

PAUL SCHERRER INSTITUT



Dr. Serge Biollaz :: Paul Scherrer Institut

Activities on measurement of biogas and biomethane impurities at PSI

Workshop on conformity assessment of biomethane, Delft, 22-23 January 2019

For questions go to:

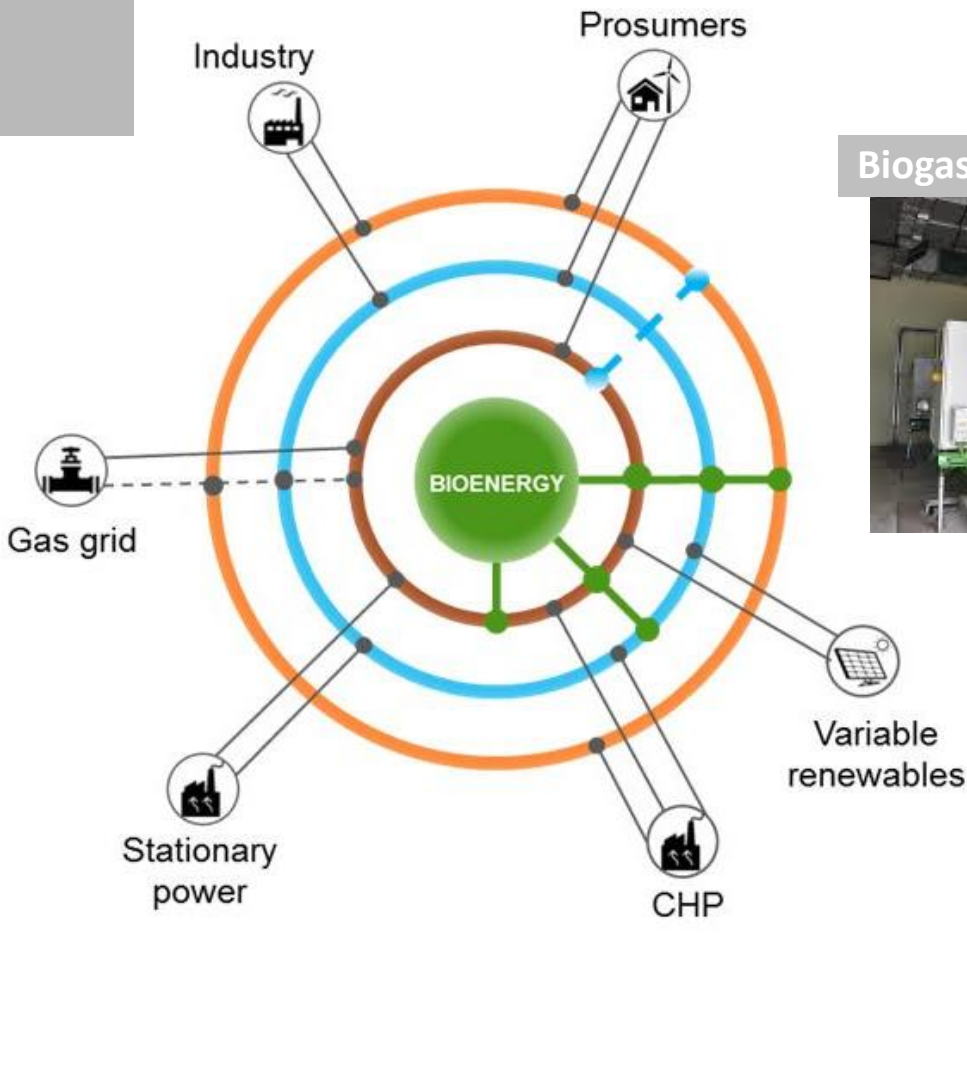
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- **PSI's interest is focusing on***:
 - total sulphur and individual sulphur compounds
 - total silicon and siloxanes
 - Terpenes
- **PSI has no activities for the moment on these contaminants in biogas/biomethane:**
 - (ii) total fluorine, chlorine and halogenates VOCs
 - (iv) amines
 - (v) ammonia
 - (vi) compressor oil
 - (vii) the biogenic methane content in blends of biogas and natural gas.
- **We are interested to learn from others and share our learnings**
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*Interest is driven by application/end use of biogas/biomethane.

Biogas grid integration

Multiple options of future use of biogas



Biogas ICE



Biomethane



Biogas SOFC

Biogas grid integration

Diverse raw biogas qualities



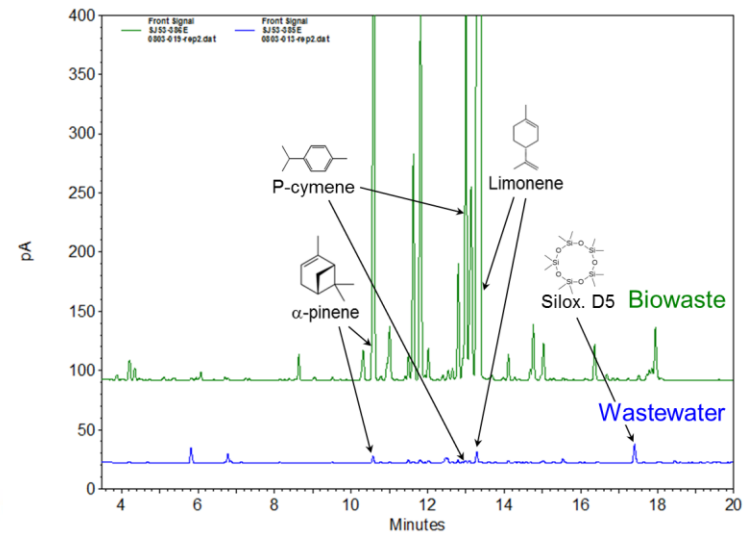
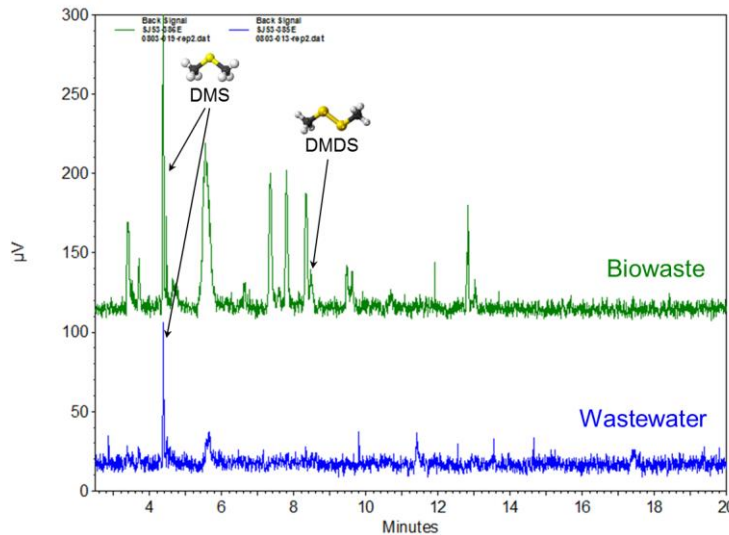
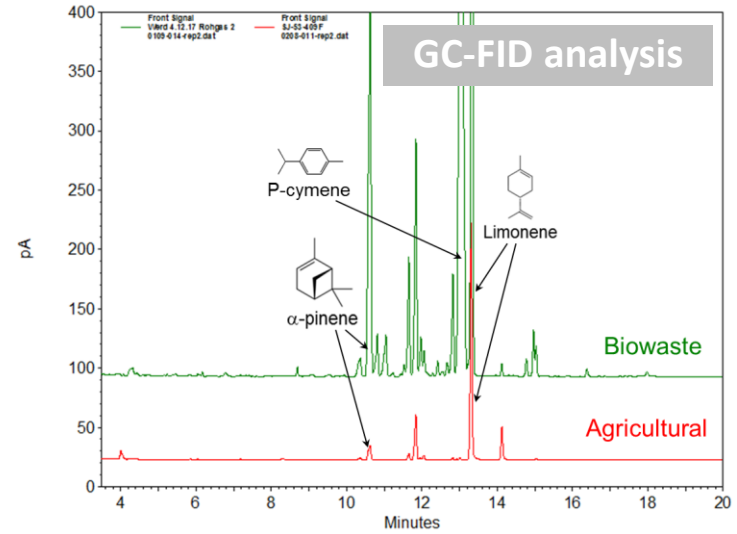
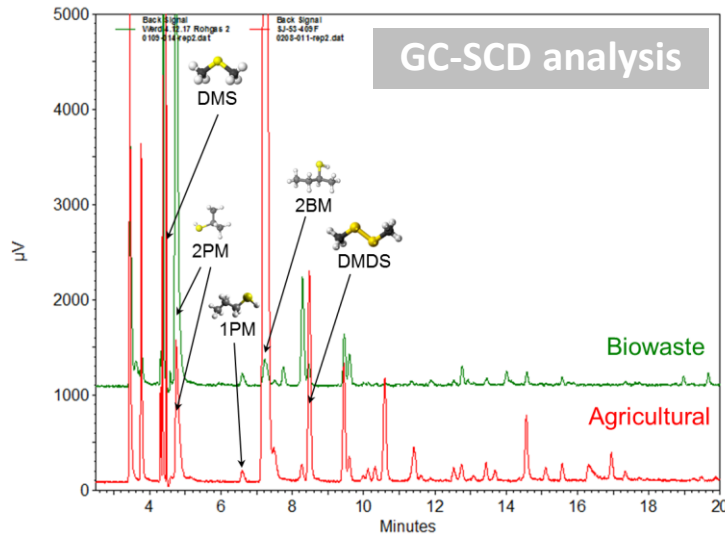
Wastewater treatment (WWTP)



Biowaste (organic fraction of municipal solid waste)

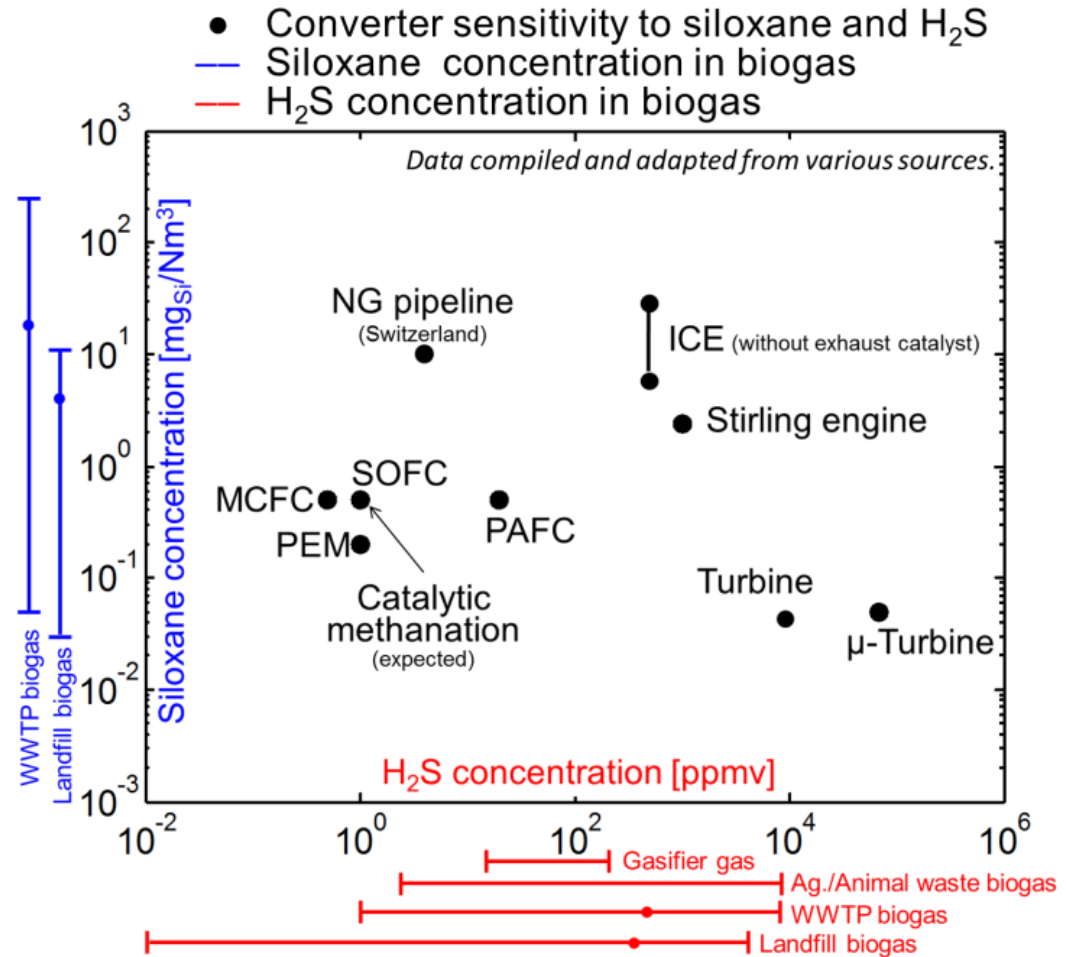


Agricultural (chicken & cow manure)



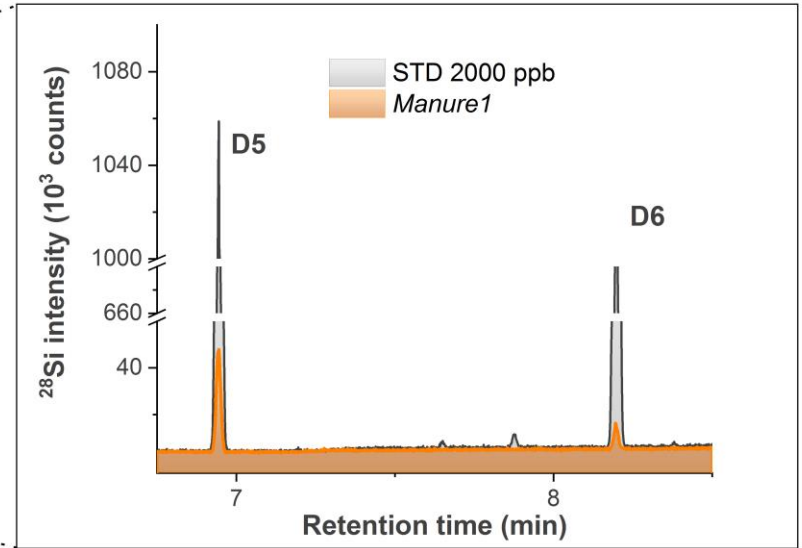
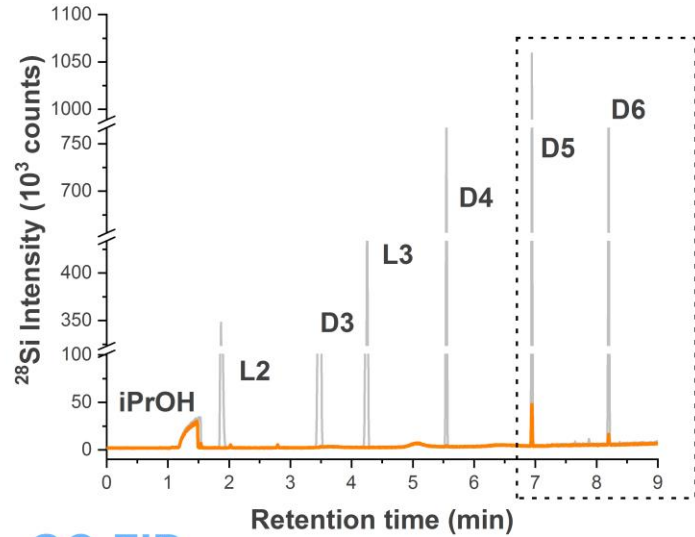
Need for robust biogas cleaning technology

- Raw biogas has high amount of sulphur
- More than just H₂S such as thiols and sulphides
- Fuel cells such as SOFC or PEMFC need a high quality gases
- Other unknown contaminants may exist, which are critical for downstream processes.
- Verification of gas cleaning on pilot scale is critical for a successful demonstration plants.

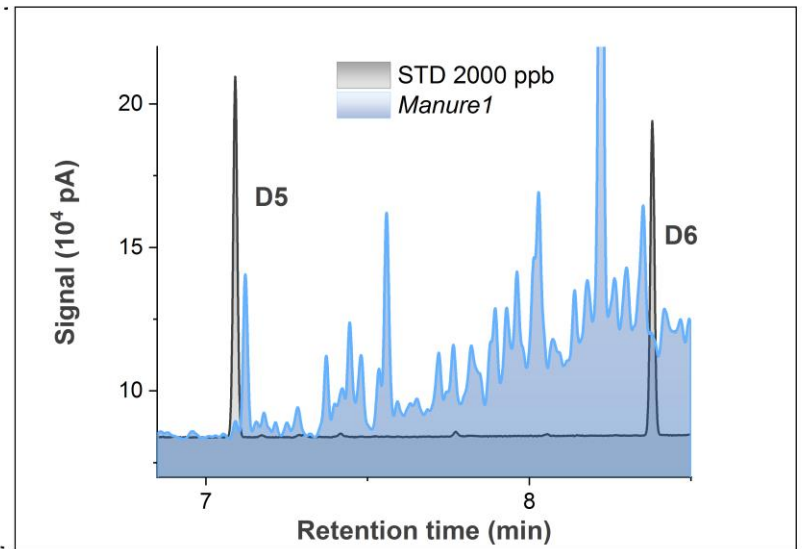
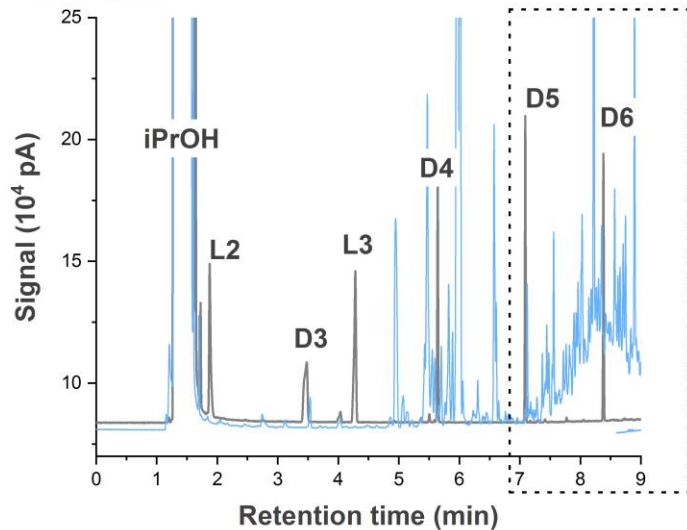


Siloxane analysis in biogases with GC-X

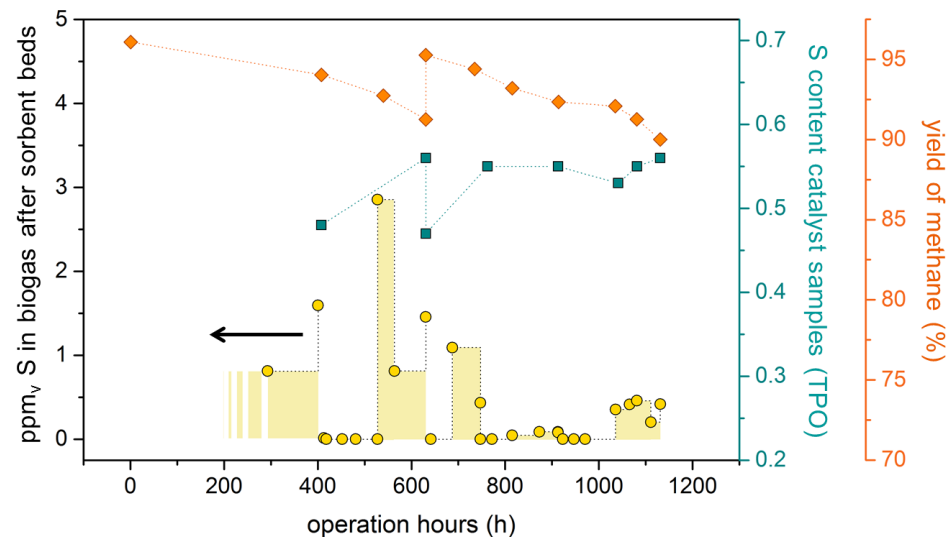
GC-ICP-MS



GC-FID



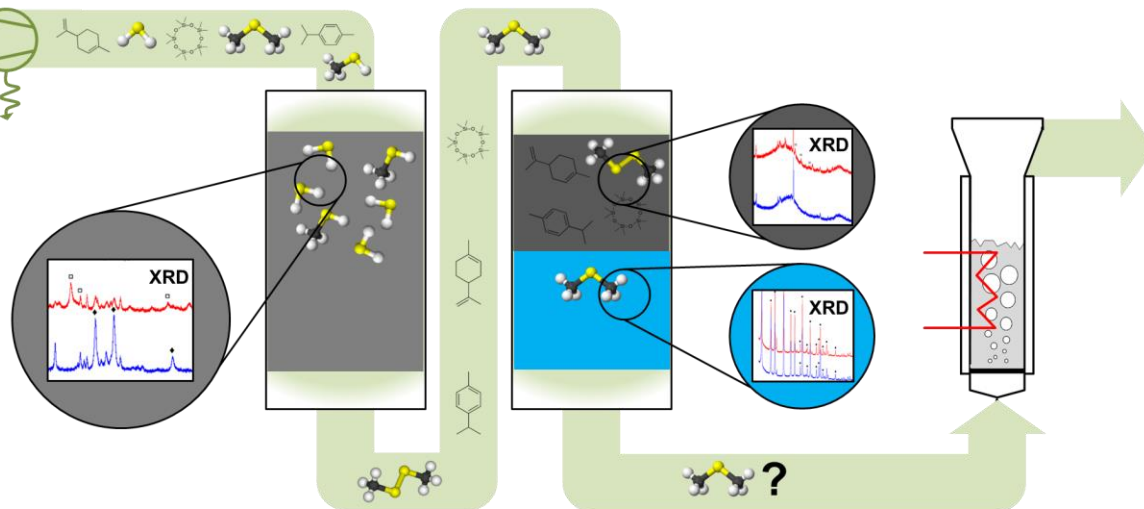
Long duration biogas field tests in 2017



Wastewater biogas

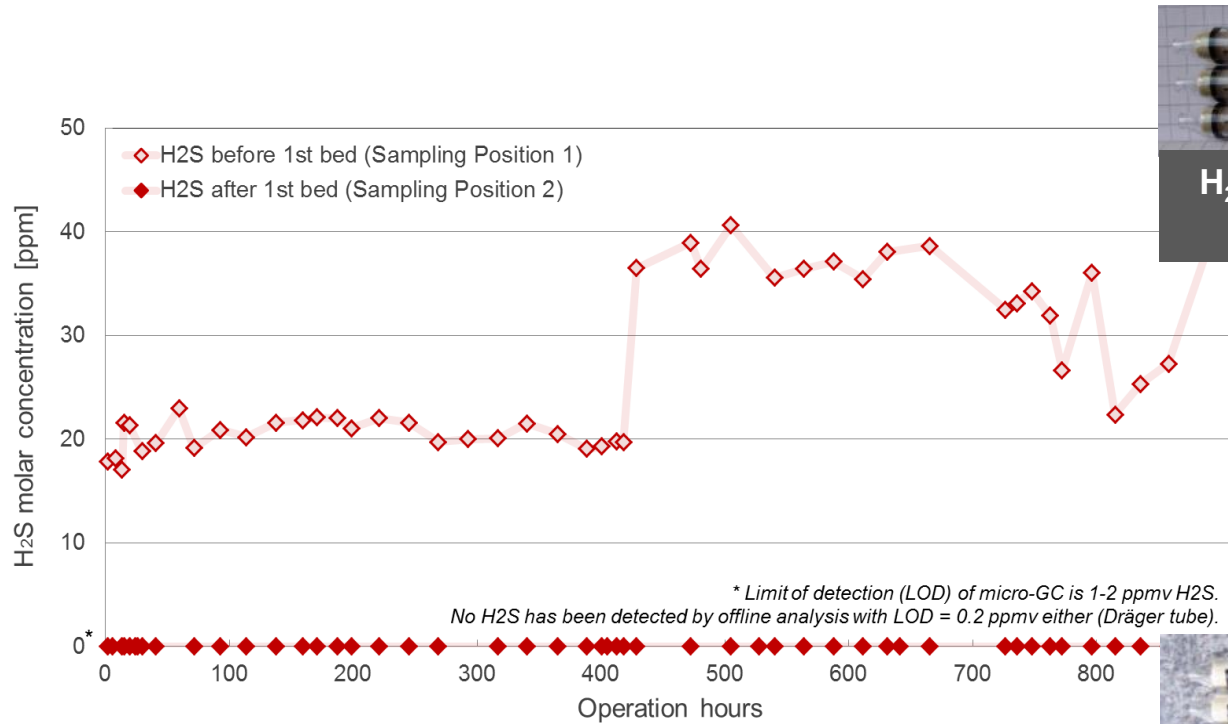


Biowaste biogas

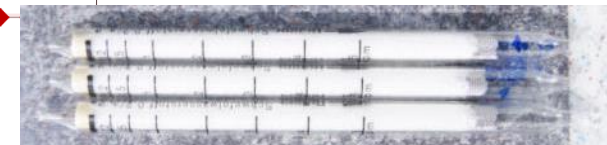


Calbry-Muzyka et al., Deep removal of sulfur and trace organic compounds from biogas to protect a catalytic methanation reactor, *Chemical Engineering Journal*, 360, 577-590 (2019).

Results of first gas cleaning step (Material A): H₂S removal monitored by μ GC and Dräger tubes



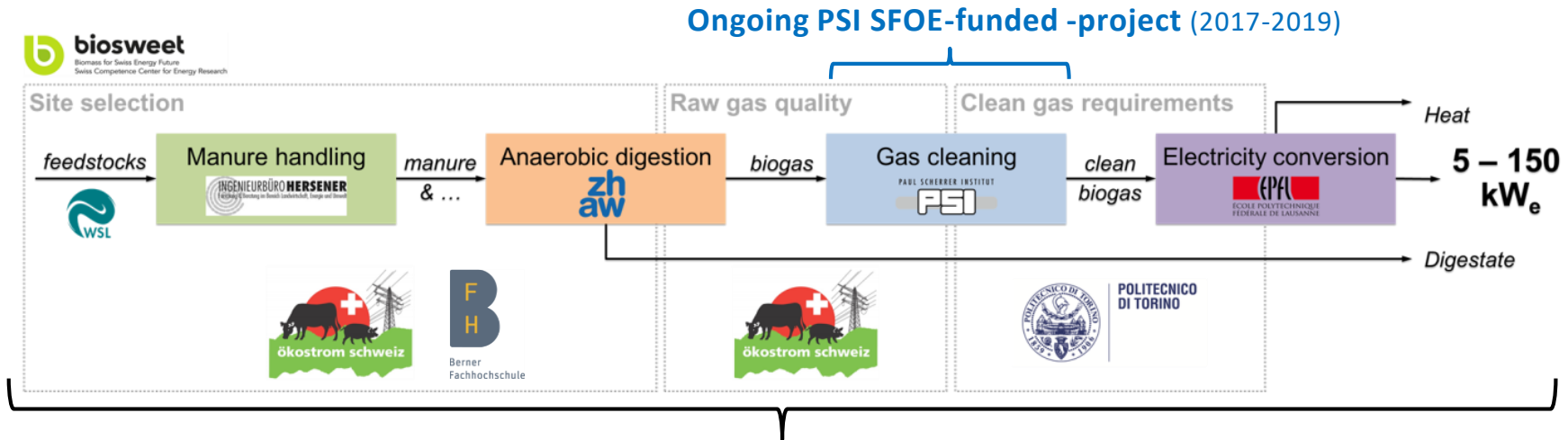
H₂S measurement with Dräger;
compressed raw biogas



H₂S measurement with Dräger;
after 1st gas cleaning step

- H₂S removal in first step was consistent, even with changes in inlet H₂S concentration and other conditions (temperature, humidity of gas).

Biogas-SOFC related activities at PSI



Ongoing BIOSWEET- Project team (2017-2020)

Ongoing EU Project
“DEMOSOFC” (2015-2020)

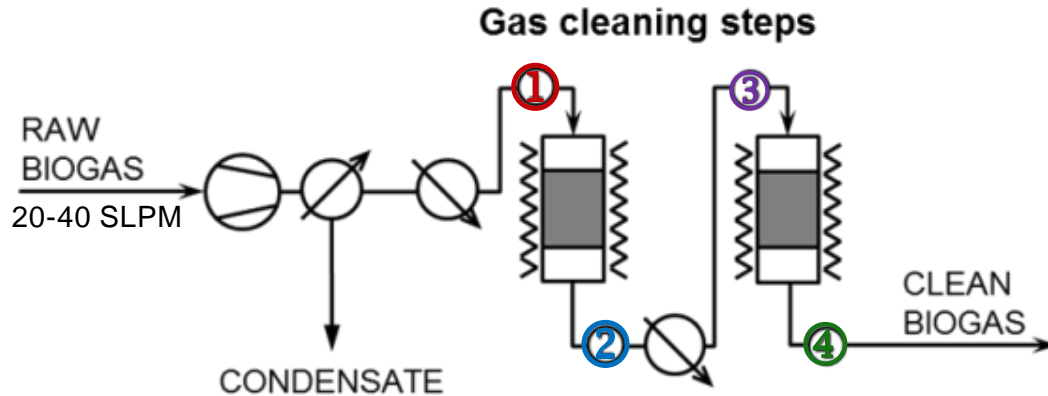
Joint field campaign in Torino
(DEMOSOFC, Nov. 2018)



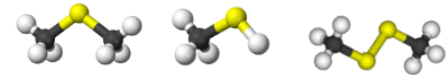
Sorbent testing in field campaign 2019 (SFOE project)

Validation of forecast of sulphur breakthrough of 2-step gas cleaning

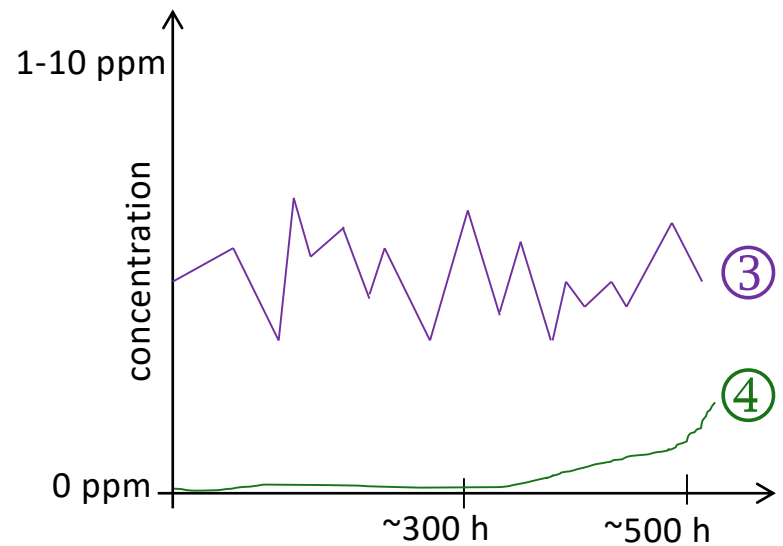
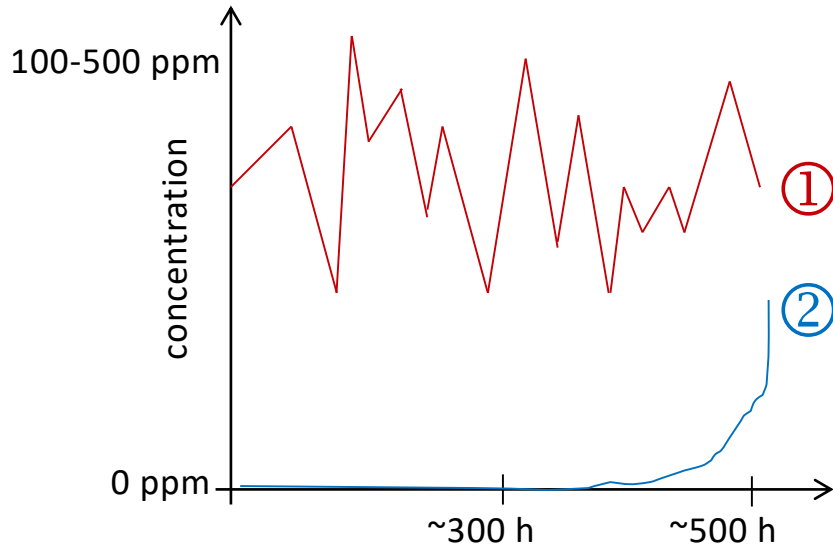
MtE Gas cleaning



1st Step: H₂S removal

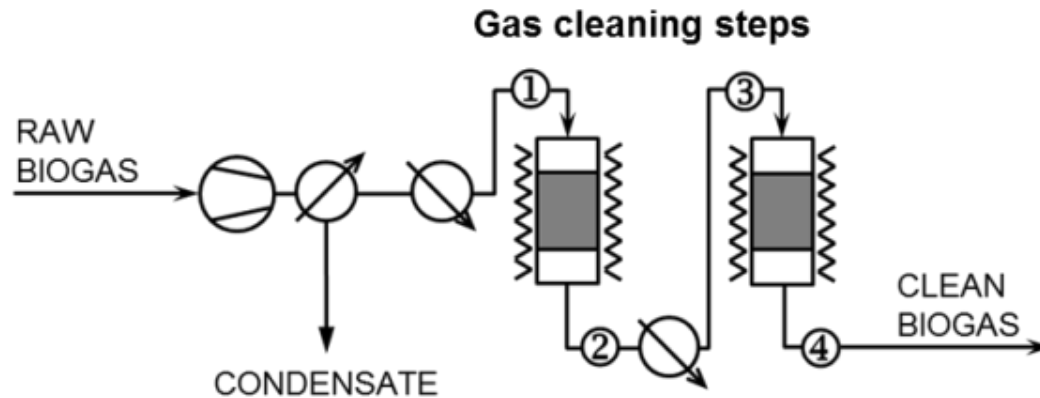


2nd Step: Removal of DMS, etc.



Analytical Instruments to be tested in 2019

Validation of sampling techniques and analytical instruments for biogas



Sampling Locations	①	②	③	④
"Process diagnostics":	CO ₂ /CH ₄ /O ₂ sensors	---	---	CO ₂ /CH ₄ sensor
H ₂ S, COS:	S-mGC	S-mGC	S-mGC	S-mGC
Trace sulphur:	---	Total sulphur SCD	Total sulphur SCD	Total-S SCD; SulfaTrack
Condensable trace compounds:	Liquid Quench sampling	Liquid Quench sampling	Liquid Quench sampling	Liquid Quench sampling
Non-condensable trace compounds:	Gas sampling: Drä./Restek	Gas sampling: Drä./Restek	Gas sampling: Drä./Restek	Gas sampling: Drä./Restek

Site for PSI biogas field campaign 2019

Swiss Farmer Power Inwil (SFPI)



Actual planning:

2 – 3 month PSI infrastructure in place for testing gas cleaning and diagnostic tools (sampling systems and analytical instruments)



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My thanks go to

- A. Calbry-Muzyka
- A. Frei
- J. Schneebeili
- D. Foppiano
- M. Tarik
- Chr. Ludwig

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- SCCER BIOSWEET
- ESI Platform

