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

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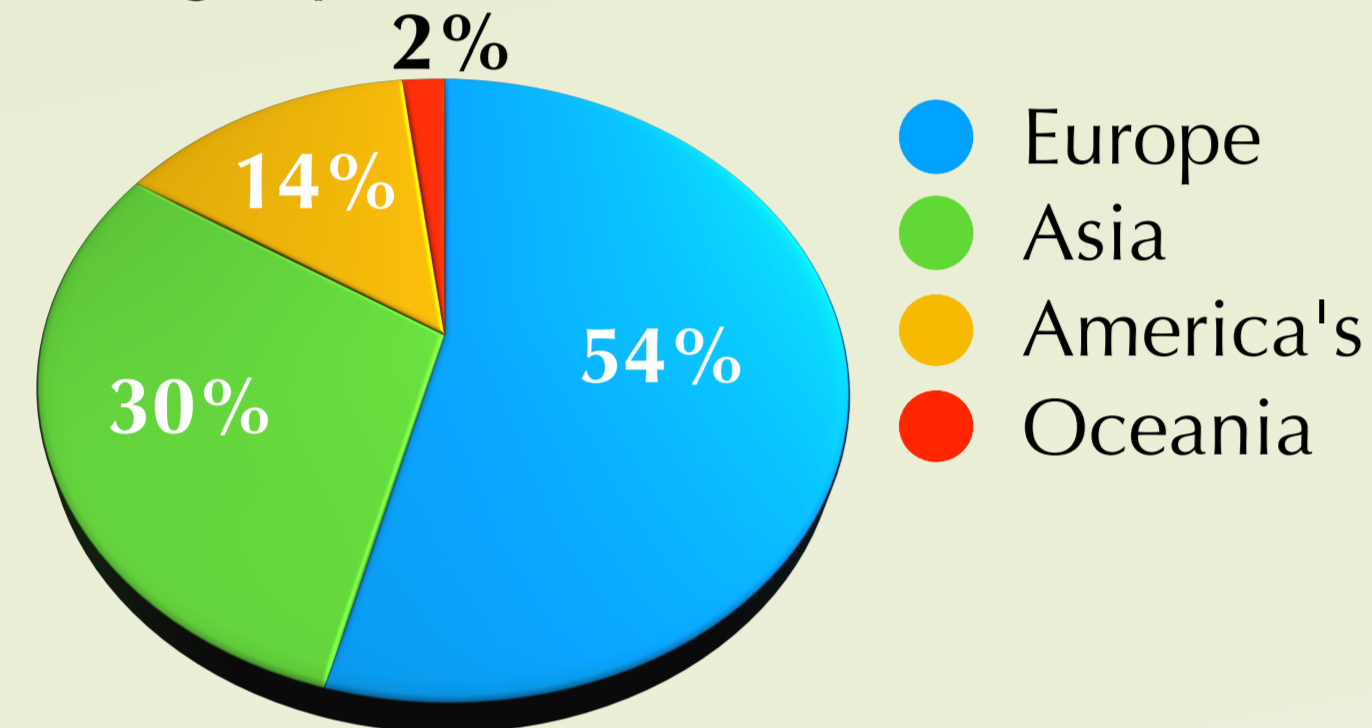
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9th GERG Young Researchers' Awards, EGATEC 2019, 6 – 8 November, Groningen, The Netherlands

Some numbers

BIOMETHANE (1,2)	NATURAL GAS (3)
≥ 97% CH ₄	70-90 % CH ₄
30-35 MJ/Sm ³	37.5-40.5 MJ/Sm ³
GHG emission saving when producing and combusting biomethane compared to NG: 218 kg CO₂-eq/MWh (4,5)	
World production in 2016 (billion Sm³)	
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 Sm³ biomethane injected in NG grid
- > 160 million Sm³ 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"> Cryotrapping Bubbling <ul style="list-style-type: none"> 10%_w HNO₃ / 5%_w H₂O₂ for metal(loid)s 1%_w KMnO₄ / 5%_w H₂SO₄ for Hg Chemotrapping 	<ul style="list-style-type: none"> GC-ICP-MS ICP-MS GC-ICP-MS / AFS

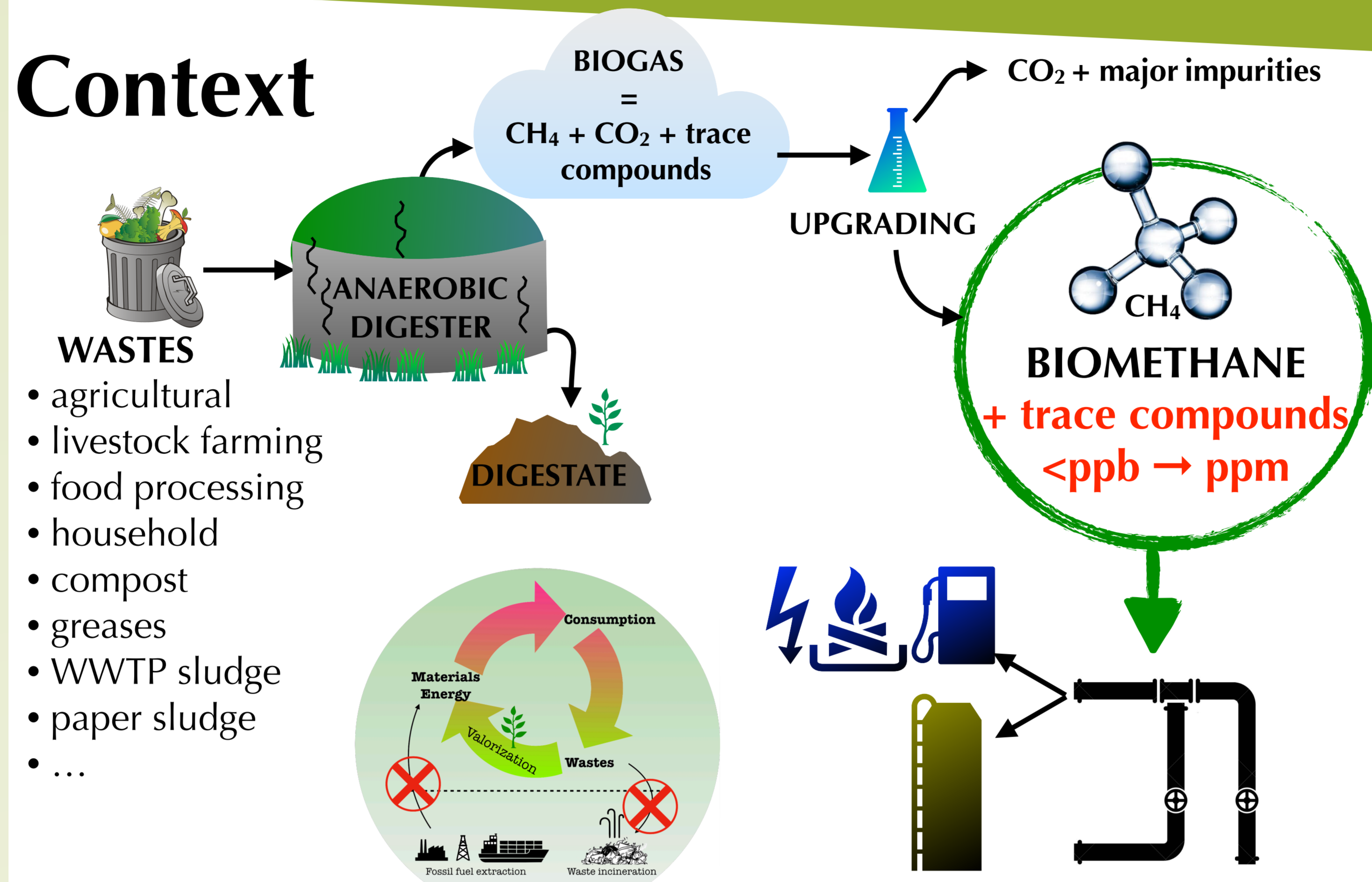
Biogas & biomethane sampling sites:

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

References:

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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

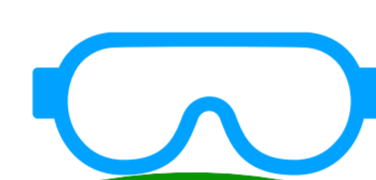
1

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

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

2

Quantification and speciation

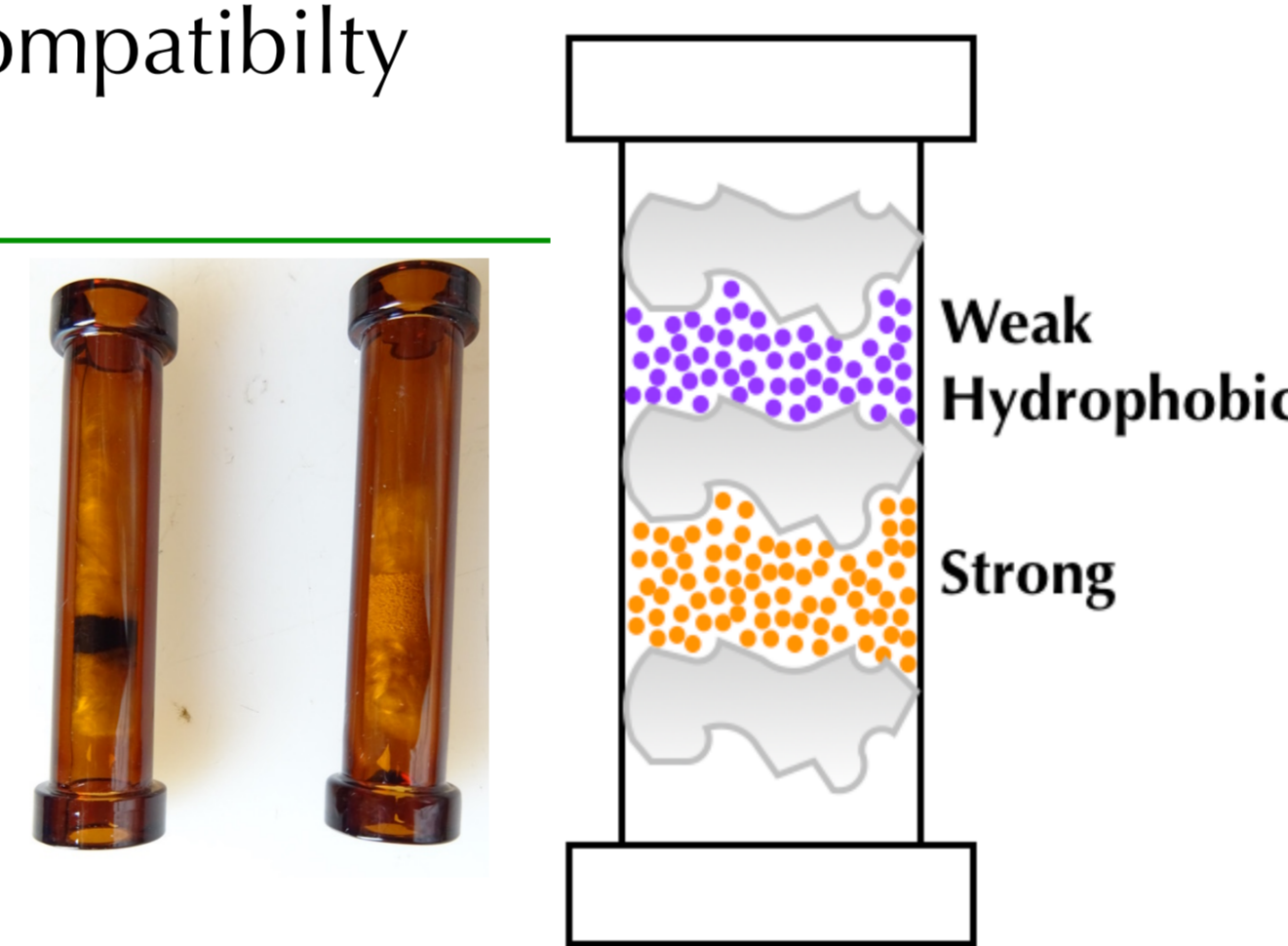


LAB SCALE OPTIMIZATION:

- Chemically = targeted adsorption
- Physically = under pressure (≤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

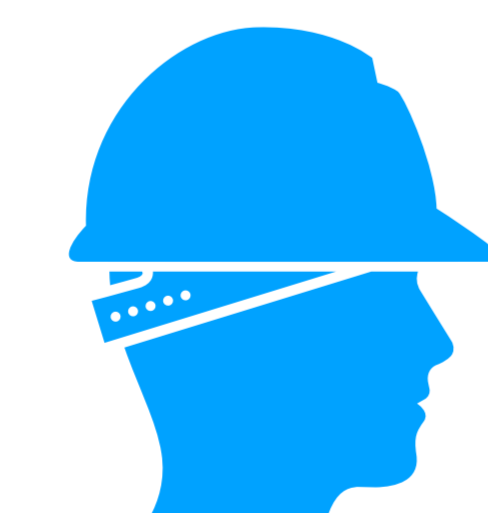
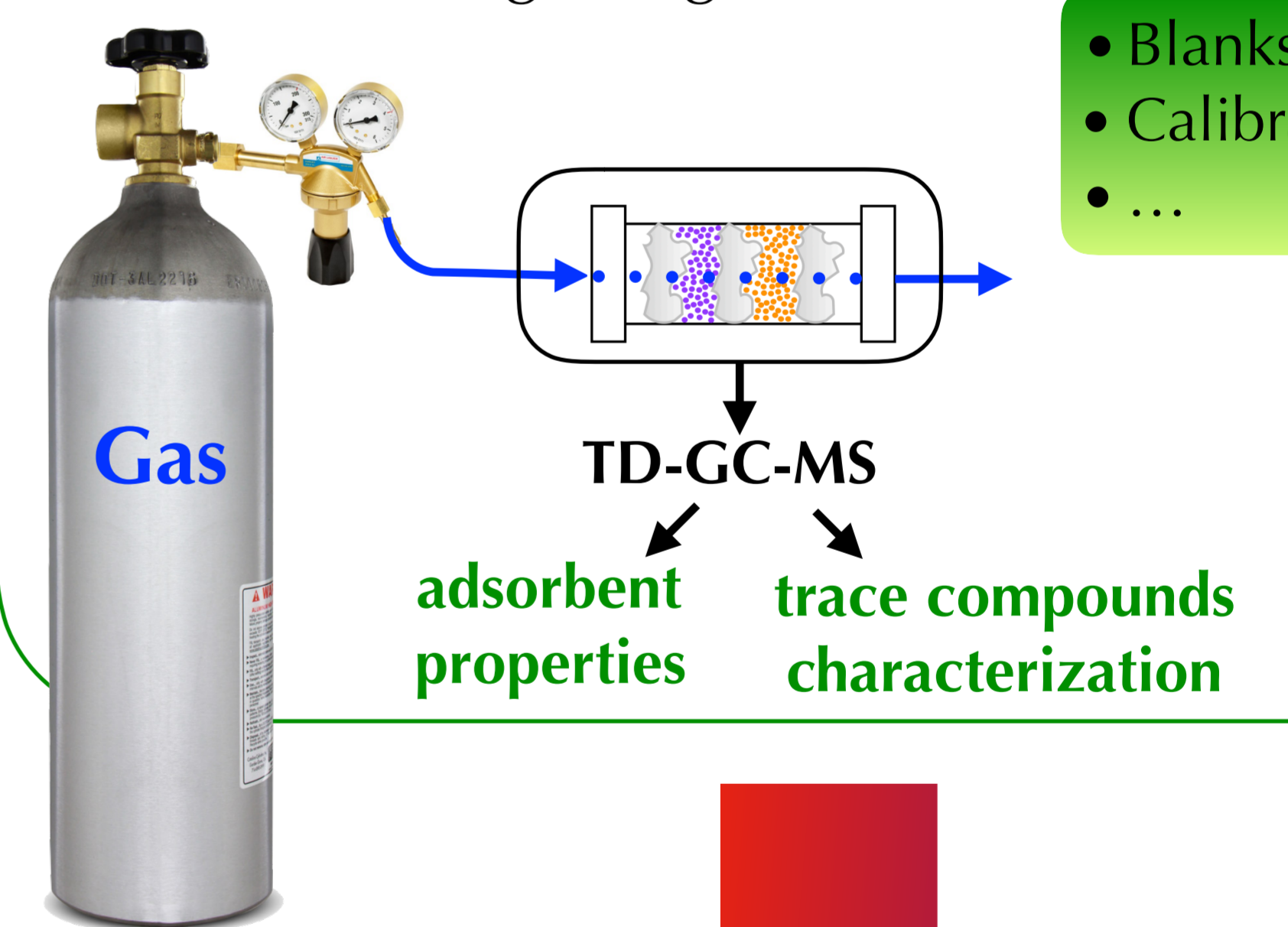


OPTIMIZATION & VALIDATION

- Standard** gases (target analytes in CH₄)
 - Pure single gases
 - Mix of standard gases
- Real** biogas and biomethane (in Tedlar bag or ogive)

- at P_{atm}
- at P_{grid} (40 - 100 bar)

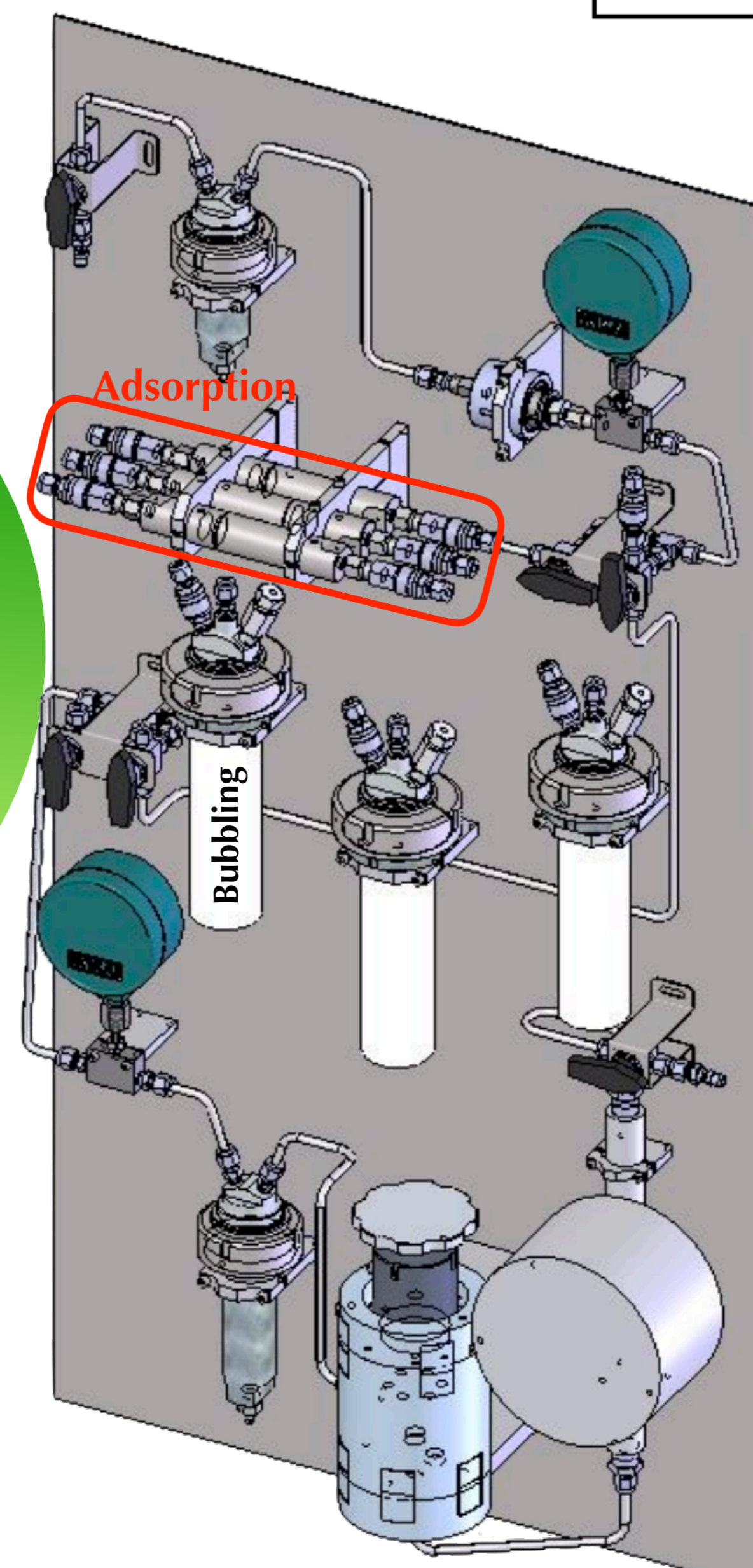
- Blanks
- Calibrations
- ...



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 (≤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