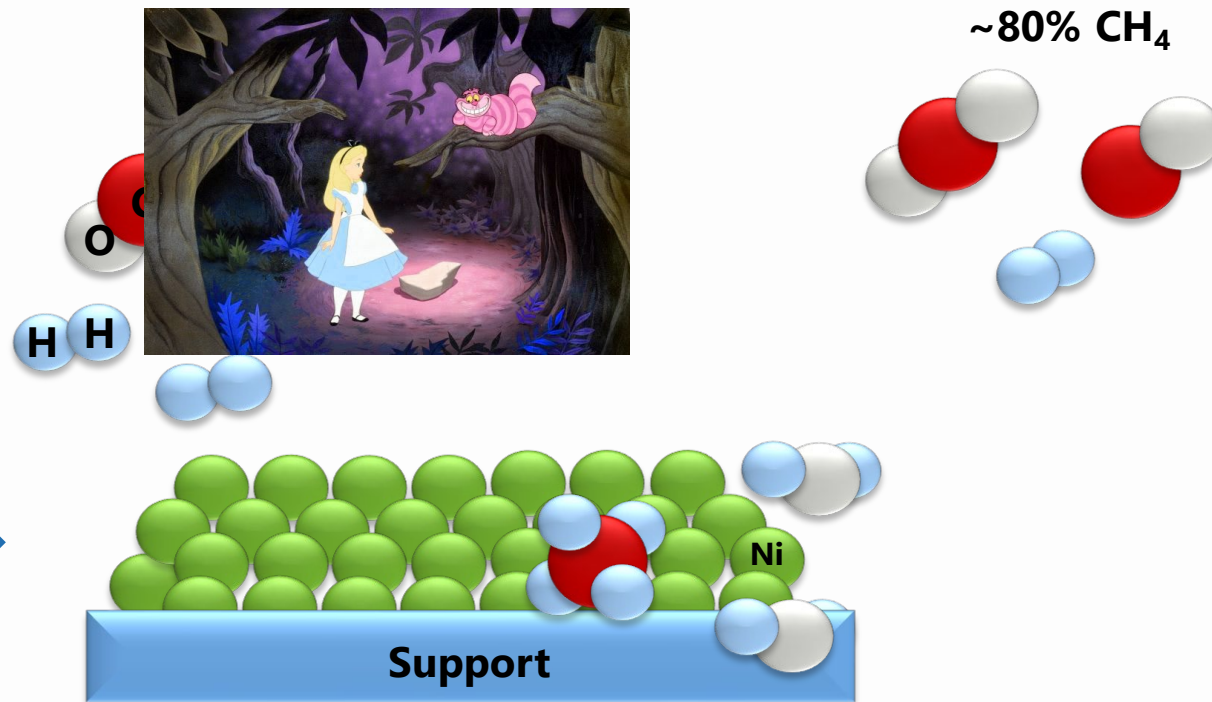


Conventional methanation – Sabatier reaction



Expensive purification step needed!

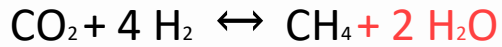
Unfortunately this is real world not Wonderland...



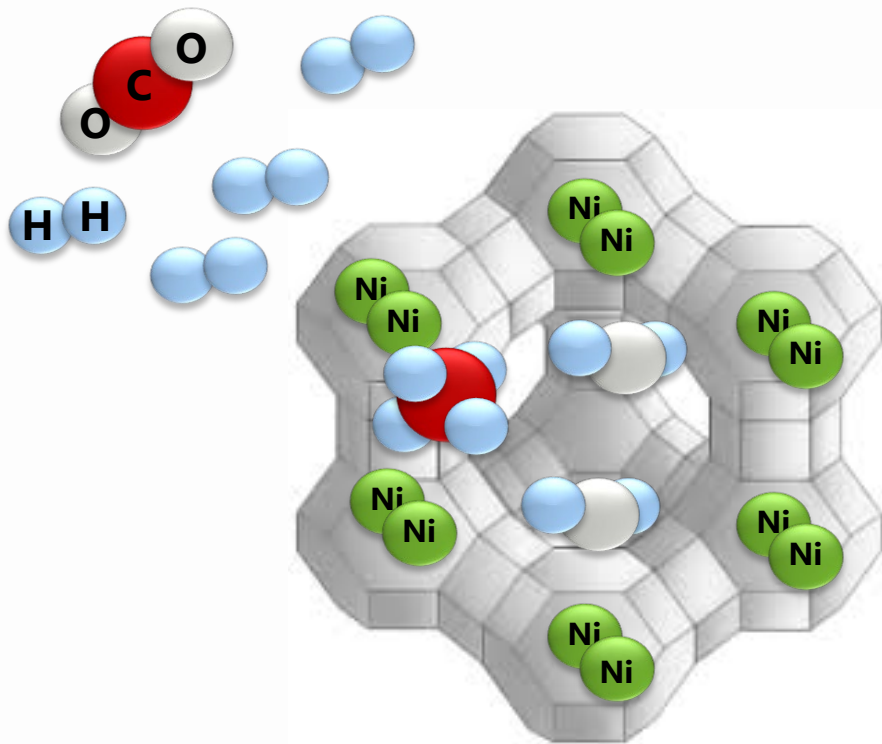
Sorption Enhanced Methanation - SmartCat



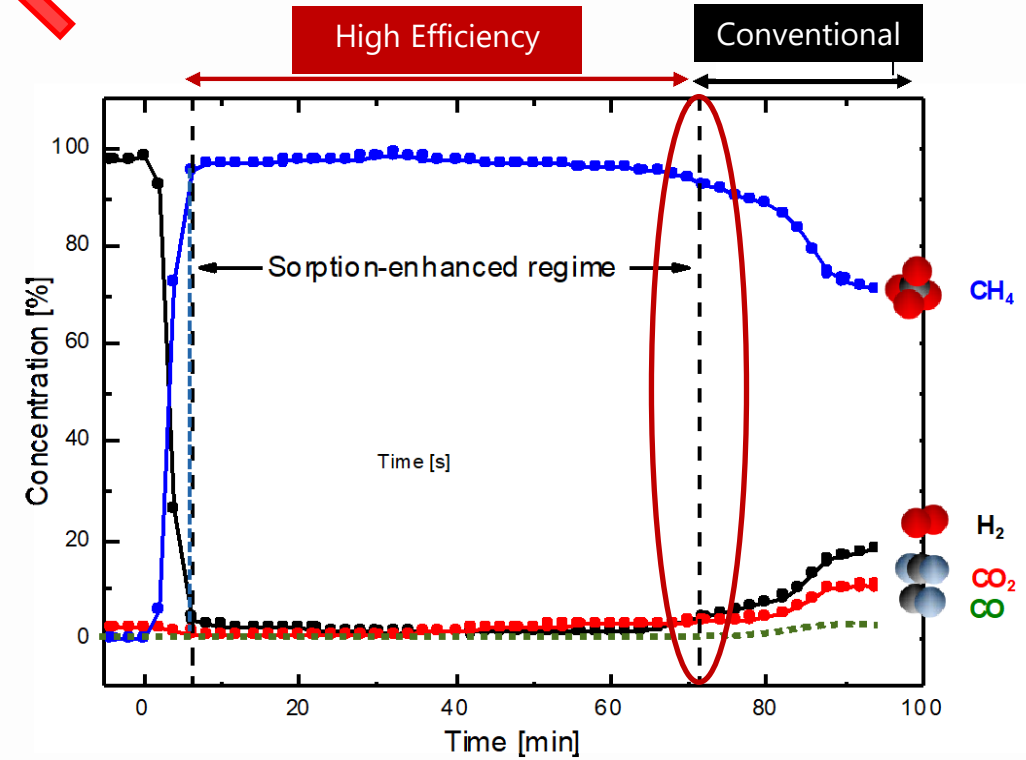
SmartCat
Smart Catalyst



Cheshire Cat



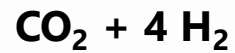
Nickel - Zeolite



100% Biomethane & no byproducts!

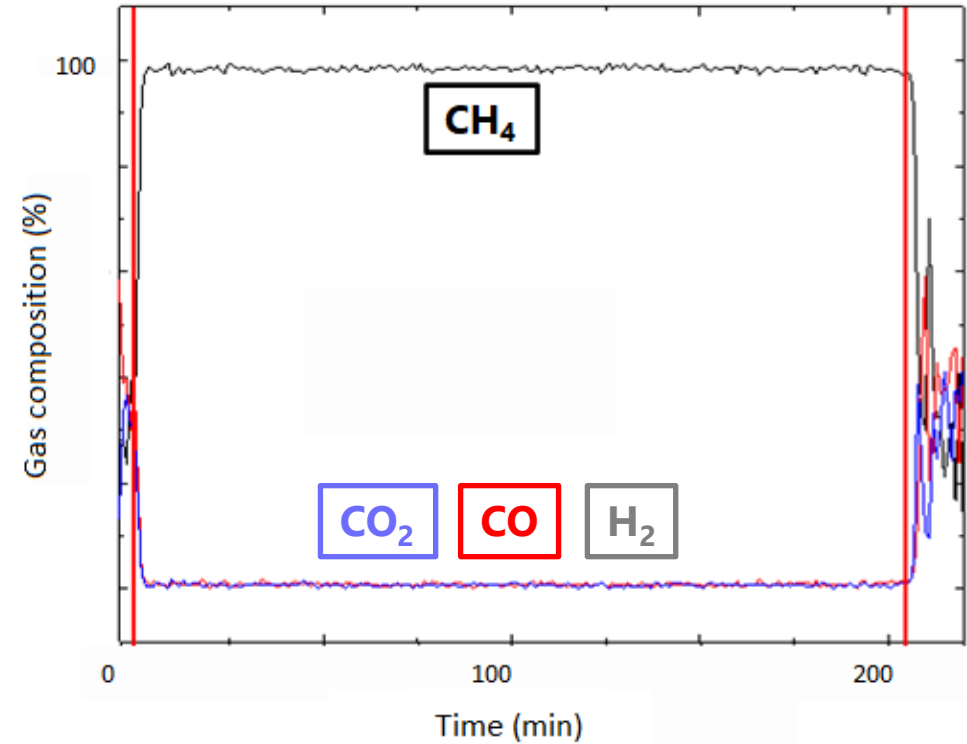
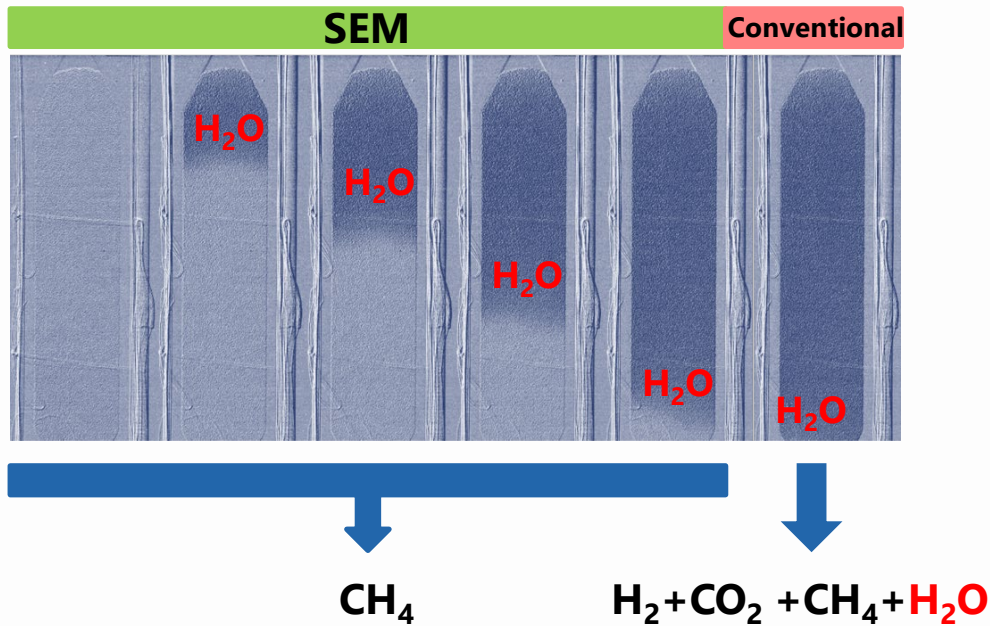
SmartCat*

SmartCat «catches» the water shifting the reaction to the product side with 100 % CO₂ Conversion



Time resolved neutron imaging

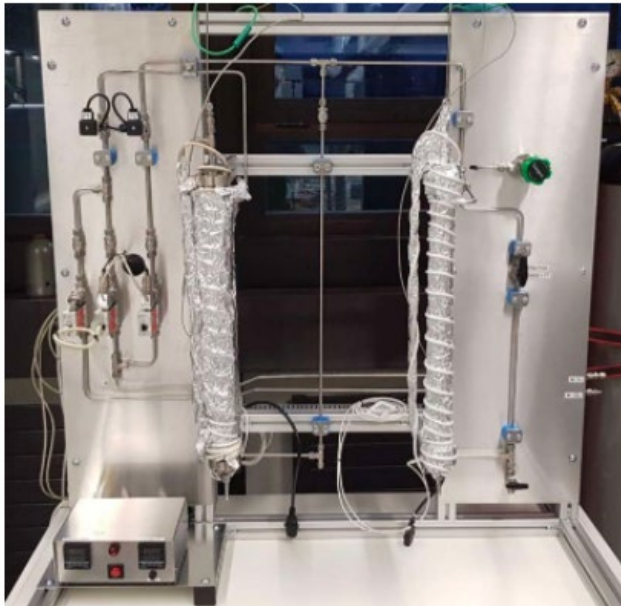
Sorption



- 100% CO₂ conversion
- 100% selectivity to CH₄
- No secondary products (CO, C_xH_y)

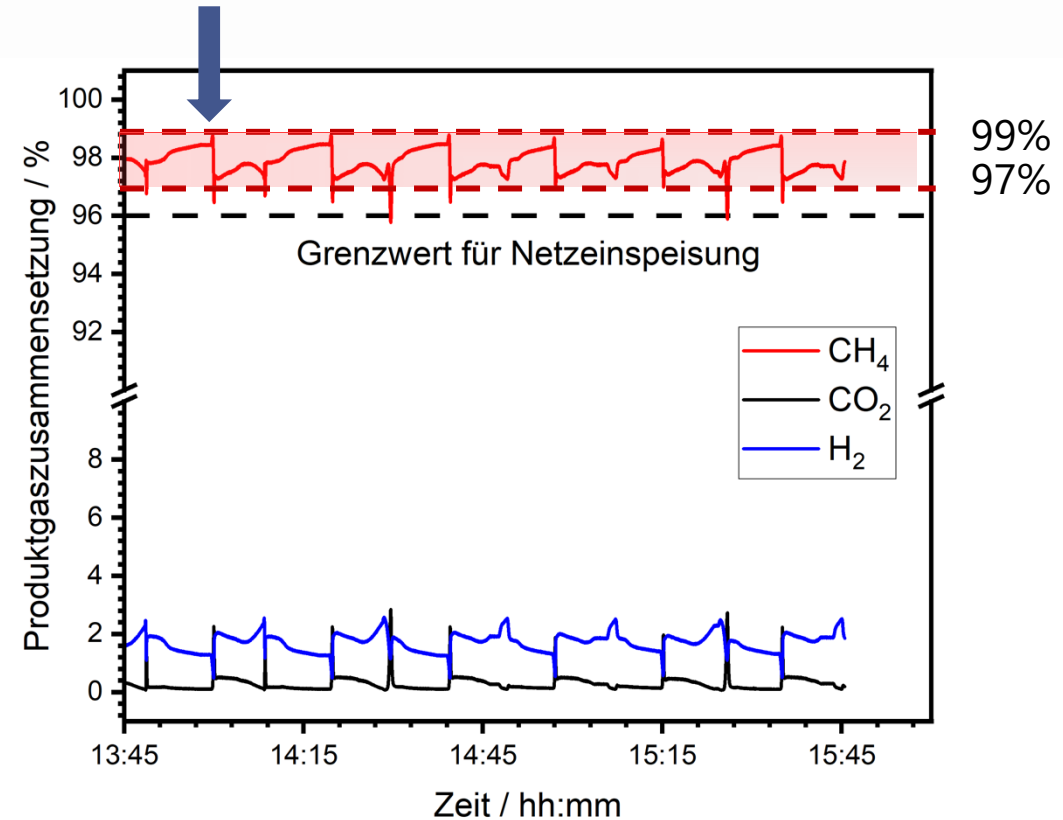
GASEM* project

Twin-reactors equipped with **mems^{AG}** sensors



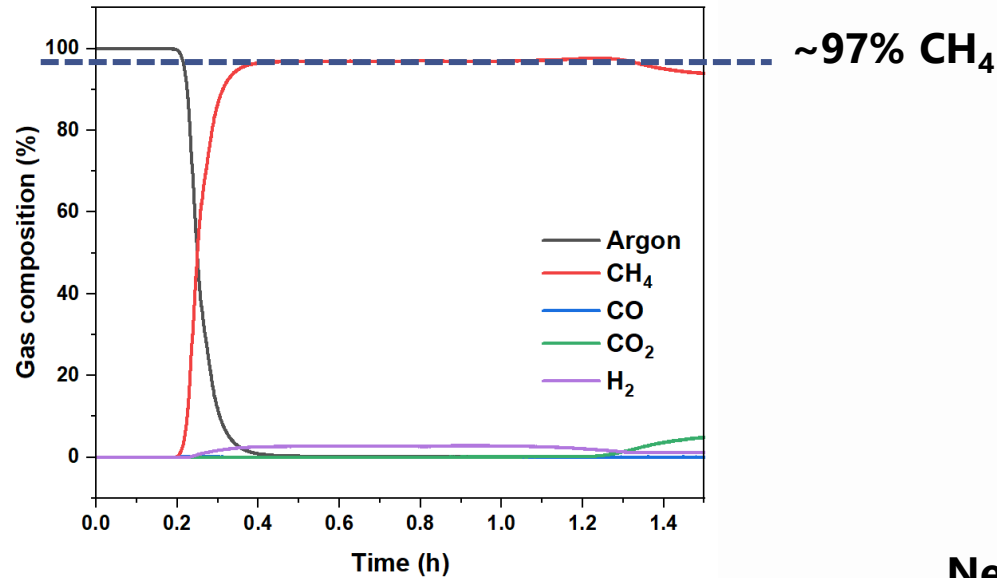
**Simultaneous
Methanation and Regeneration**

Sensor triggers the reactor switch



**Automated SEM unit (twin-system) allows
continuous production of high quality
biomethane (99-97%)**

10 L reactor developed with our partner Fluitec



Methanation results in gas composition versus time.
Catalyst: Ni13X. Conditions: T=300°C, 1bar, GHSV~ 100 h⁻¹

Testing the SmartCat under realistic conditions



**New reactor design “hotspots-free”
(Patent submitted)**

**«Industry-ready»
Scalable up to D=2 m**

Better understanding of operational parameters

Innovative reactor with accurate temperature control ($\Delta T < 5K$)



SmartCat technology status

...

From the LAB

to

HEPP

Industry



Material is functional



Twin-reactor system



Hotspot-free reactor

Process development:

AUTOMATION + HIGH EFFICIENCY

Installation site

*In parallel: development of Nickel-free materials (environmental friendly Iron-based materials)

SmartHife²



THANK YOU FOR YOUR ATTENTION!!!

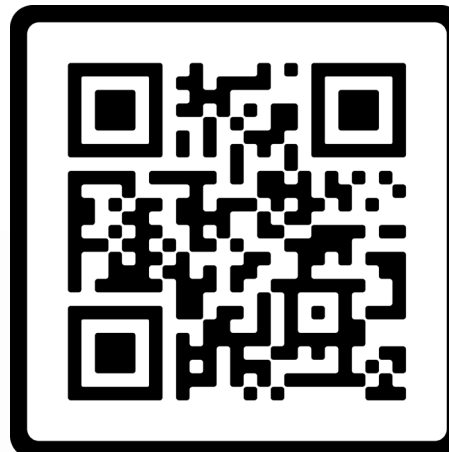


Advanced **M**aterials and **P**rocesses group

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Delmelle, R., Terreni, J., Remhof, A., Heel, A., Proost, J. & Borgschulte, A. (2018): Evolution of Water Diffusion in a Sorption-Enhanced Methanation Catalyst. *Catalysts* 8, 341, doi:10.3390/catal8090341.

Kirchner, J., Anolleck J. A., Lösch H., Kureti S. (2018): Methanation of CO₂ on iron based catalysts. *Applied Catalysis B: Environmental* 223, 47, doi: 10.1016/j.apcatb.2017.06.025.

Franken, T., Heel A. (2020): Are Fe based catalysts an upcoming alternative to Ni in CO₂ methanation at elevated pressure?. *Journal of CO₂ Utilization* 39, 101175, doi:10.1016/j.jcou.2020.101175.