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OBIWAN

Electrothermal Fluidized-Bed Reactor Technology for Carbon-Assisted Electrified Hydrogen Production

Simon De Langhe¹

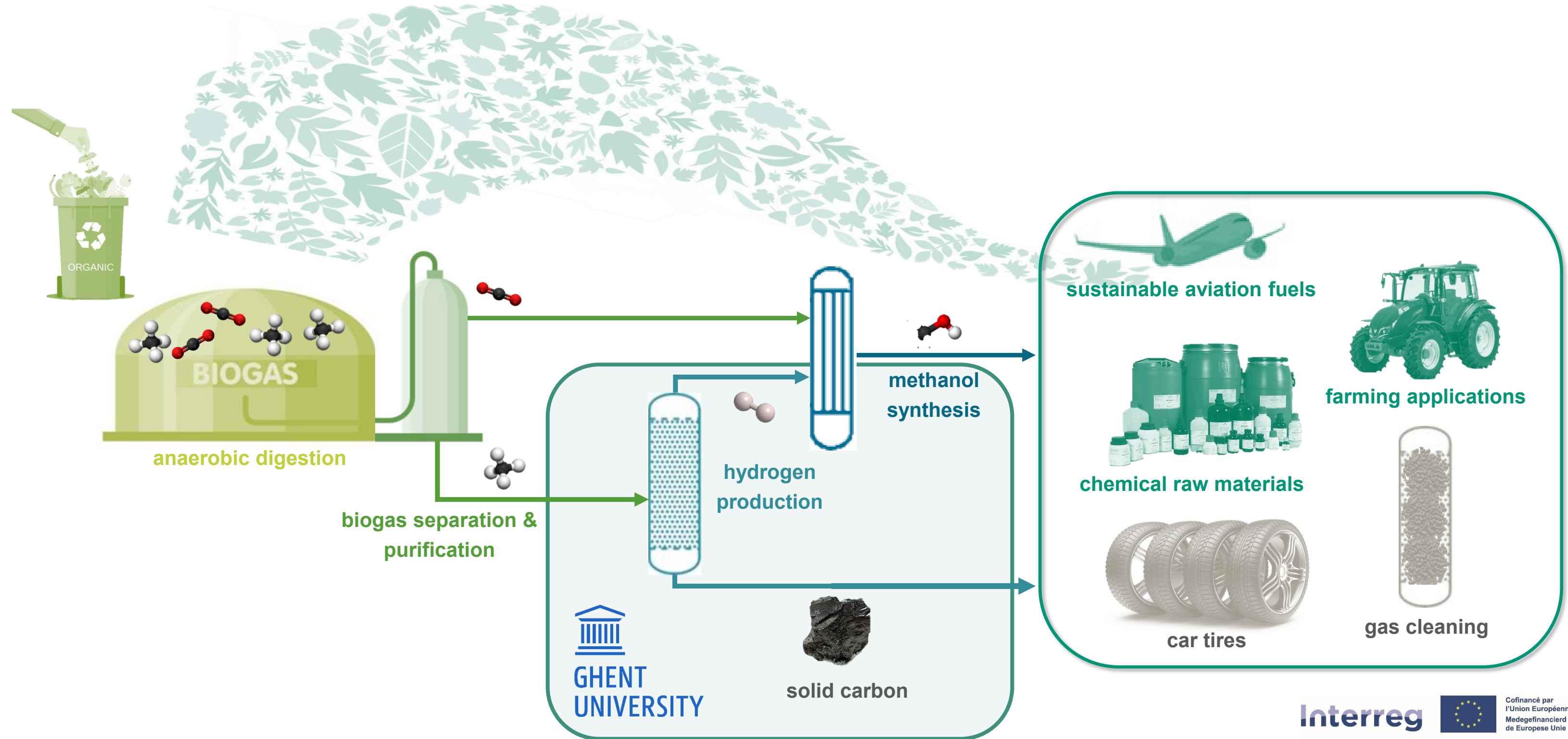
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30th April 2026



OBIWAN concept



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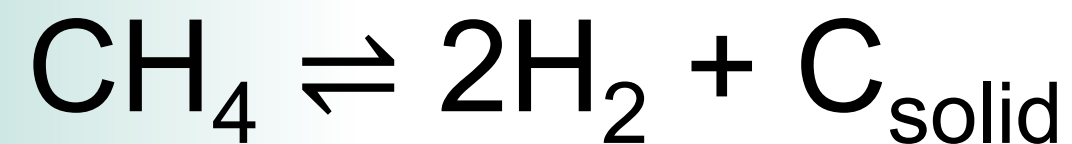
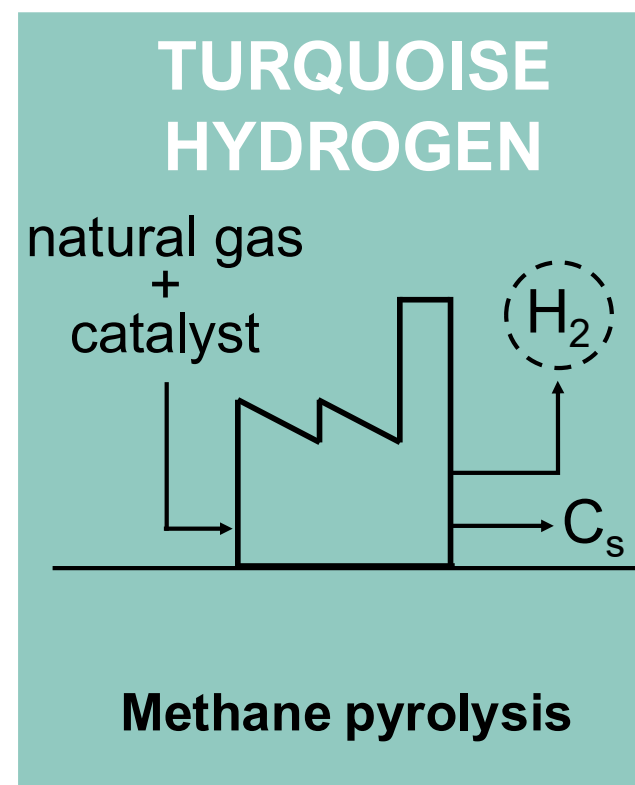
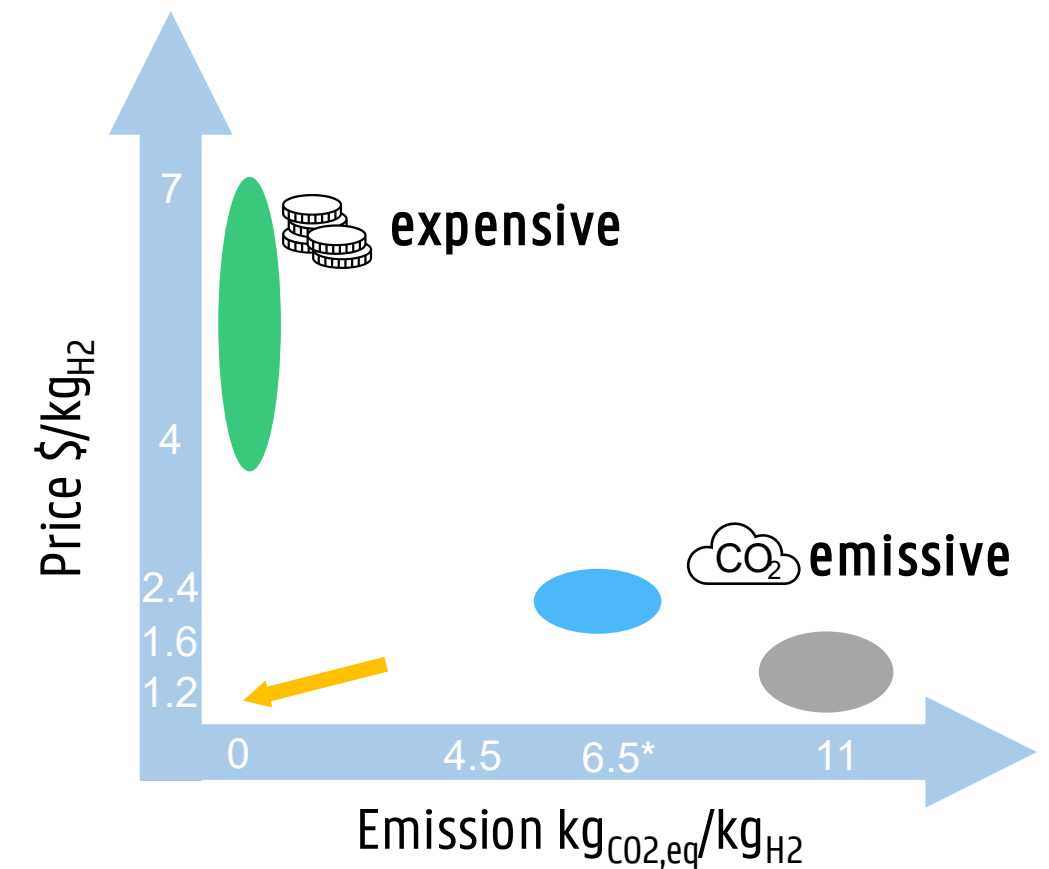
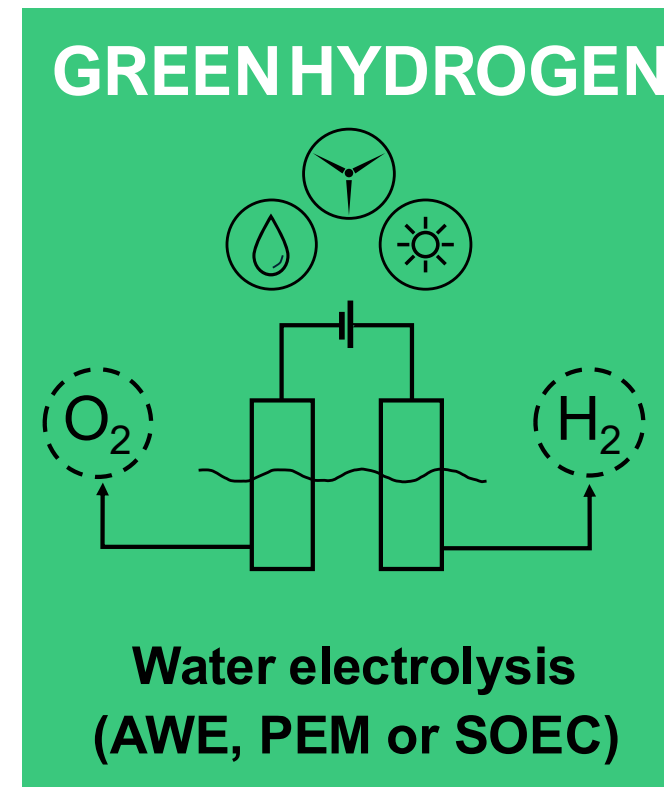
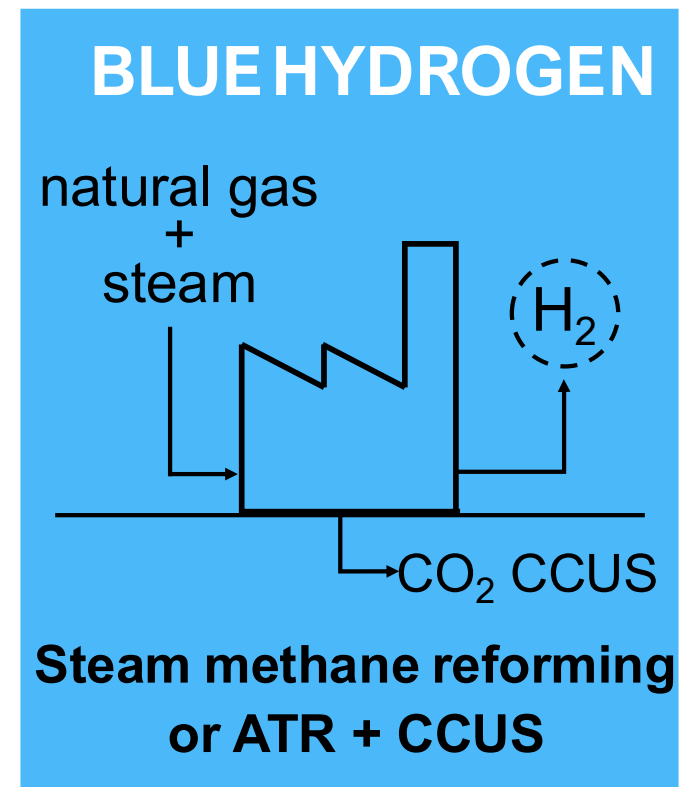
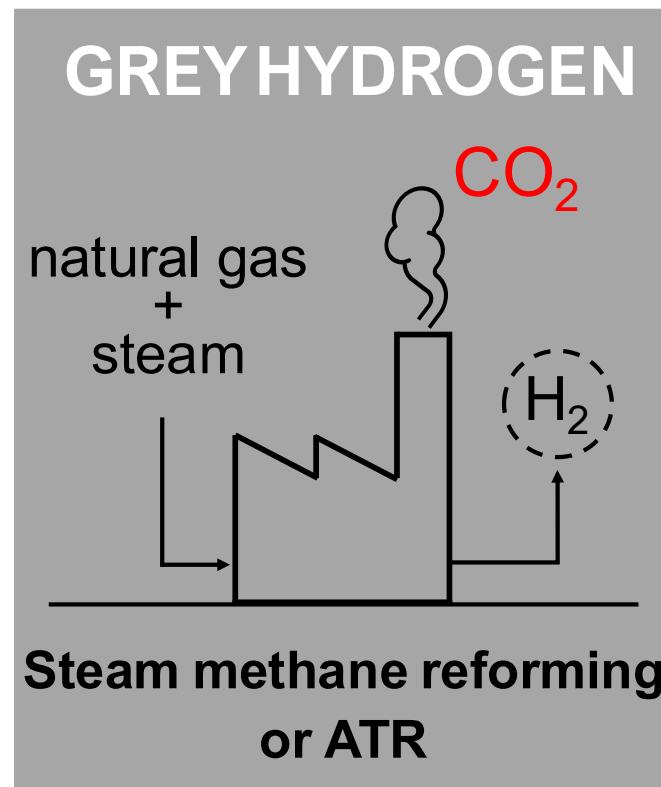
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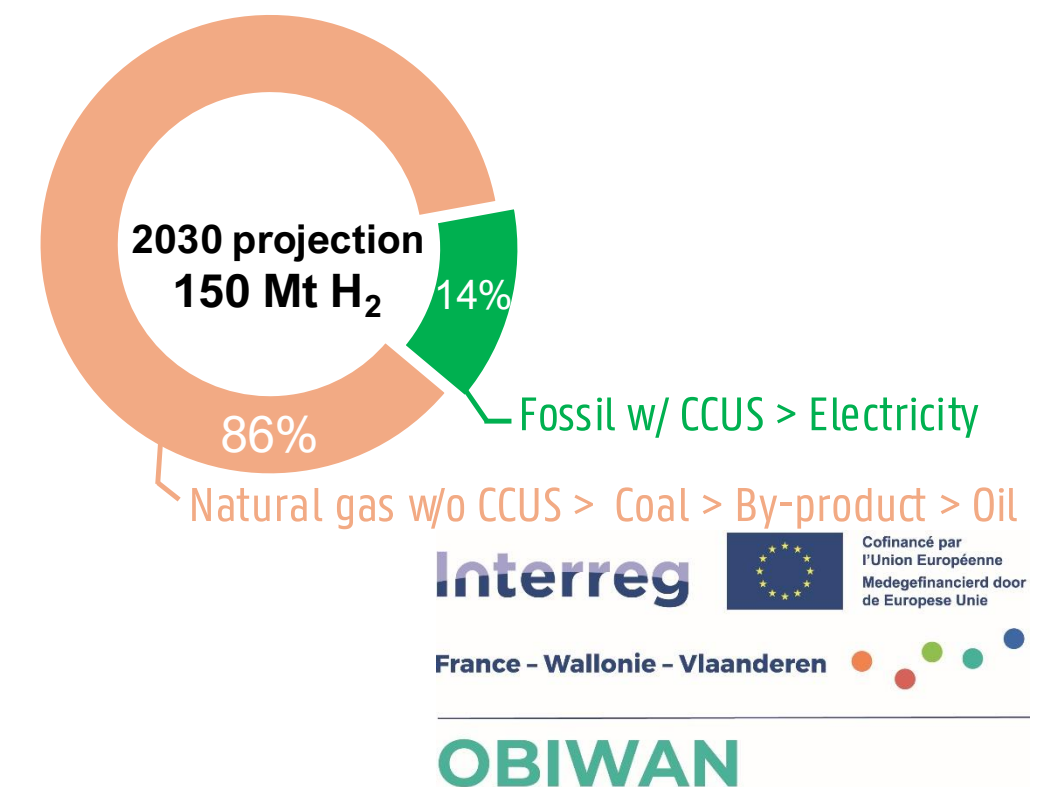
Hydrogen and carbon from biomethane

(N. Sánchez-Bastardo et al., Ind. Eng. Chem. Res. 2021, 60)
(A.O. Oni et al., Energy Convers. Manag. 2022, 254)
85% onsite emissions captured
(IEA (2025), Global Hydrogen Review 2025)



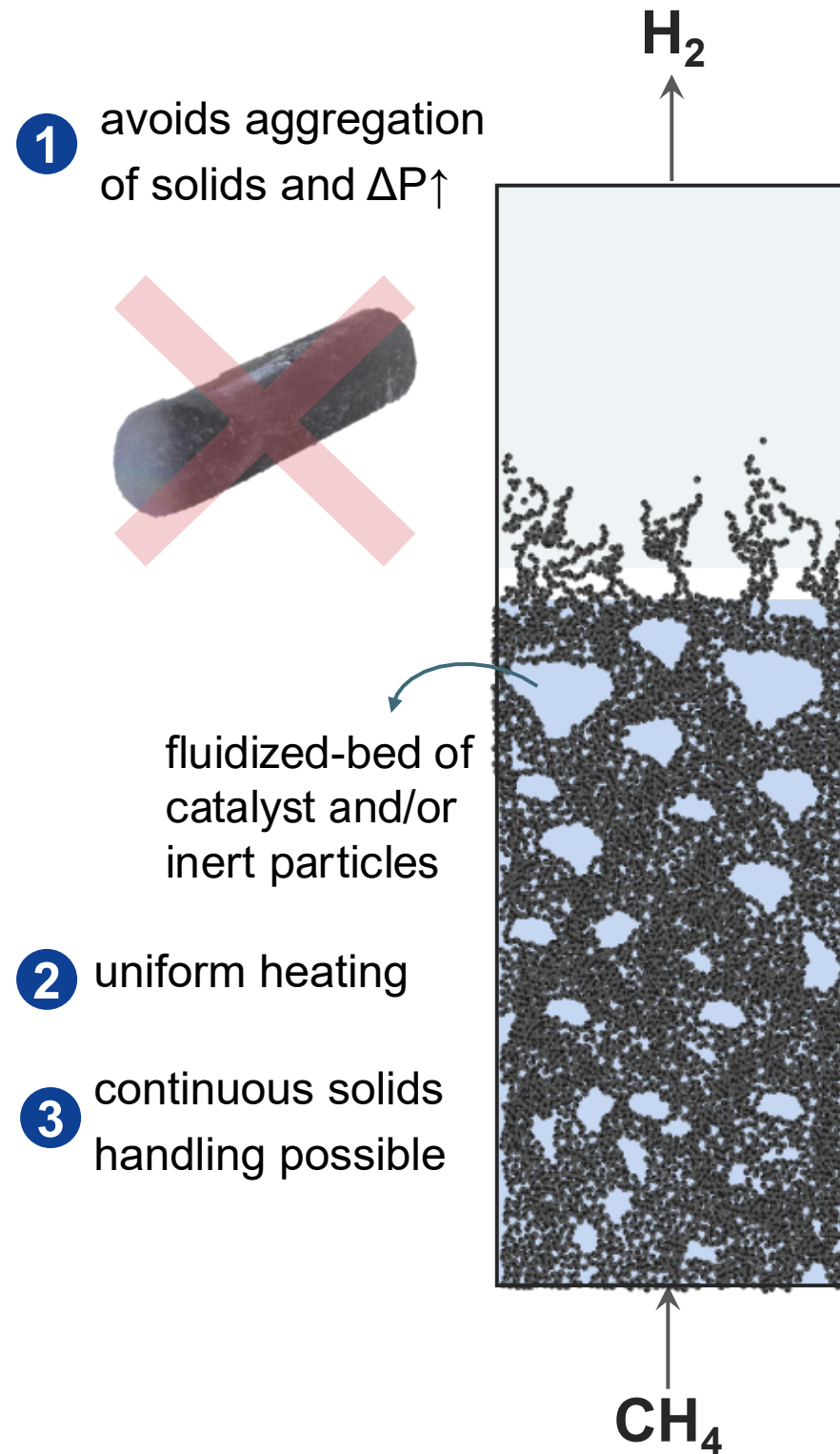
$$\Delta H_{298\text{K}} = 37.7 \text{ kJ/mol}_{\text{H}_2}$$

carbon ↔ metal catalyst

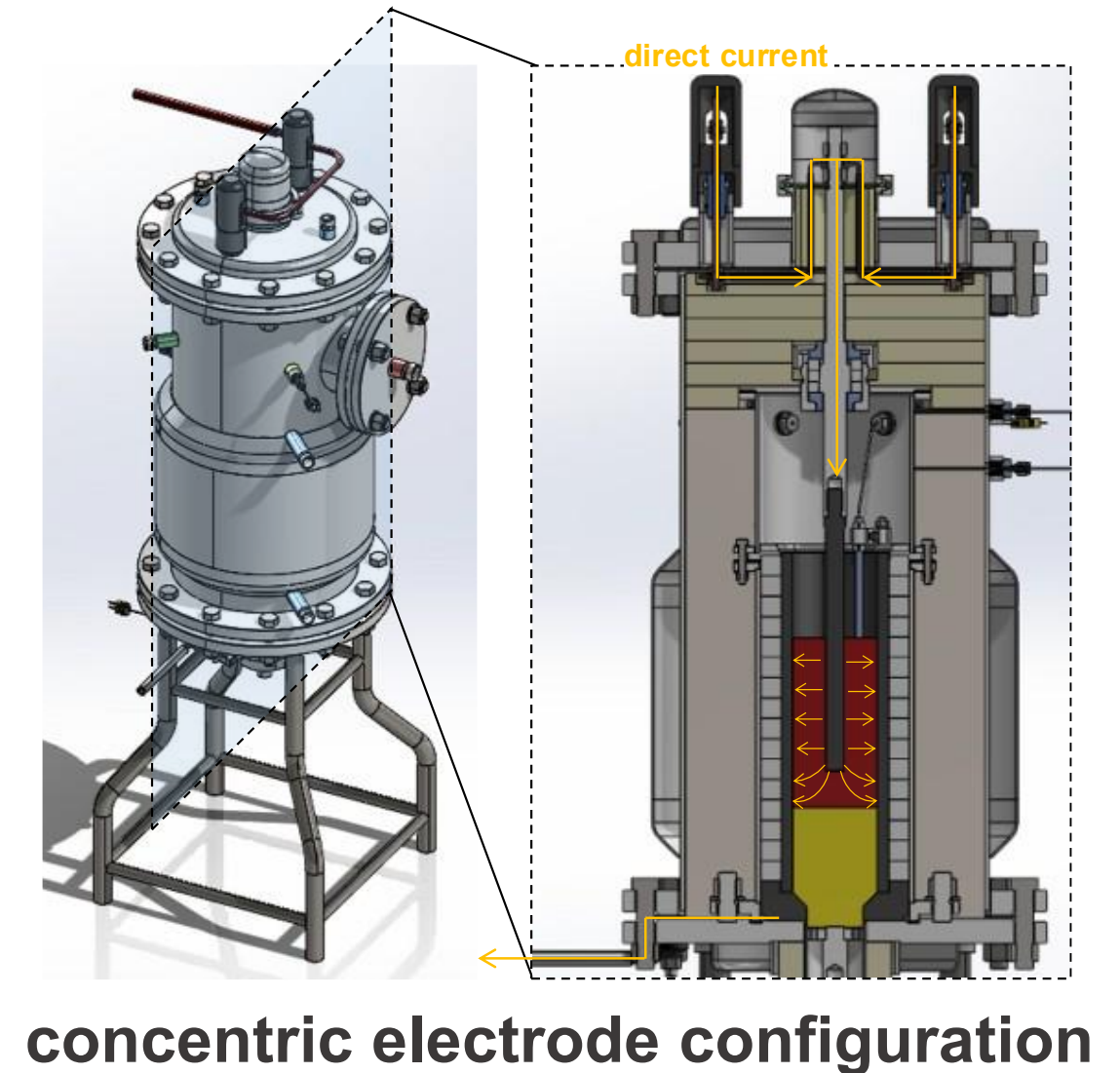
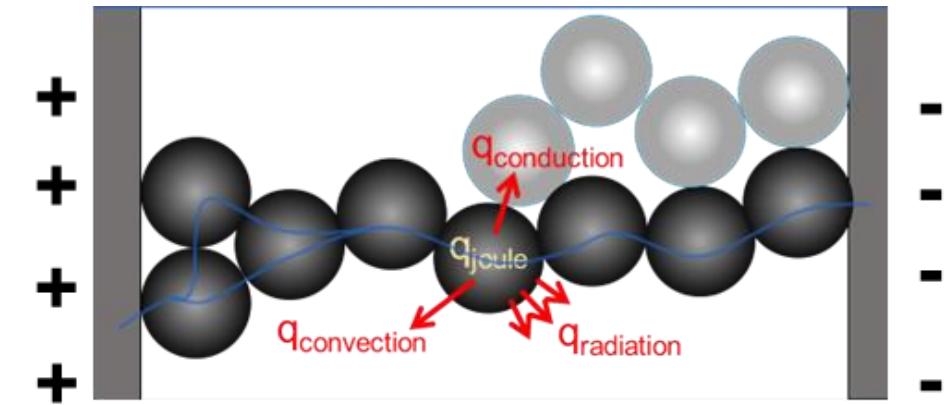
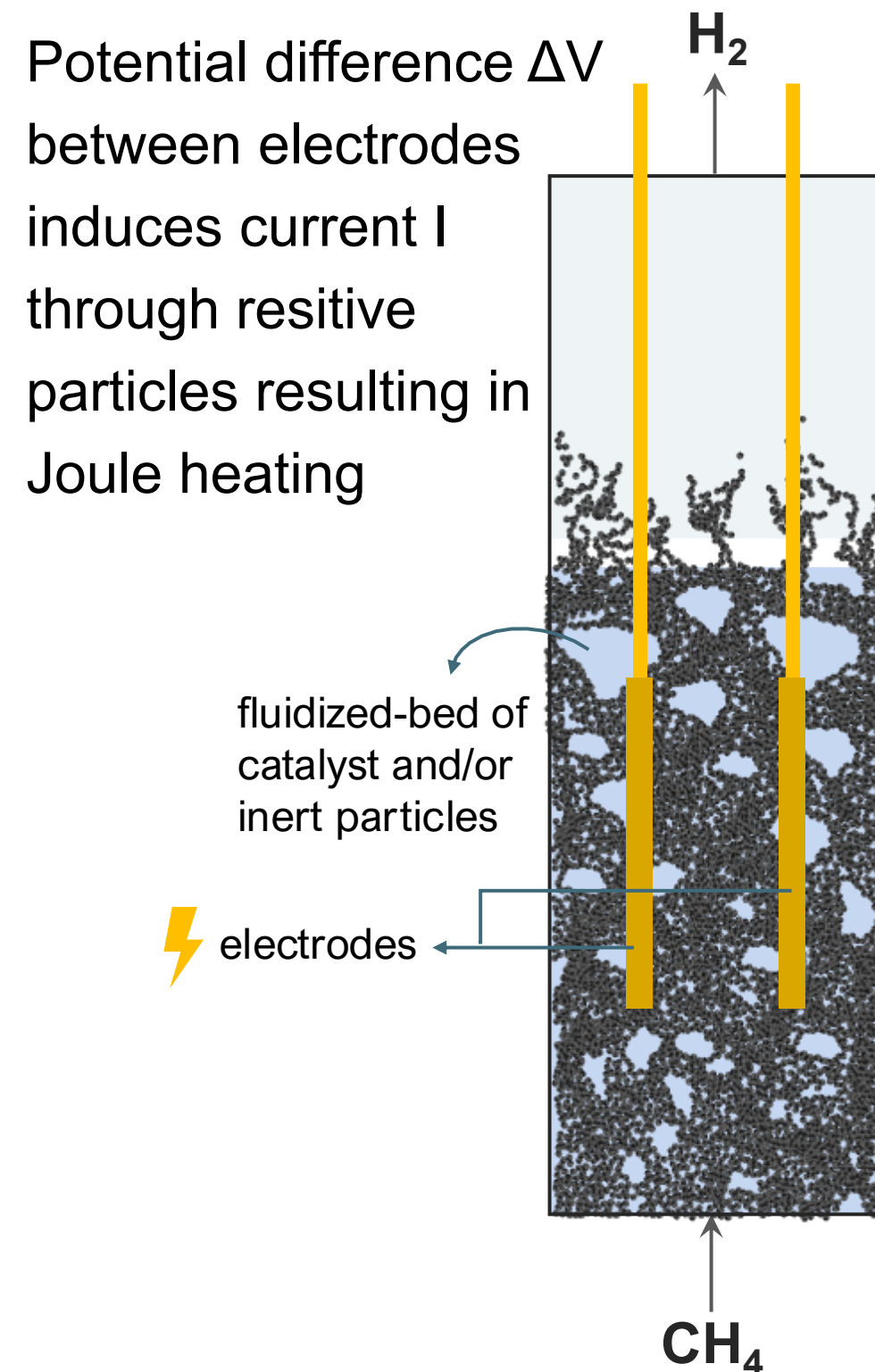


Electrothermal Fluidized-Bed Reactor (ETFB)?

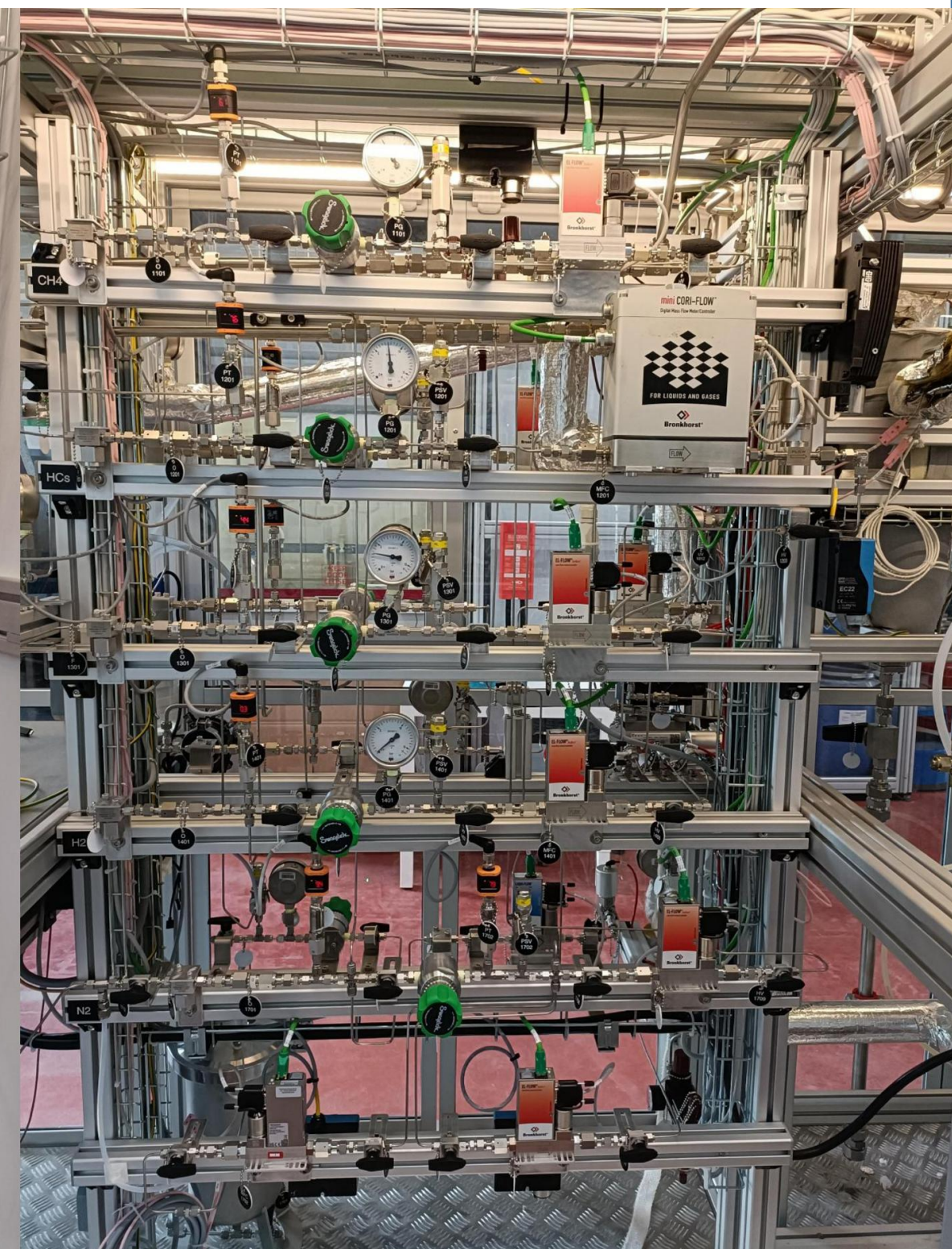
FLUIDIZATION OF CATALYST



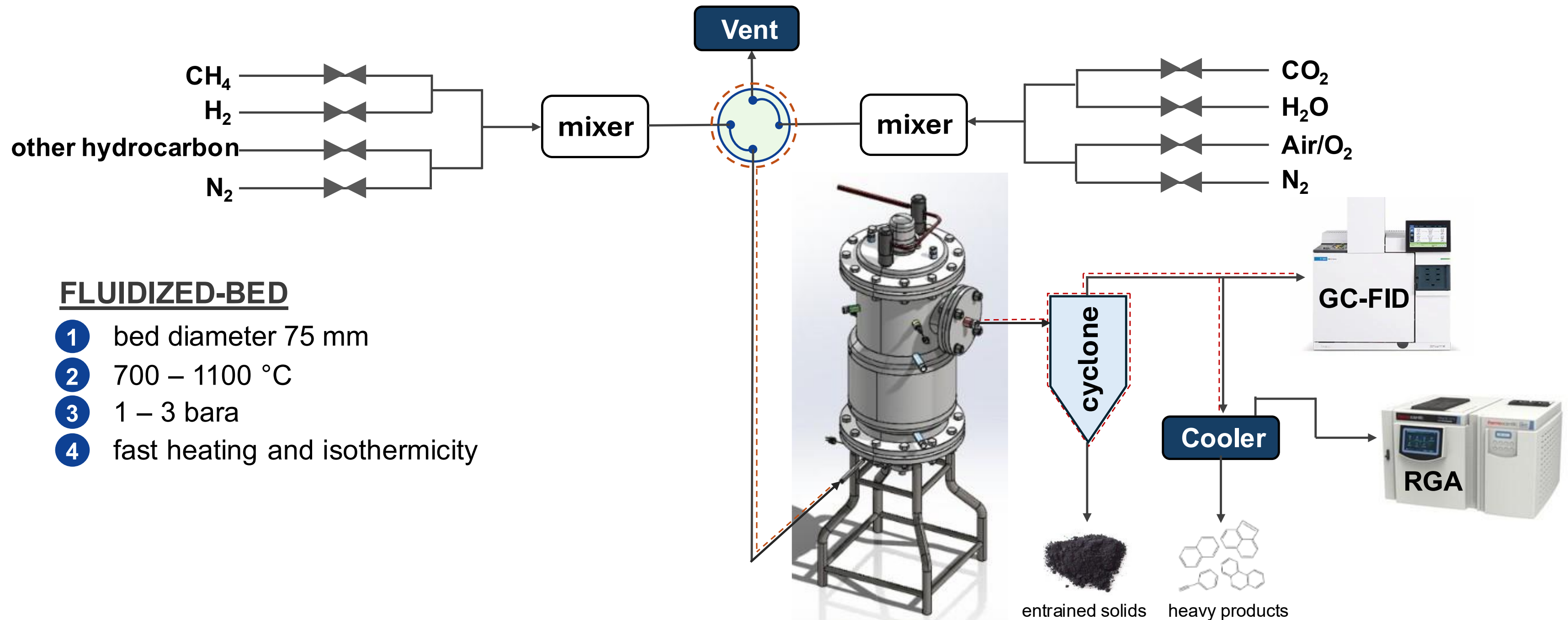
ELECTRICAL HEATING THROUGH JOULE EFFECT



Electrothermal Fluidized-Bed Reactor unit



ETFB unit block flow & process schematic



FLUIDIZED-BED

- 1 bed diameter 75 mm
- 2 700 – 1100 °C
- 3 1 – 3 bara
- 4 fast heating and isothermicity

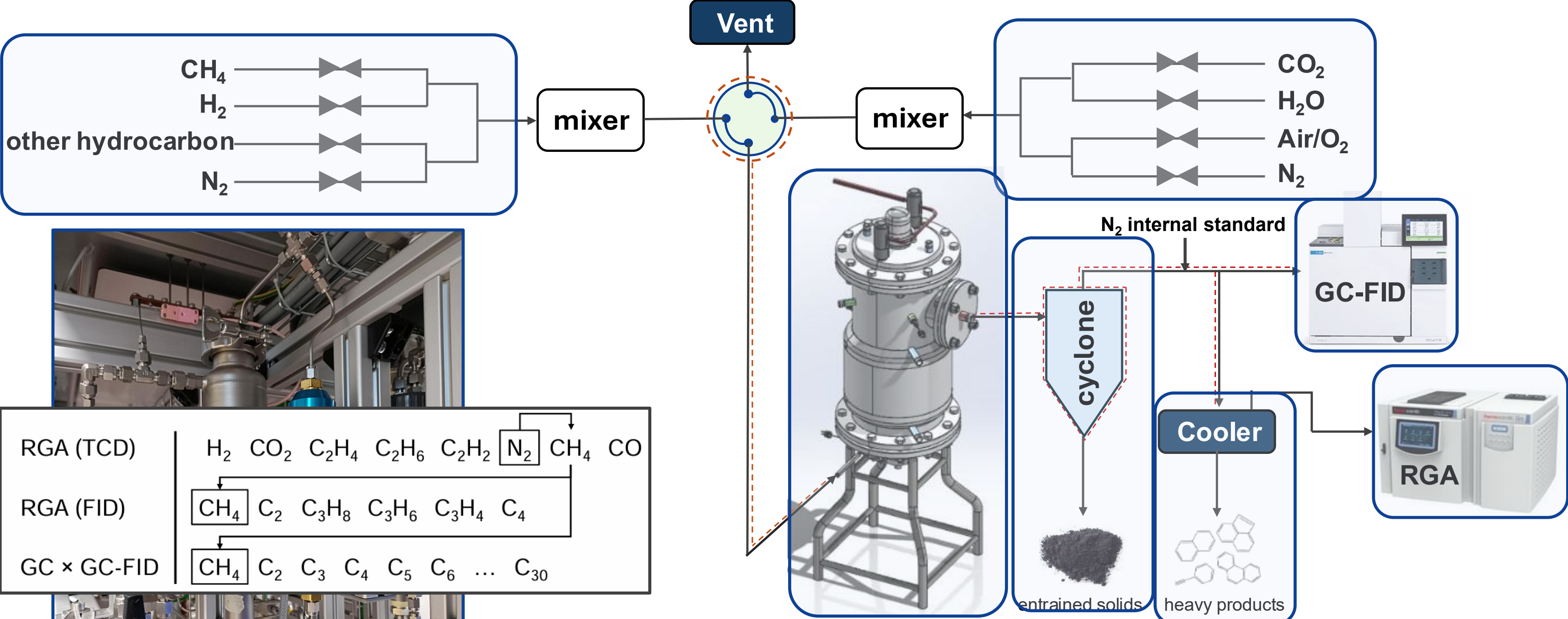
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ETFB unit block flow & process schematic



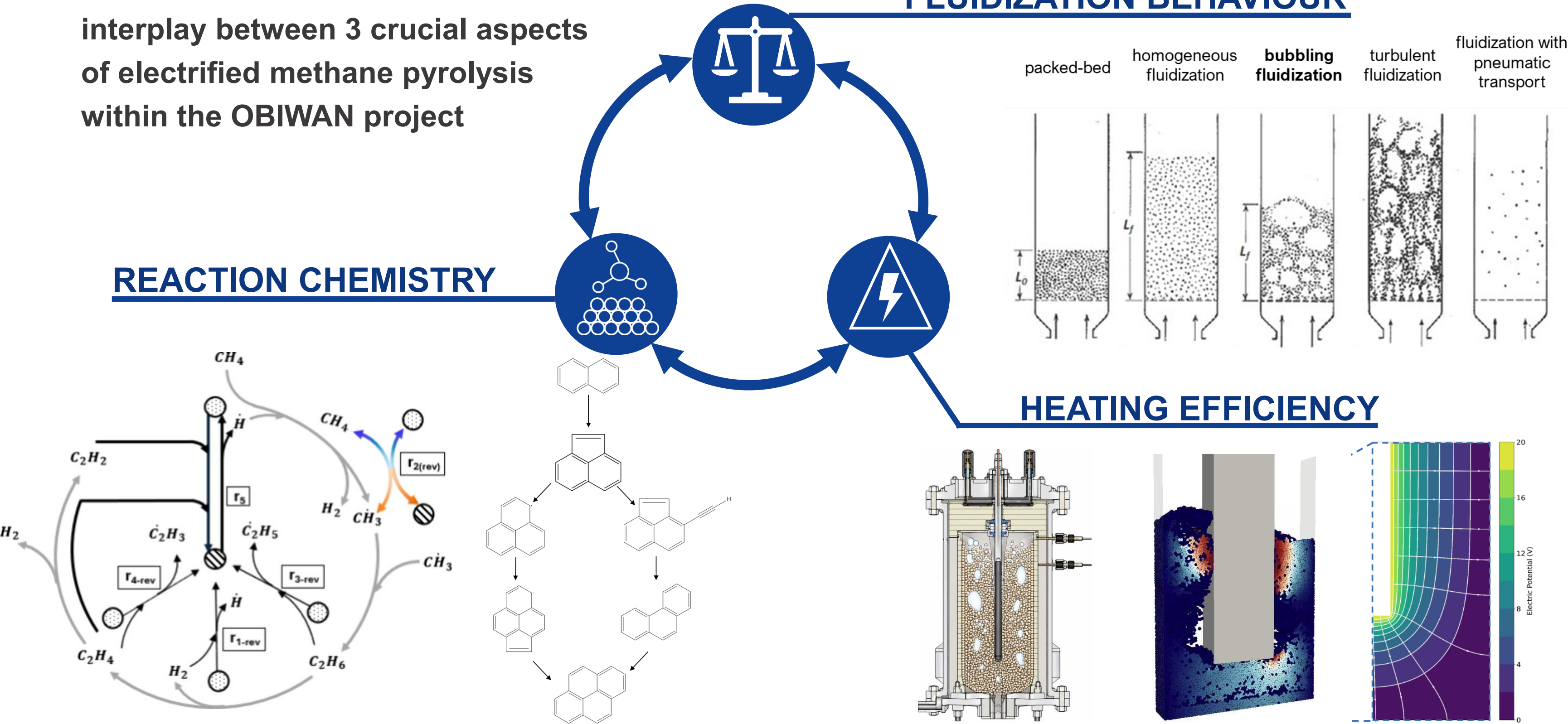
Electrothermal Fluidized-Bed Reactor (ETFB)

ETFB unit allows to determine the interplay between 3 crucial aspects of electrified methane pyrolysis within the OBIWAN project

FLUIDIZATION BEHAVIOUR

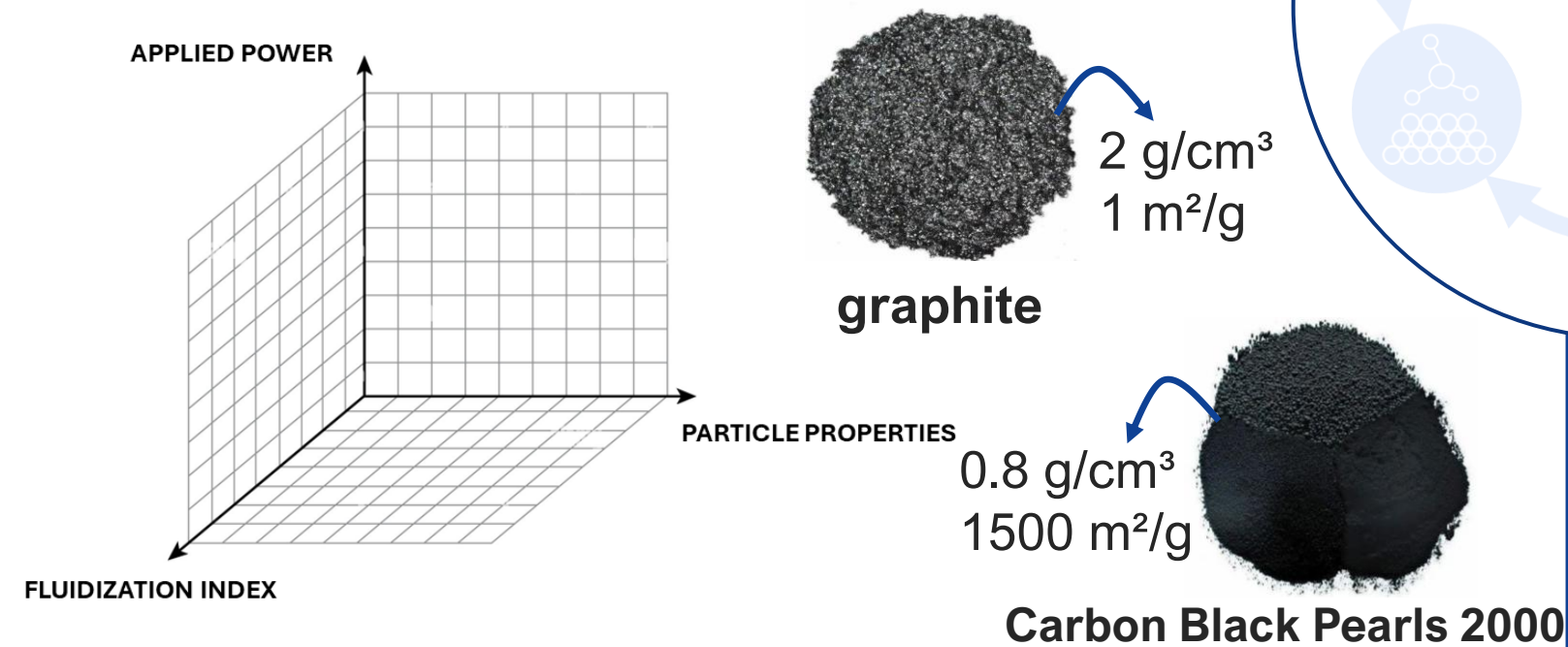
REACTION CHEMISTRY

HEATING EFFICIENCY



Experiments in ETFB unit non-reactive vs. reactive

NON-REACTIVE TESTING



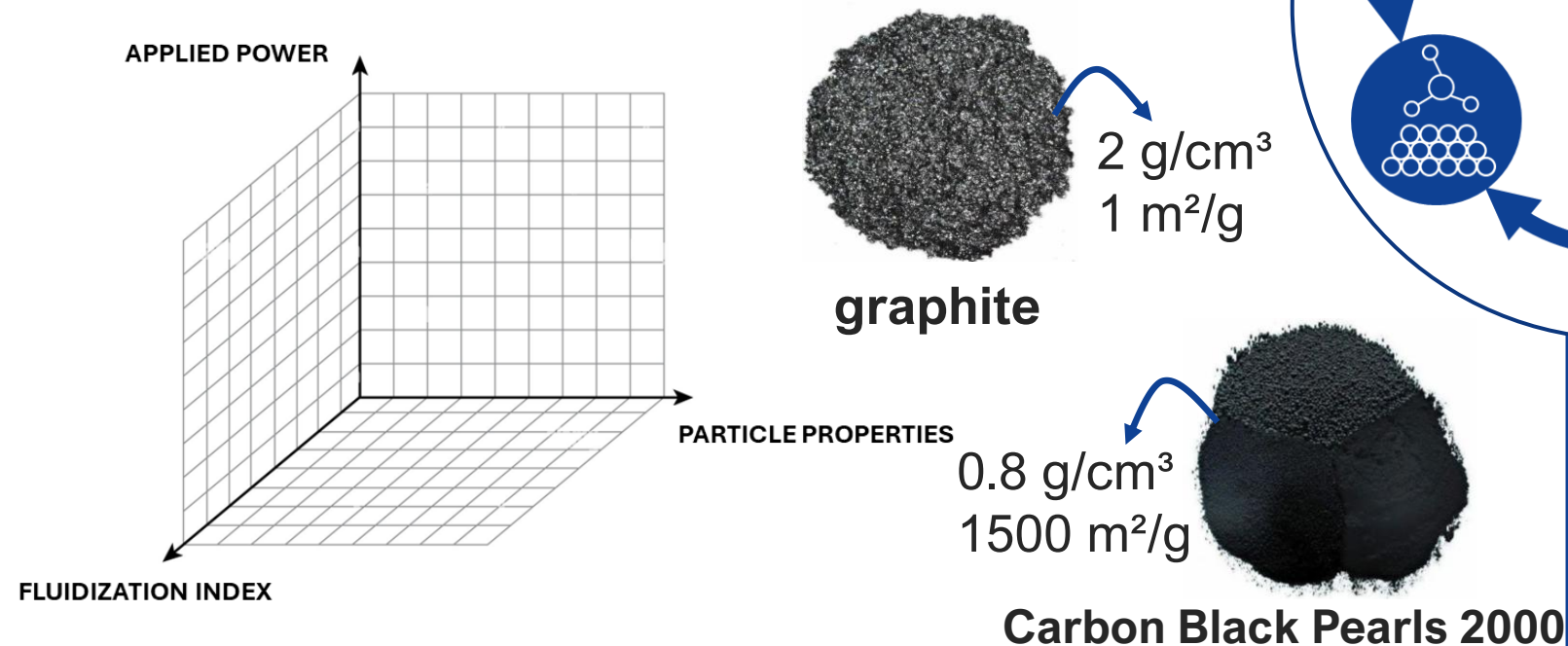
experiments at varying conditions

- ⚖ fluidization index $FI = \frac{U}{U_{mf}} = 2 \rightarrow 4$
- ⚖ applied power $Power = 0 \rightarrow 7 \text{ kW}$
- ⚡ particle properties (density, diameter)

$$\rho_{bed} = f(T, p, Power, \rho_{solid}, d_{solid}, FI)$$

Experiments in ETFB unit non-reactive vs. reactive

NON-REACTIVE TESTING

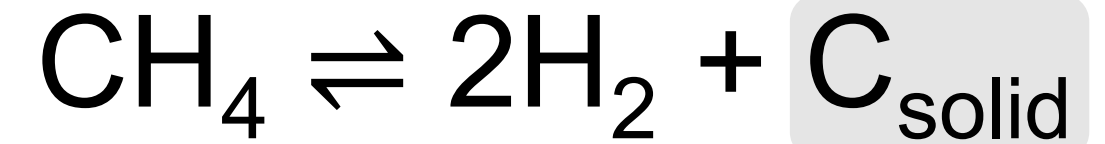


experiments at varying conditions

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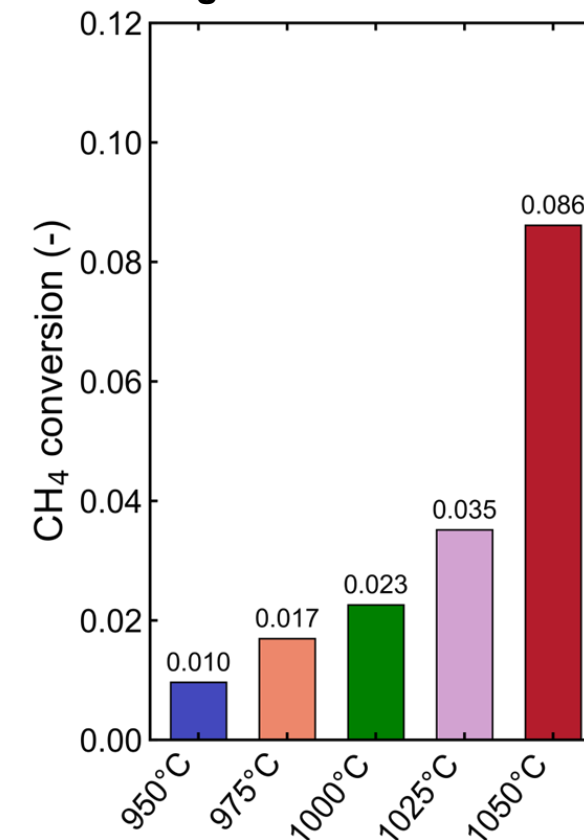
$$\rho_{bed} = f(T, p, Power, \rho_{solid}, d_{solid}, FI)$$

REACTIVE TESTING



- deposition carbon (acetylene) on carbon catalyst
- formation of polyaromatic hydrocarbons and soot

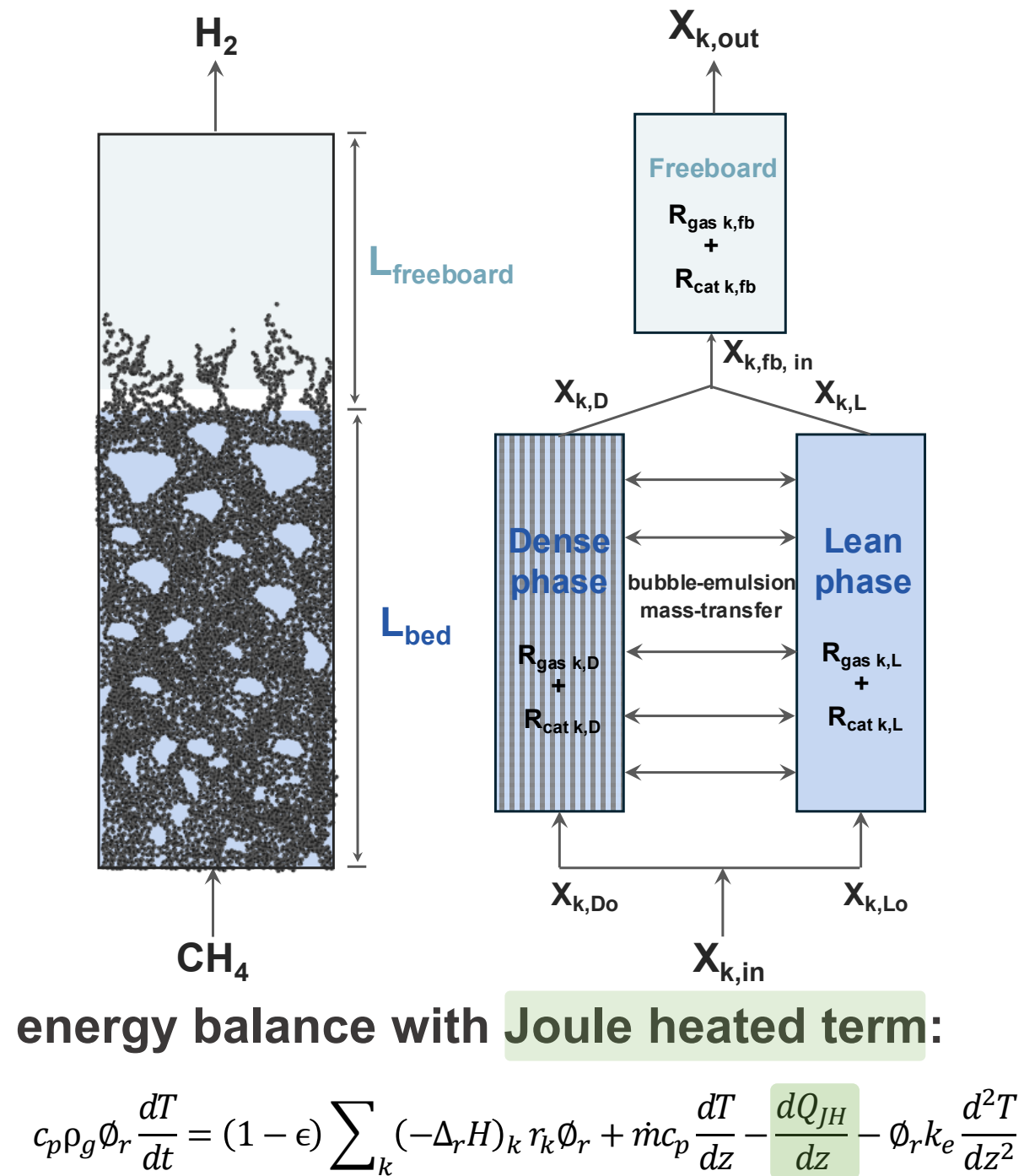
effect of heating and fluidization on H₂ yield?



- change particle diameter
- change carbon structure
 - graphitic
 - amorphous
- agglomeration/attrition to dust formation
- fouling of electrodes

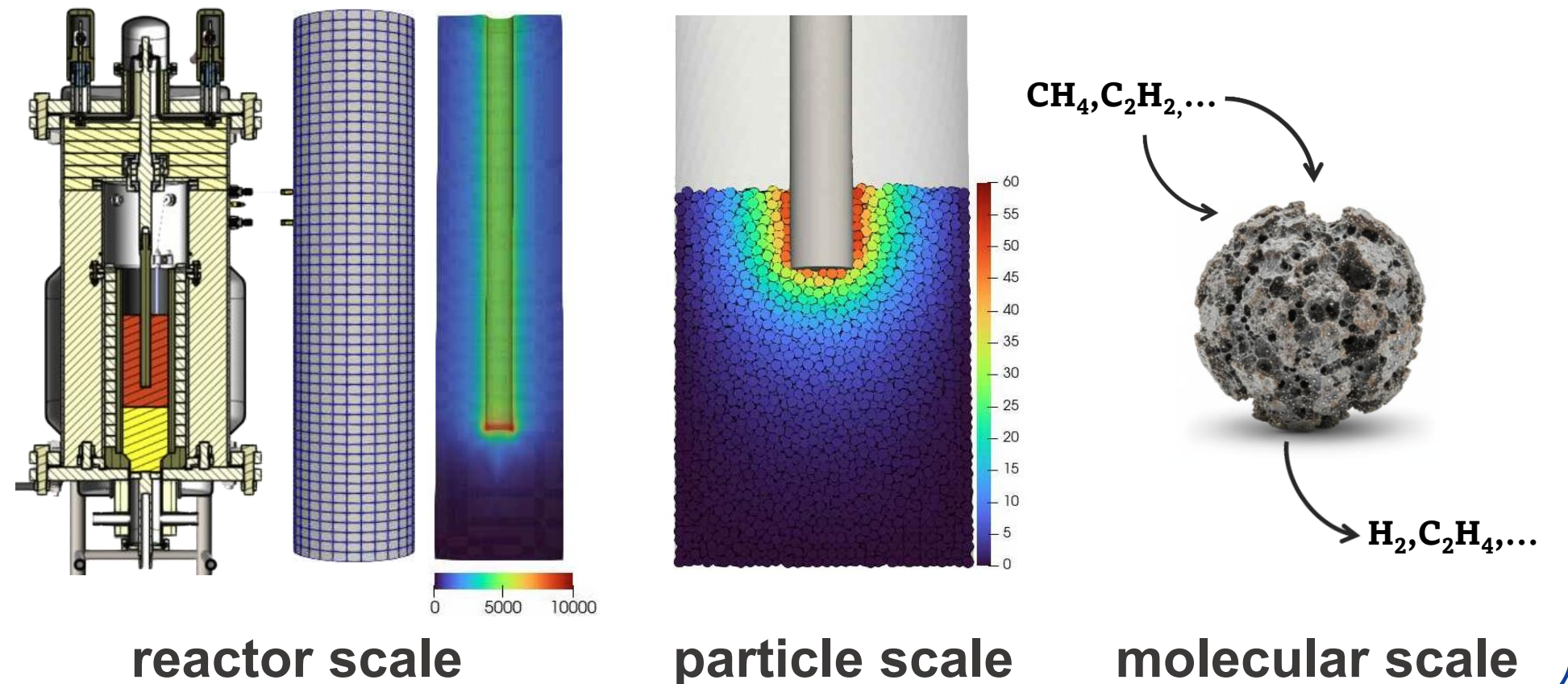
From laboratory- to industrial scale

1D TWO-PHASE FLUIDIZED-BED MODEL



CGDEM-CFD MODEL OF ETFB UNIT

- 1 built a coupled multiphysics
- 2 validation of Joule-heated fixed-bed reactor
- 3 validation of pseudo-2D Joule-heated fluidized-bed reactor
- 4 Study of pseudo-2D Joule-heated fluidized-bed reactor
- 5 CGDEM-CFD study of lab-scale ETFB reactor



Ghent University - People



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Acknowledgements



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