Laborelec
RESEARCH & INNOVATION

Webinar
Carbon capture and flue gas characterization

December 2024

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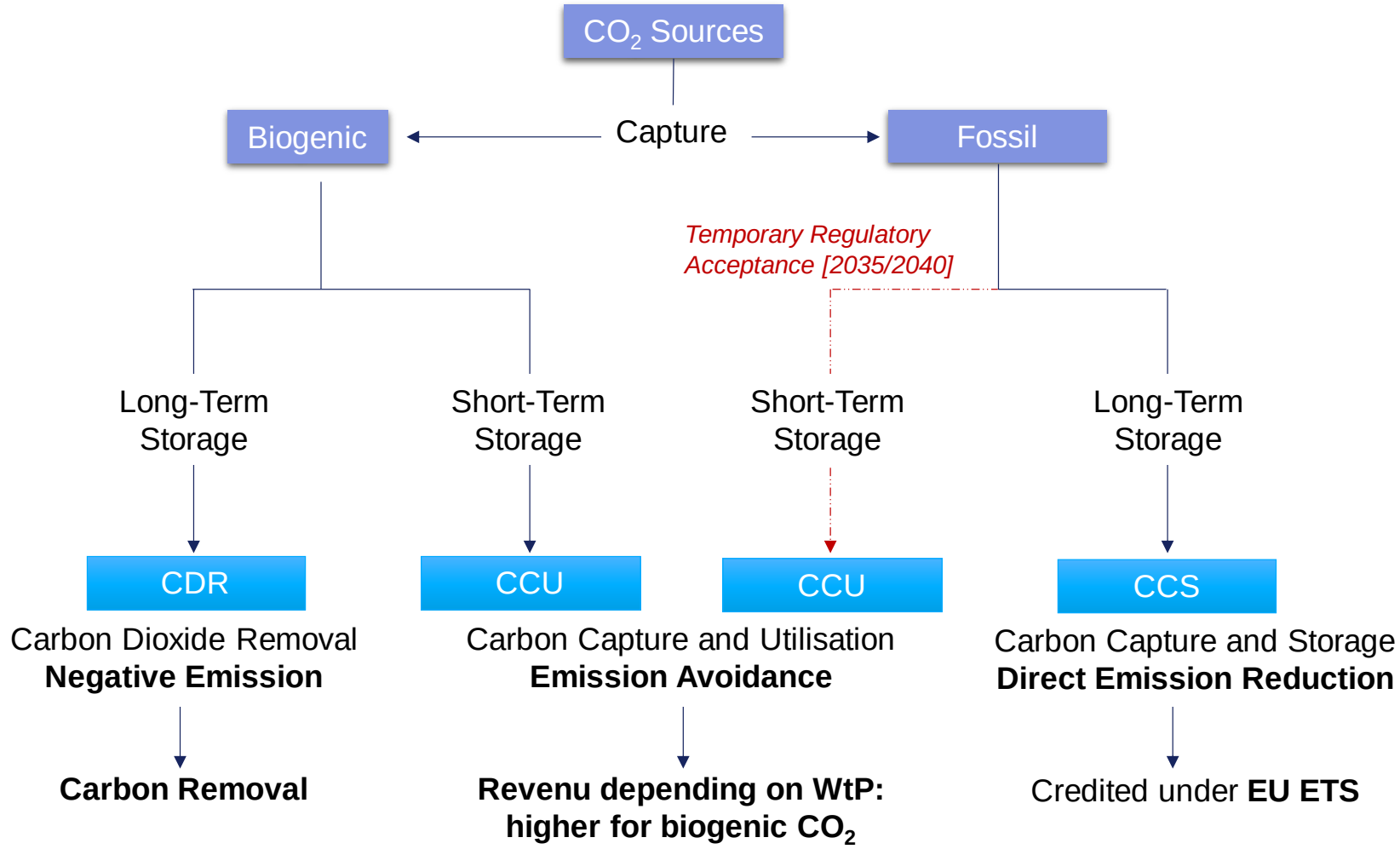
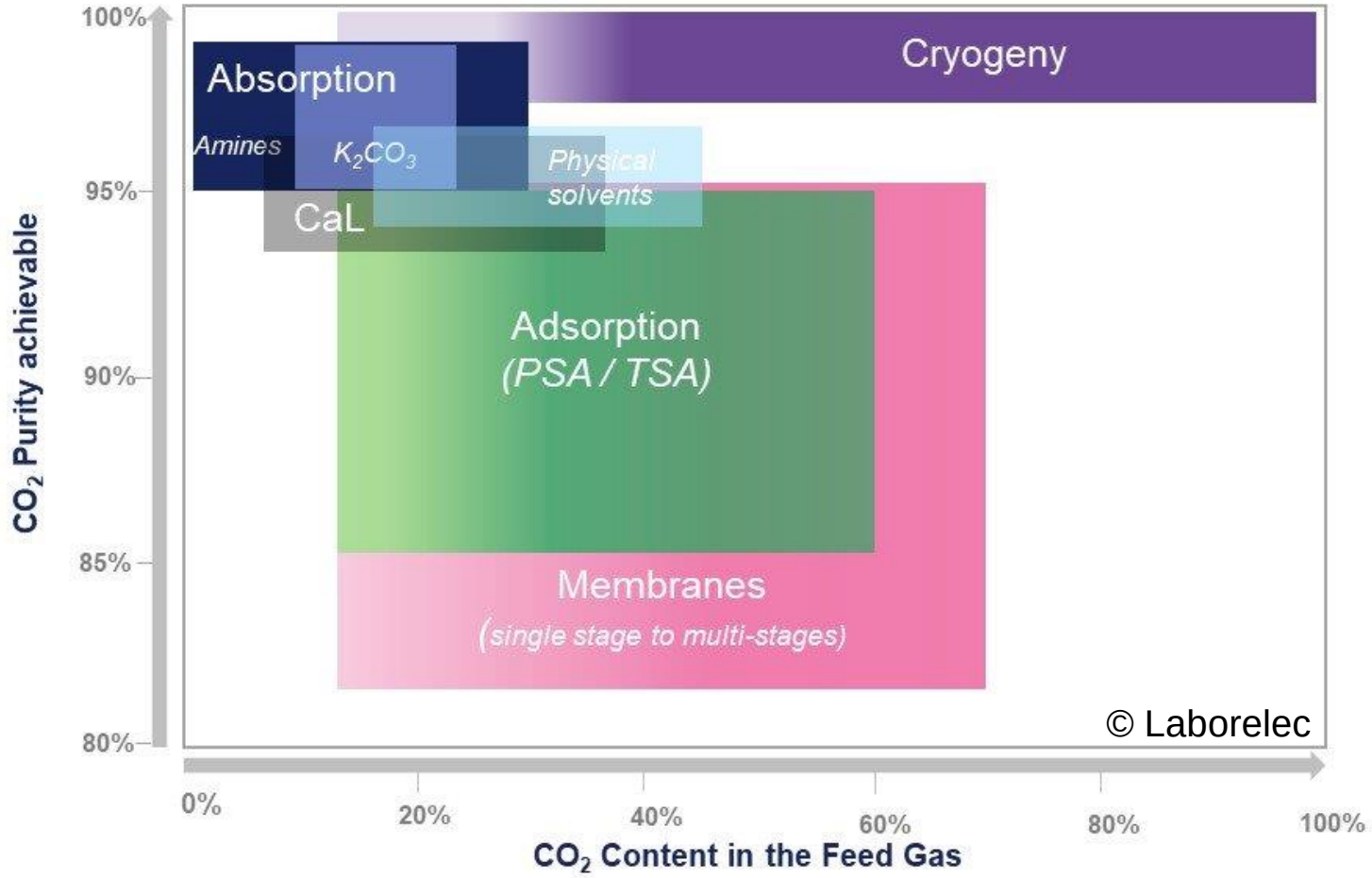
Carbon Capture consists in separating CO_2 from other gases for subsequent use or storage

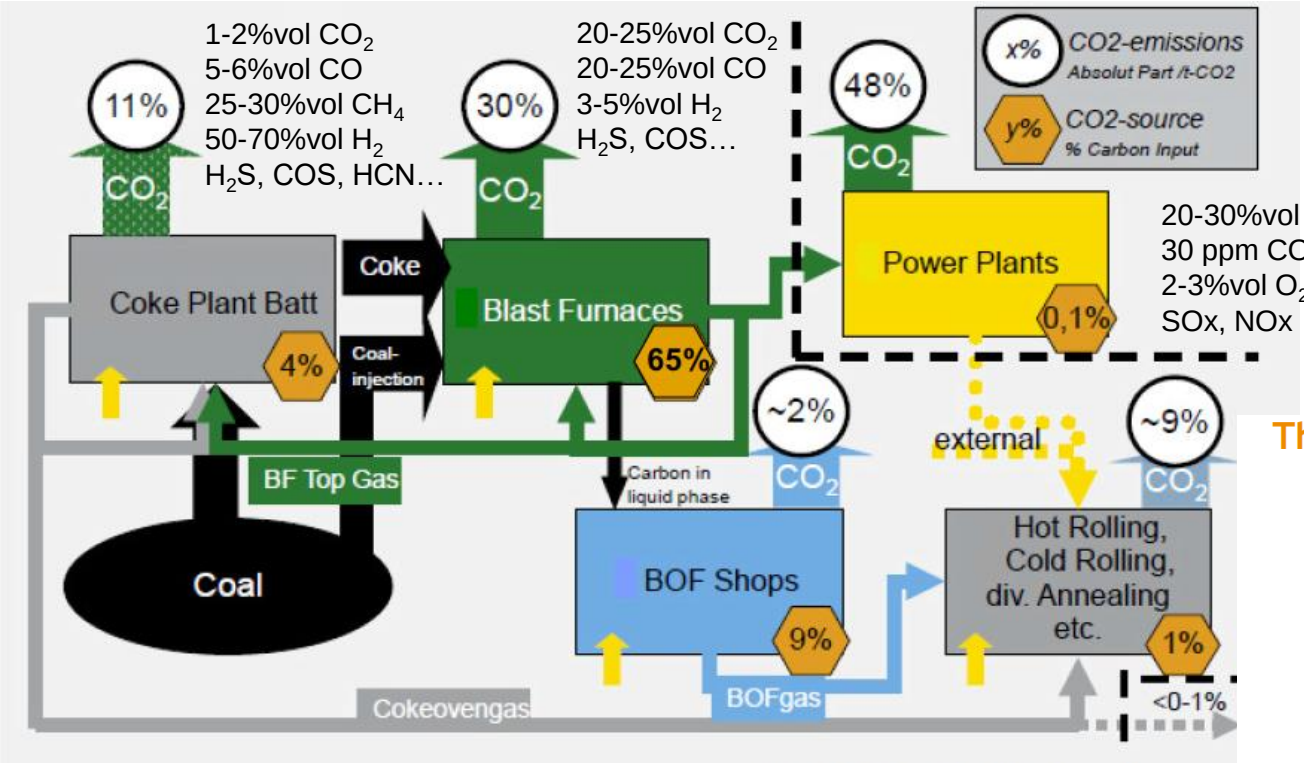


Post Combustion Carbon Capture is today the most mature technology

Domain of maturity and competitiveness for different capture technologies and applications

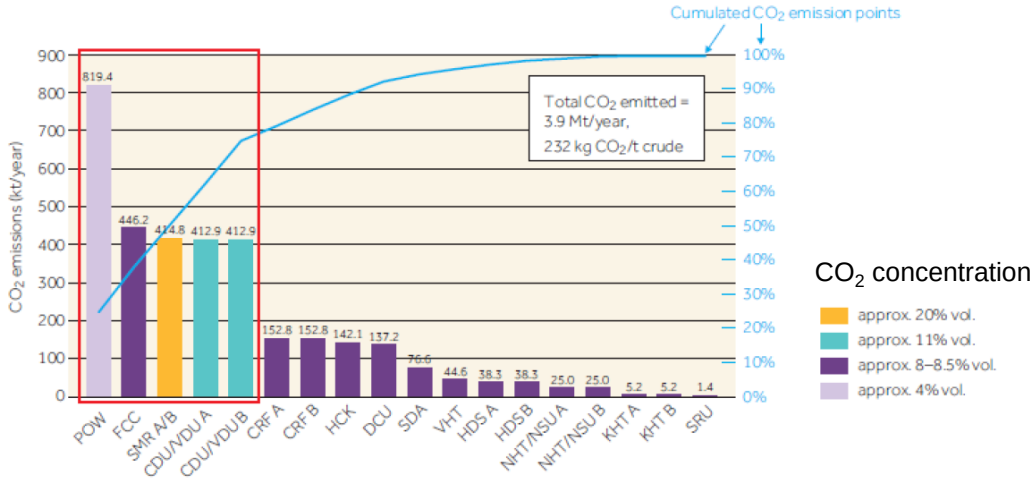


CO_2 capture integration in industrial process can be complex due to multiple emission points with different composition



Main CO_2 emission sources on Iron&Steel Plant

The main CO2 emission sources for a typical complex refinery with a nominal capacity of 350,000 bbl/day



Source: Adapted from SINTEF (2017). *ReCAP Project—Evaluating the Cost of Retrofitting CO₂ Capture in an Integrated Oil Refinery: Description of Reference Plants.* https://www.sintef.no/recap

Many components present in the exhaust gas can impact the Carbon Capture performance

→ Specific exhaust gas characteristics depending on the process and existing flue gas pre-treatment

- **Physical parameters:** flow, temperature, pressure
- **Gas composition**
- **Temporal variability**

% mol

N_2,
CO_2,
O_2 / Ar, H_2O

ppm

Dust
CO
NOx (NO + NO_2)
NH_3
S-impurities: SOx,H_2S, COS, mercaptans …
HCl, HF, HCN
Halogens (e.g. NH_4Cl)
Hydrocarbons
H_2SO_4 aerosols / PM

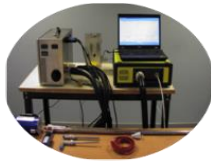
ppb

Metals (Hg, As, Cd …)

Design, cost and performance of the Carbon Capture plant

Flue Gas Characterisation is key for CO_2 Capture Unit design… To address the question, Laborelec has developed tools and expertise

- Flue gas characterisation is **necessary** during project development phase for **carbon capture design,** for **tender** and can support **performance validation** and **troubleshooting** during implementation phase
- Laborelec has **more than 10 years-experience supporting industries, carbon capture licensor's, carbon capture pilot and demonstration plants**



On-line measurement of organics (MEA, NH_3, aldehydes…) and inorganics (NH_3, CO_2, H_2O, NOx, CO …) at ppm level

SO_3/ H_2SO_4 determination

ELPI
Real-time characterization of Particulate Matters (PM) / aerosols in gaseous streams PSD and number concentration (6 nm-10 µm)

The measurements shall be carried out in accordance with the standards to provide reliable results for carbon capture projects

Reliable SO_3 measurement is challenging !

Low concentration (sub ppm)

Interferences with SO_2 which is at 100x higher

Fastidious collect of the formed aerosols

Rapid condensation (H_2SO_4) at any colder point

Reaction or condensation on dust at < dew point temp

Controlled condensation method (VDI2462):

Emission measurements enable to predict the risk of aerosols and emissions related

Very fine particles + SO_3 = Risk of **aerosol formation** = risk of amine emission

Critical parameter to measure!

Prediction model

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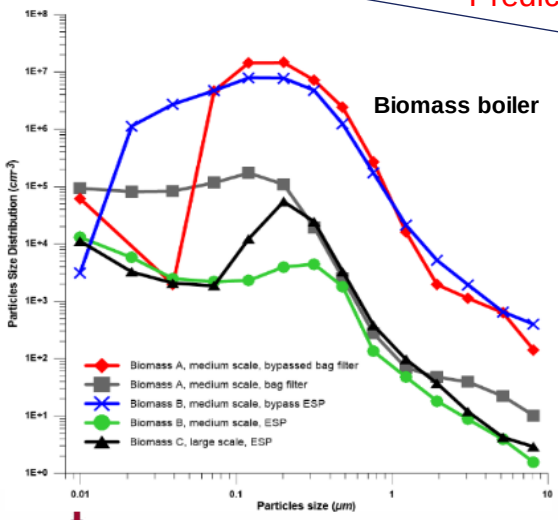
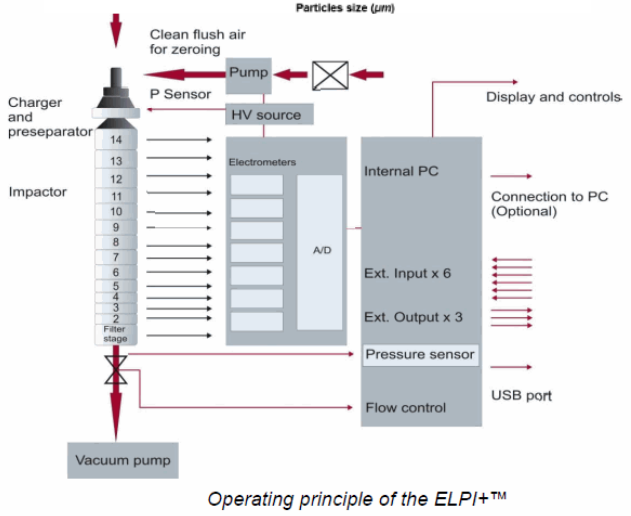
Contents lists available at ScienceDirect
Atmospheric Pollution Research
journal homepage: www.elsevier.com/locate/apr

Fine and ultrafine particle number and size measurements from industrial combustion processes: Primary emissions field data

Jan Mertens[a,e,*], H. Lepaumier[b], P. Rogiers[b], D. Desagher[b], L. Goossens[a], A. Duterque[c], E. Le Cadre[a], M. Zarea[a], J. Blondeau[d], M. Webber[a,f]





Operating principle of the ELPI+™

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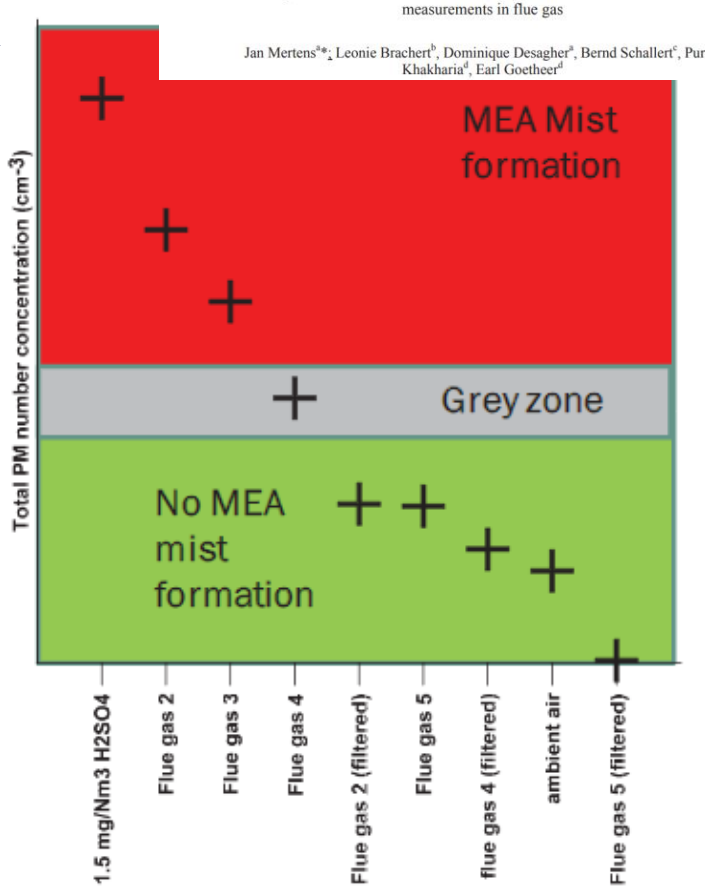
Available online at www.sciencedirect.com
ScienceDirect
Energy Procedia 63 (2014) 893 – 901
Energy Procedia

GHGT-12

Predicting amine mist formation based on aerosol number concentration and size measurements in flue gas

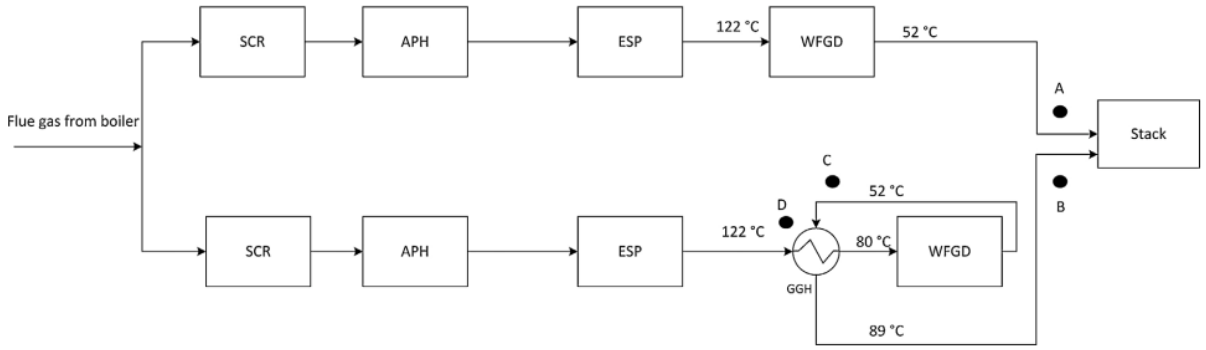
Jan Mertens*, Leonie Brachert, Dominique Desagher, Bernd Schallert, Purvil Khakharia, Earl Goetheer

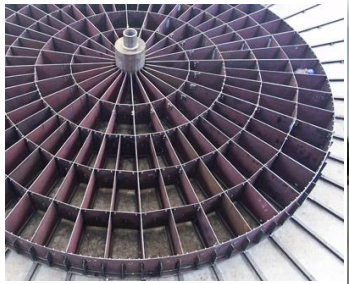


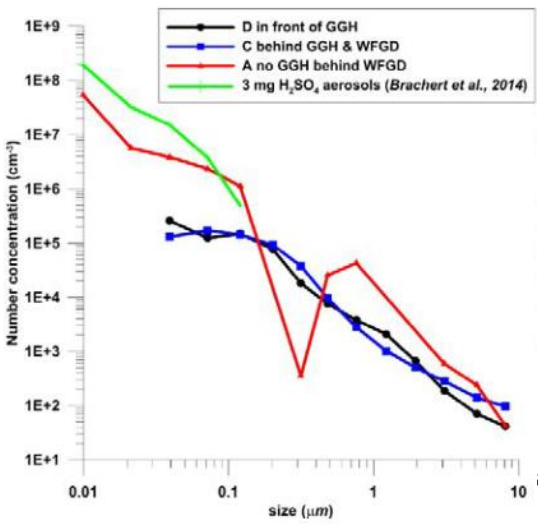
… to evaluate the impact of the existing flue gas pre-treatment

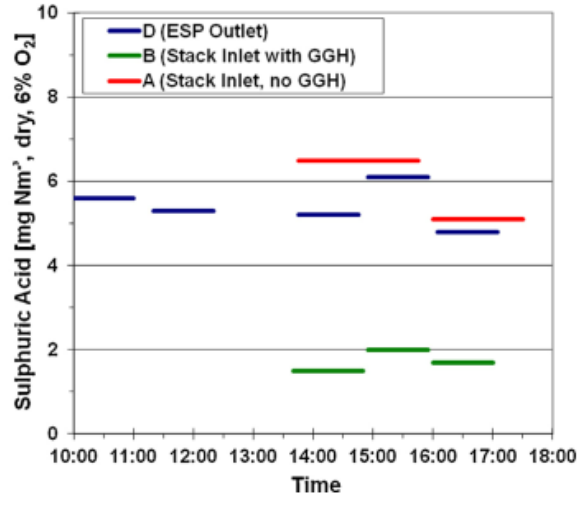
Effect of Gas-Gas Heat Exchanger

Unique layout of the flue gas treatment system at formerly GDF SUEZ's Nijmegen power plant:





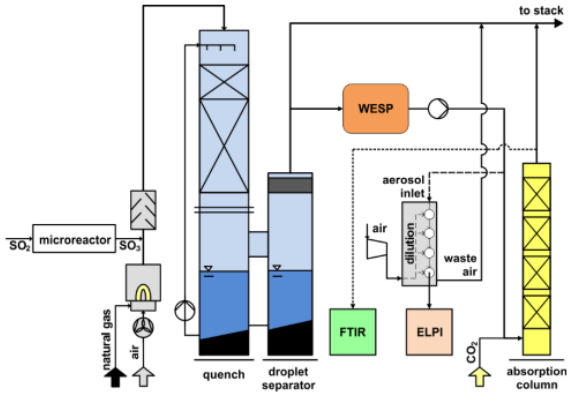




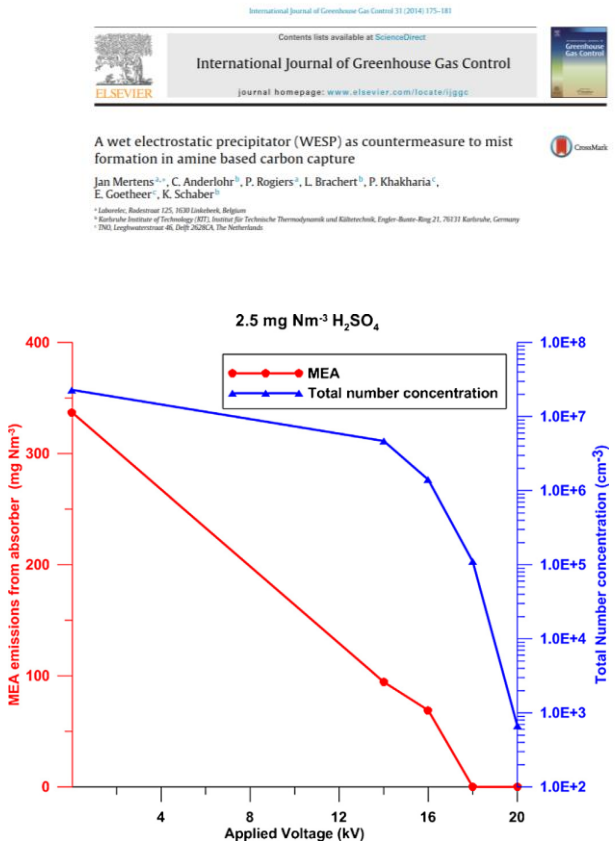
… and to assess the efficiency of possible mitigation strategies

Aerosol / Particulate Matters removal technologies

Wet Electrostatic Precipitator (WESP)

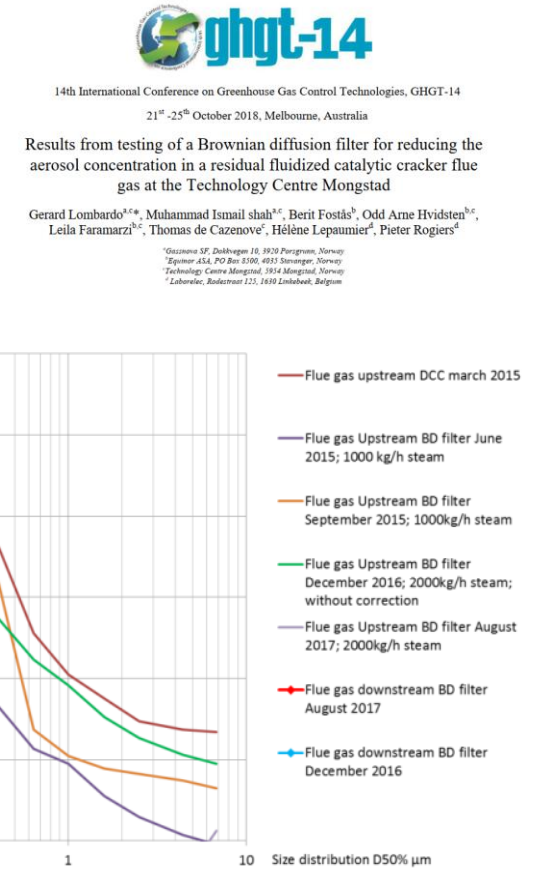


Pilot plant layout at Karlsruhe Institute of Technology



Optimization of the WESP operating conditions

Brownian Demister Unit (BDU)



Emission monitoring to validate new technologies

Objective: evaluate the effect of process parameters and design adaptation on gas composition to support the design of the most suitable post-treatment for large-scale demonstration plant.

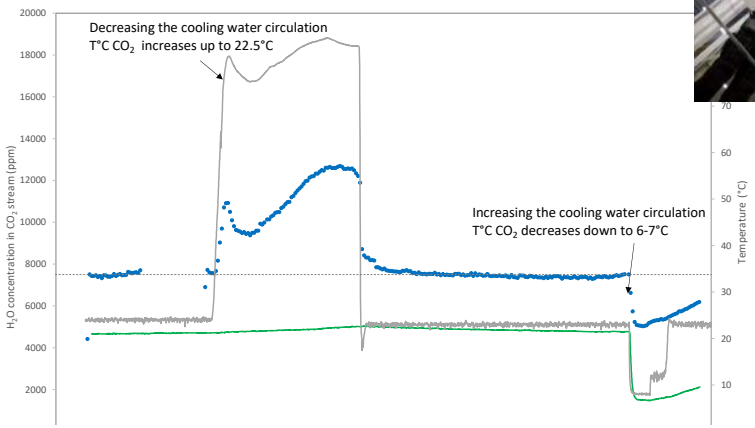
Laborelec has:

- Developed a dedicated sampling set-up to take into account the process specificities
- Performed on-line measurement of the CO_2 product and exhaust gases

Development of reliable, accurate and sensitive analytical tools for CO_2 quality will be critical for future CCUS projects

- The **nature** and **level** of impurities in CO_2 will depend on the process, capture and purification design
- **Different CO_2 purity requirements** with **more and more stringent** specifications.
- Identifying the most **relevant online and/or offline methodologies for sampling and analytical techniques** is key:
  - to ensure a **reliable** operation of the CCP
  - to detect at early-stage process malfunction / aging
  - to provide contractual **guarantees** on the CO_2 quality

Effect of the temperature of the condenser on water content in the CO_2 stream

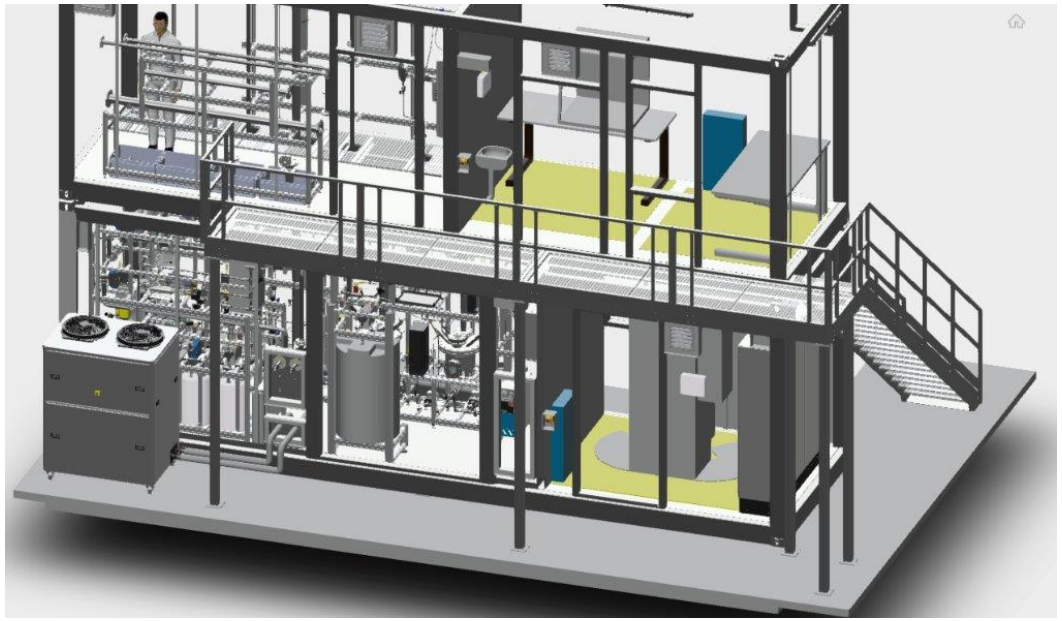


Lepaumier H. *et al.Online emission monitoring of CO_2 stream by Gas Chromatography.* 4th Post-Combustion CO_2 Capture conference, **Sept 2017**, Birmingham, Alabama.

Mobile Capture Unit, a unique asset which enables de-risking carbon capture over a wide range of applications (4% to 20% CO_2)

Why do we need hands on experience?

- → To **get acquainted with CO_2 capture in the field before applying it on any industrial installation**
- → To have access to representative experimental data (emissions, wastes) key to **support/facilitate environmental permitting process** through long-term testing
- → To **validate independently from supplier claims the performance of the proprietary solvents** (stability, emission, corrosion, efficiency, kinetics)
- → To test advanced configurations to **optimise capture costs**
- → To assess the **potential and limitations of dynamic operation** of carbon capture by testing some strategies to improve the flexibility and optimise capture costs
- → To support **troubleshooting**



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CARBON CAPTURE CLINIC

30 minute free consultation

Contact us for details: ngochan.huynhthi@engie.com

Laborelec
Supporting the entire electricity value chain

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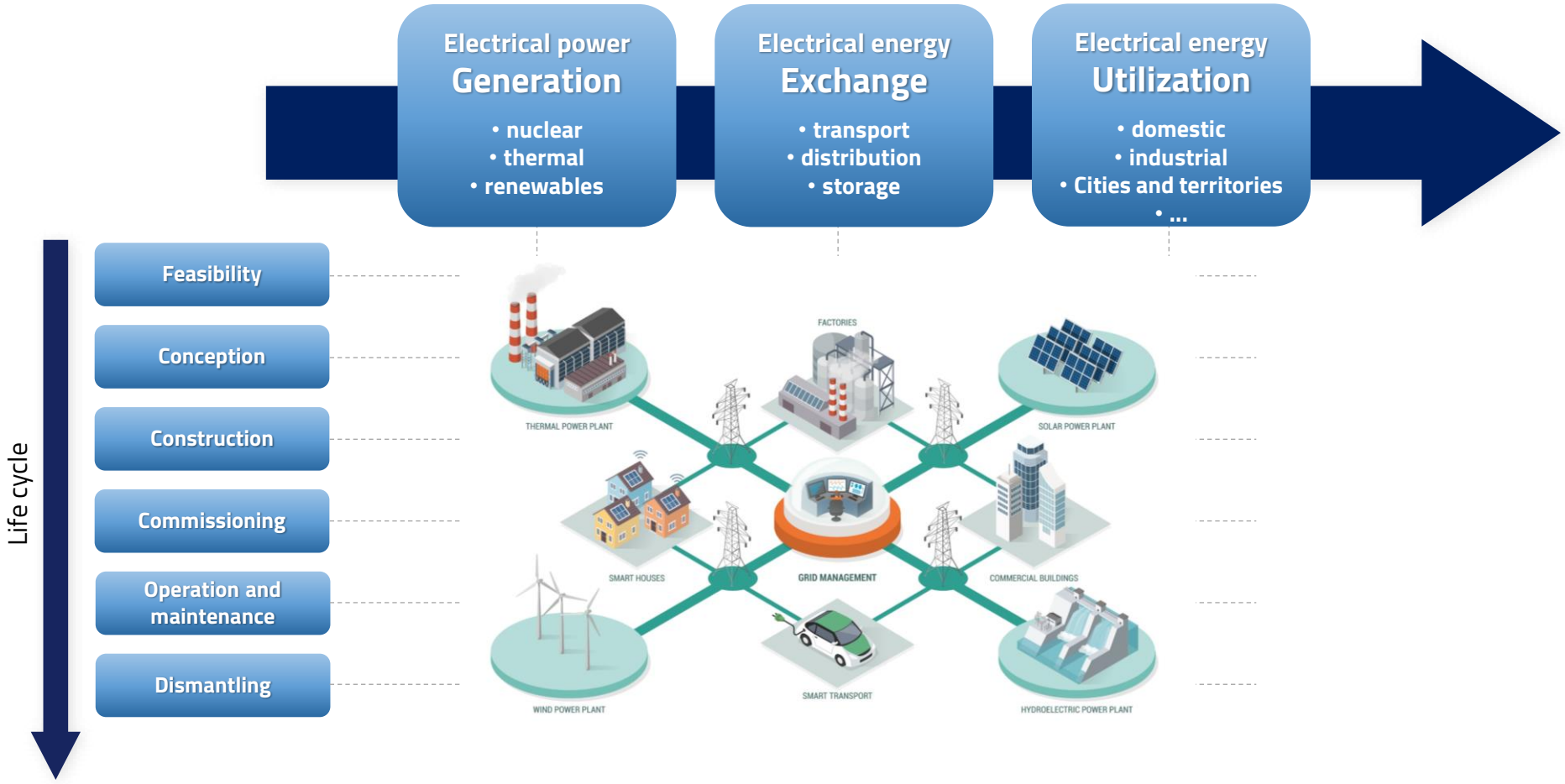

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Two complementary business models

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Examples

Research and development

Local energy communities

Pilot installation design and operation, as here in Agri-PV

Performance improvement, as here in bi-facial PV plant

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Differentiated markets:
Industry
Third parties

Customer support in OEM consultations / RCA

1

2

Operational assistance

Examples

Assessment, diagnosis and remediation, as here in end-of-warranty inspections.

Flexibility and start up improvements of the thermal fleet

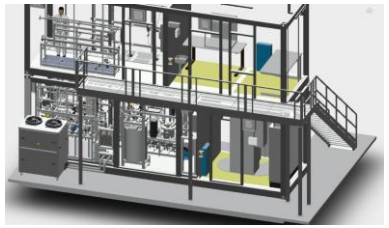
Failure analysis.

More than 15 years experience with Carbon Capture and CCU
Building technical and operational experience to support Industrialisation

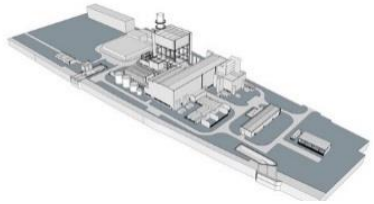
Capture Research Program

AeroSolve

Mobile Capture Unit
(commissioned Q4-2024)



Carbon Capture for thermal assets and onsite utilities



R&D → Pilot → Demonstration

E-fuel Research Program

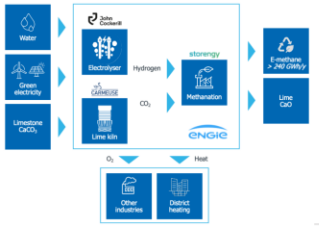
NKL

PTM – Port of Antwerp

E-methanol

Columbus

E-methane



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