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# Characterization of Biogas and Biomethane: Trapping, Analysis and Speciation of Trace Compounds

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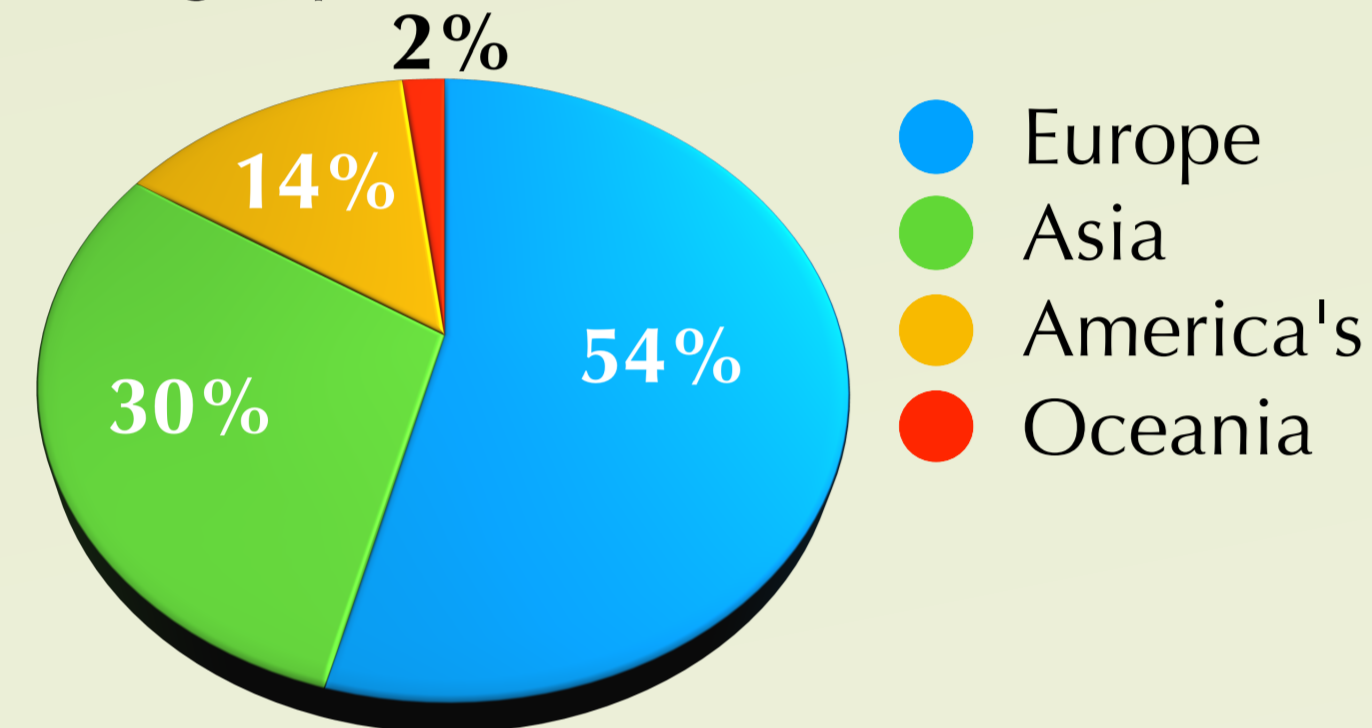
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9th GERG Young Researchers' Awards, EGATEC 2019, 6 – 8 November, Groningen, The Netherlands

## Some numbers

BIOMETHANE (1,2)	NATURAL GAS (3)
≥ 97% CH <sub>4</sub>	70-90 % CH <sub>4</sub>
30-35 MJ/Sm <sup>3</sup>	37.5-40.5 MJ/Sm <sup>3</sup>
GHG emission saving when producing and combusting biomethane compared to NG: <b>218 kg CO<sub>2</sub>-eq/MWh</b> (4,5)	
<b>World production in 2016 (billion Sm<sup>3</sup>)</b>	
BIOGAS (6)	NATURAL GAS (7)
61	3551.6

Biogas production in 2016 (6)



European Union (1,8,9,10)

- > 17400 biogas production plants
- > 400 biogas upgrading plants (biomethane)
- > 1.5 million Sm<sup>3</sup> biomethane injected in NG grid
- > 160 million Sm<sup>3</sup> biomethane for transport fuel

## Methods

Target compounds	Pre-concentration	Quantification and Speciation
(H)VOC oxygenated N-, S-, Si-	Adsorption	TD-GC-MS
Metals	<ul style="list-style-type: none"> <li>Cryotrapping</li> <li>Bubbling                             <ul style="list-style-type: none"> <li>10%<sub>w</sub> HNO<sub>3</sub> / 5%<sub>w</sub> H<sub>2</sub>O<sub>2</sub> for metal(loid)s</li> <li>1%<sub>w</sub> KMnO<sub>4</sub> / 5%<sub>w</sub> H<sub>2</sub>SO<sub>4</sub> for Hg</li> </ul> </li> <li>Chemotrapping</li> </ul>	<ul style="list-style-type: none"> <li>GC-ICP-MS</li> <li>ICP-MS</li> <li>GC-ICP-MS / AFS</li> </ul>

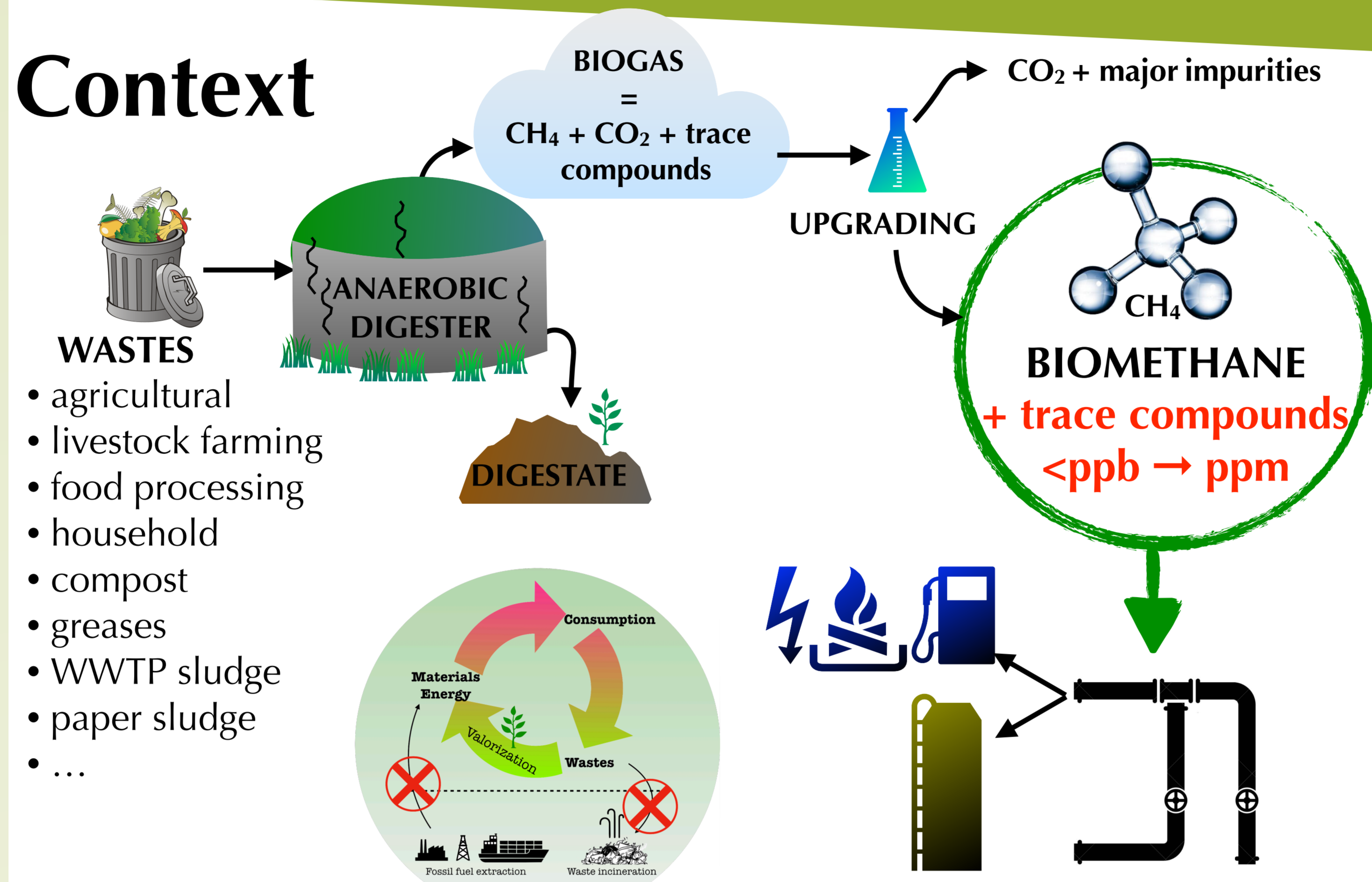
## Biogas & biomethane sampling sites:

- Landfills
- Agricultural waste digesters
- Household waste digesters
- Food waste digesters
- ...
- a.m.a.p. different sites !

## References:

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- Scarlat N. et al. Renew Energy. 2018 Dec;129:457–72
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## Context



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## SECTOR INTEGRATION:

Biomethane must meet the same norms and specifications as NG to be injected in the gas grid

**BUT**

## KNOWLEDGE GAP on trace compounds

- S-, N-, Si-
- (H) VOC
- Oxygenated organic compounds
- Metal(oid) compounds

## Impacts ??

- on gas infrastructures
- on environment
- on users

**HENCE**

Need to expand knowledge on biomethane's trace compounds

## Objectives

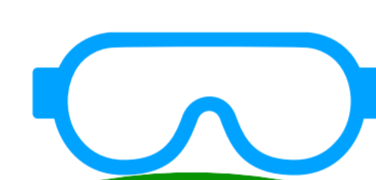
**1**

On site **pre-concentration** of biomethane's trace compounds:

- high pressure
- adsorption** bubbling, cryotrapping, chemotrapping

**2**

Quantification and speciation



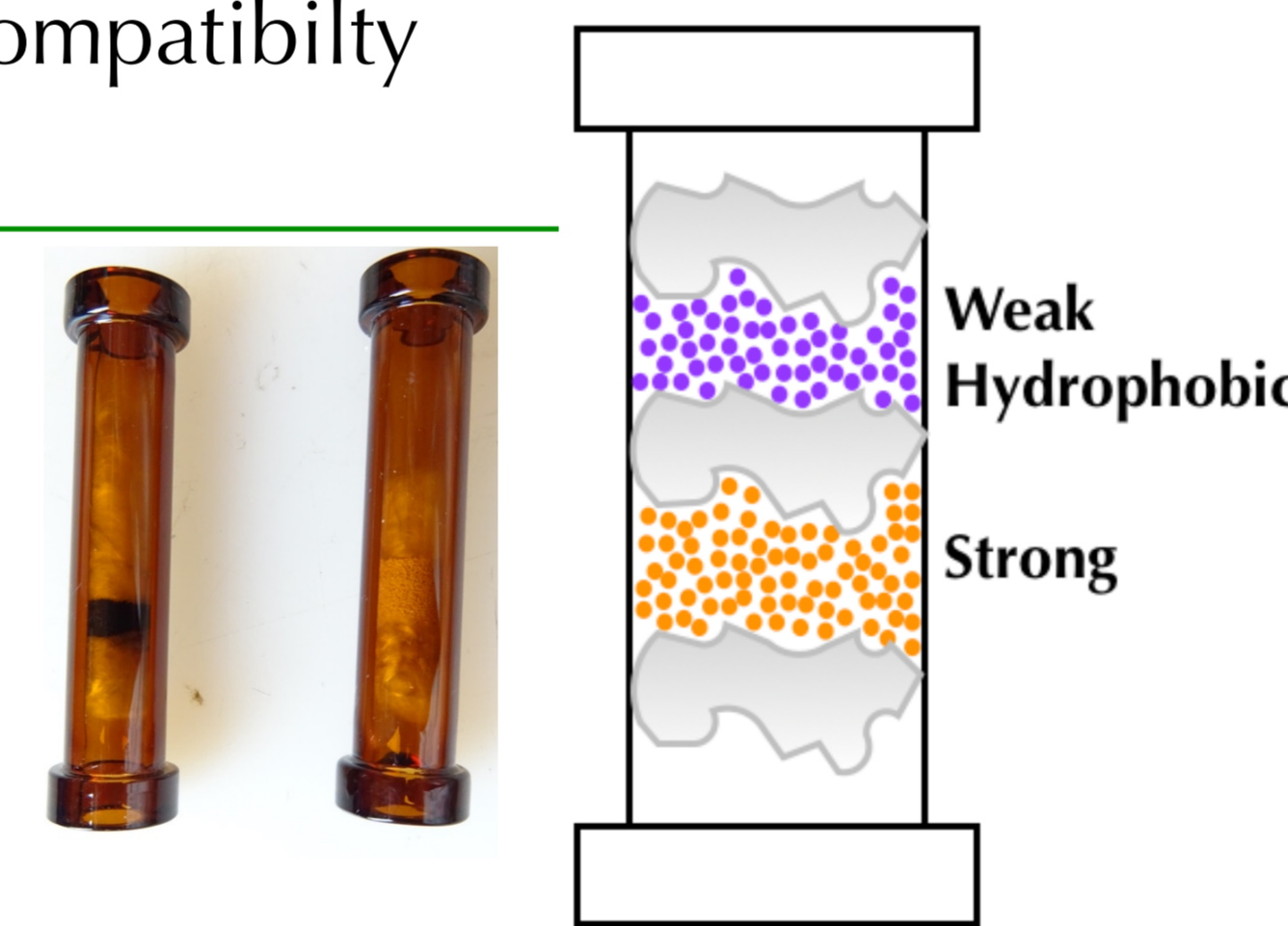
**LAB SCALE OPTIMIZATION:**

Chemically = targeted adsorption

Physically = under pressure ( $\leq 100$  bar)

## Materials and methods: DEVELOPMENT

- Criteria** for pertinent **adsorbent choice**:
  - Quantitative adsorption and desorption
  - Polarity, strength
  - Compatibility thermal desorption
  - Cover all range target analytes (broad volatility range)
- Mutlibeds** self-assembly from A to Z
  - ⚠ T compatibility

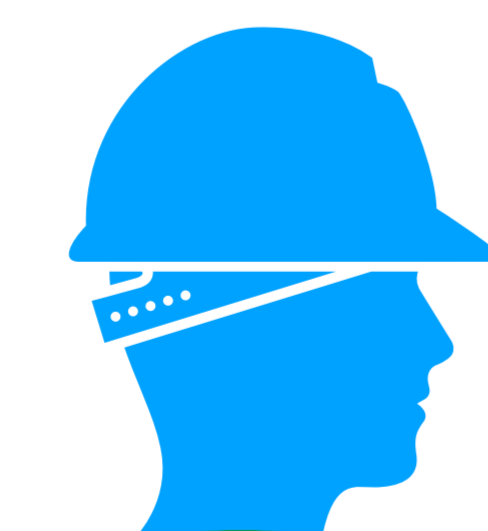
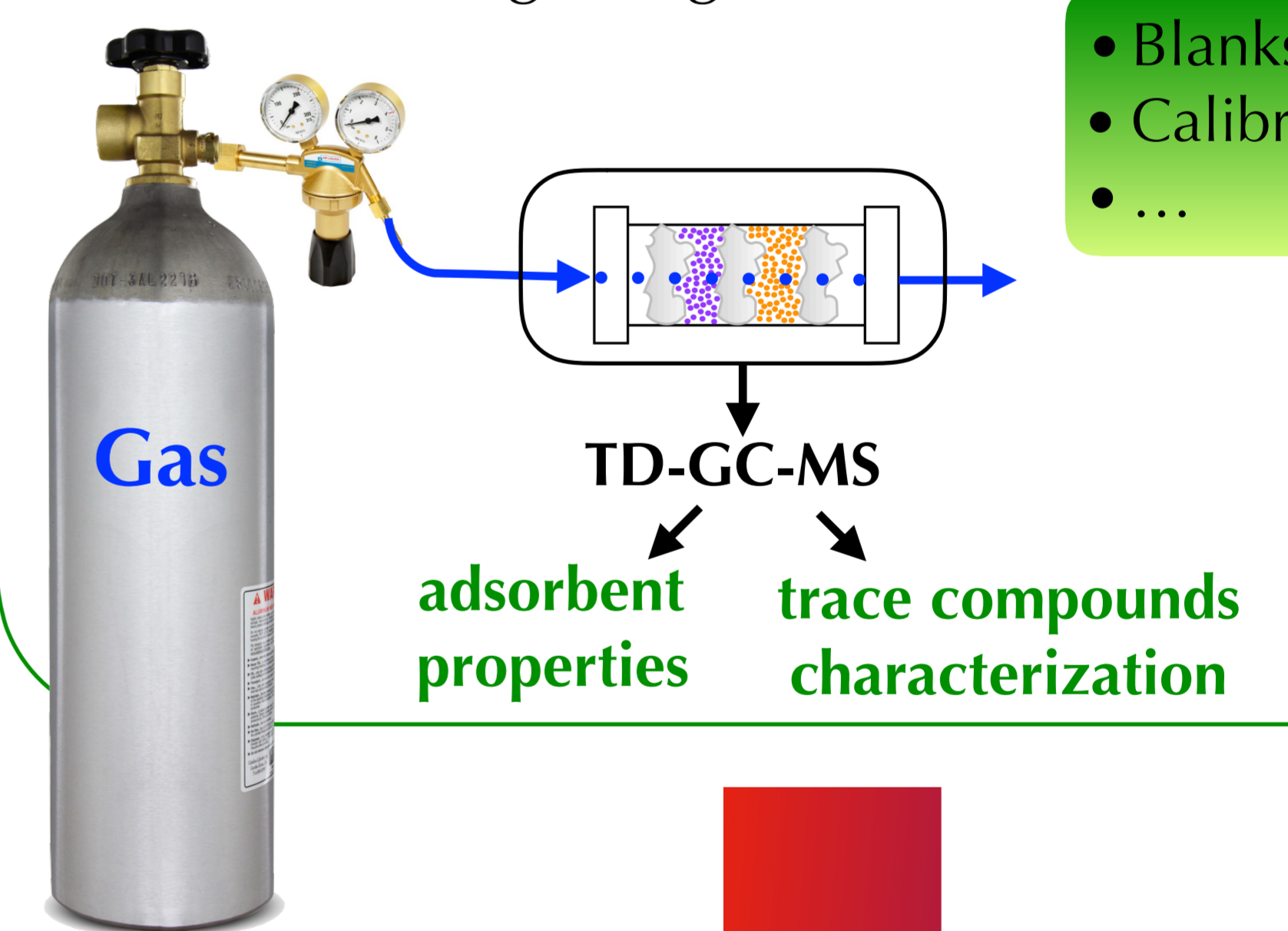


## OPTIMIZATION & VALIDATION

- Standard** gases (target analytes in CH<sub>4</sub>)
  - Pure single gases
  - Mix of standard gases
- Real** biogas and biomethane (in Tedlar bag or ogive)

- at P<sub>atm</sub>
- at P<sub>grid</sub> (40 - 100 bar)

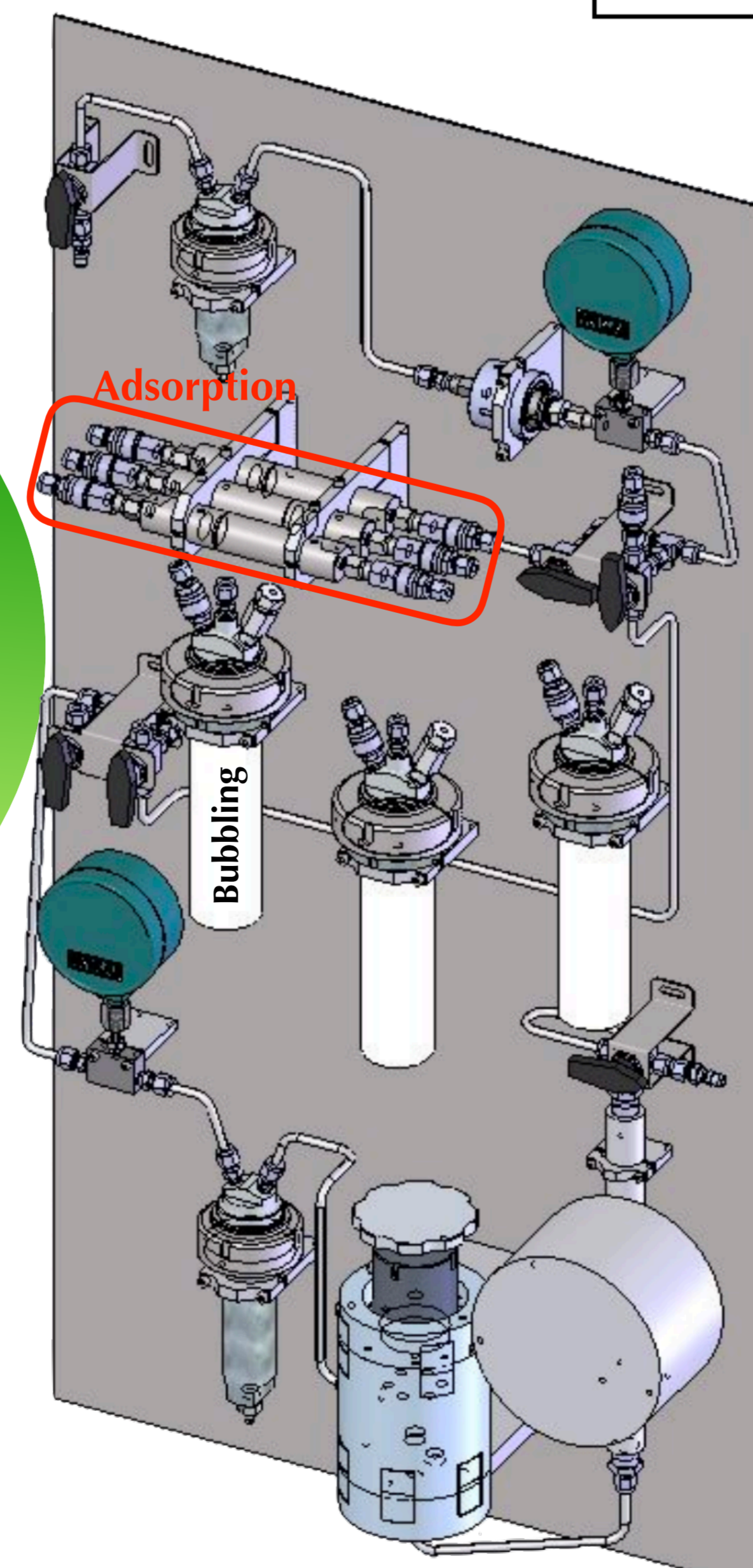
- Blanks
- Calibrations
- ...



**FIELD IMPLEMENTATION:** lab work and knowledge integrated in a field case

on site **sampling and pre-concentration** of trace compounds in

- Natural gas
- Biomethane
- Biogas



- polyvalent
- easy handling
- no sample transfer
- anywhere at any pressure ( $\leq 100$  bar)
- ATEX

## DELIVERABLES

- Optimized polyvalent **field tool** for gaseous trace compounds pre-concentration
- Database** biomethane's trace compounds i.f.o. feedstock & operating conditions
- Adapt **upgrading** technologies
- Adapt existing / define new **norms** and **specifications** for biomethane grid injection