

PERMA

PHOTOCHEMICAL ERADICATION OF METHANE FROM ANIMAL PRODUCTION

Participants:

AU-BCE and AU-CAE

KU Dept of Chemistry

Ambient Carbon Aps

SKOV A/S

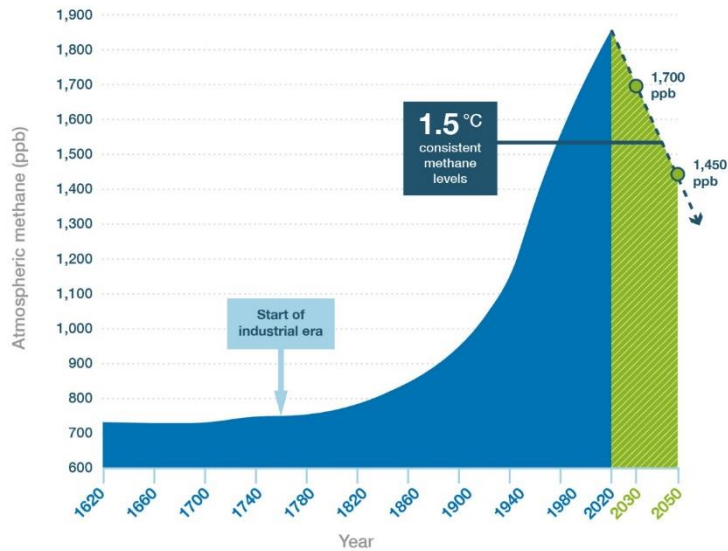
Arla Foods amba



IMPORTANCE OF METHANE MITIGATION

- International climate targets can not be reached without methane emission reduction
- National climate targets can not be reached without reducing agricultural methane emissions

Global atmospheric methane



Source: Ed Dlugokencky, NOAA/ESRL

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Limiting warming to 1.5°C at the lowest cost

By **2030**

methane emissions need to be reduced in each of the three main emitting sectors:

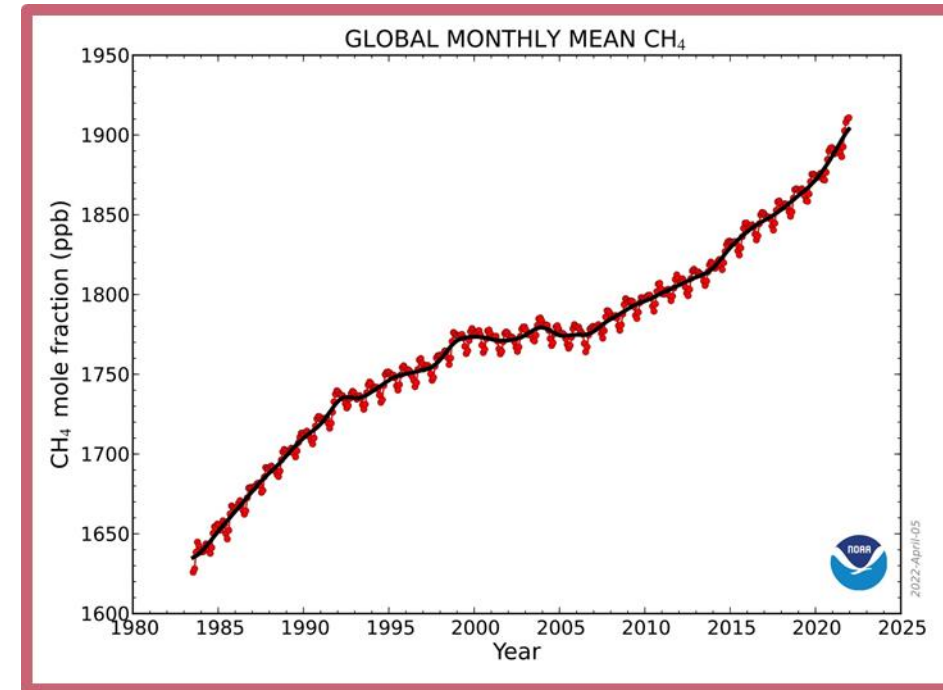


Reductions relative to 2020 emissions

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AGRIFOODTURE CONFERENCE
9 MAY 2023

ANDERS FEILBERG
PROFESSOR



LIMITED OPTIONS FOR LOW-CONCENTRATION SOURCES

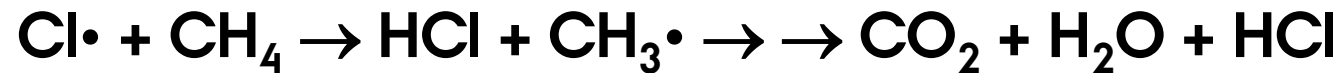
- Biological oxidation require >1000 ppm CH_4 and long residence times (=large filters)
- Catalysis: high concentrations, clean gas, pressure/temperature
- Photocatalysis limited by poor adsorption, fouling and low quantum yields

- What we need:
- Efficiency for concentrations <100 ppm
- Photochemical oxidation: Quantum yield e.g. $>7\%$ at 365 nm
- Cost <100 USD/tCO_{2e} (?)
 - Societal (global) cost of methane (O₃ formation!): 1800 USD/tonnes CH_4
 - 420 DKK/tCO_{2e}



PERMA: MEPS TECHNOLOGY

- Methane Eradication Photochemical System: MEPS
- Based on a well-known reaction in the marine boundary layer

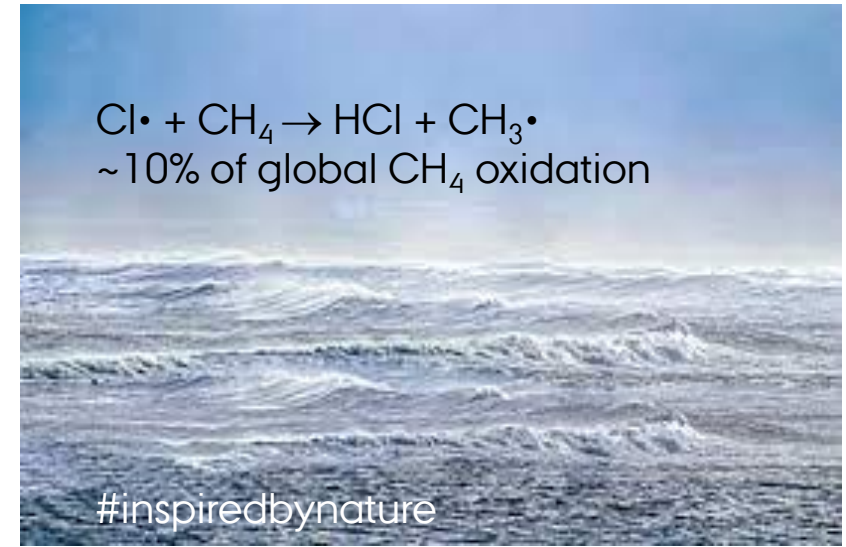


Cl• can be generated from photolysis of Cl₂

Cl₂ can be prepared from electrolysis of acidic salt water

HCl is re-used for Cl₂ production and/or pre-scrubbing (NH₃ removal etc)

Purely gas-phase process: no phase exchange, no packing material



PERMA OBJECTIVE

- Develop and test new technology for mitigating methane from agricultural sources
- Long-term primary target is methane from cattle buildings BUT...
...Project will start with pig facilities (mechanical ventilation = operational ease)

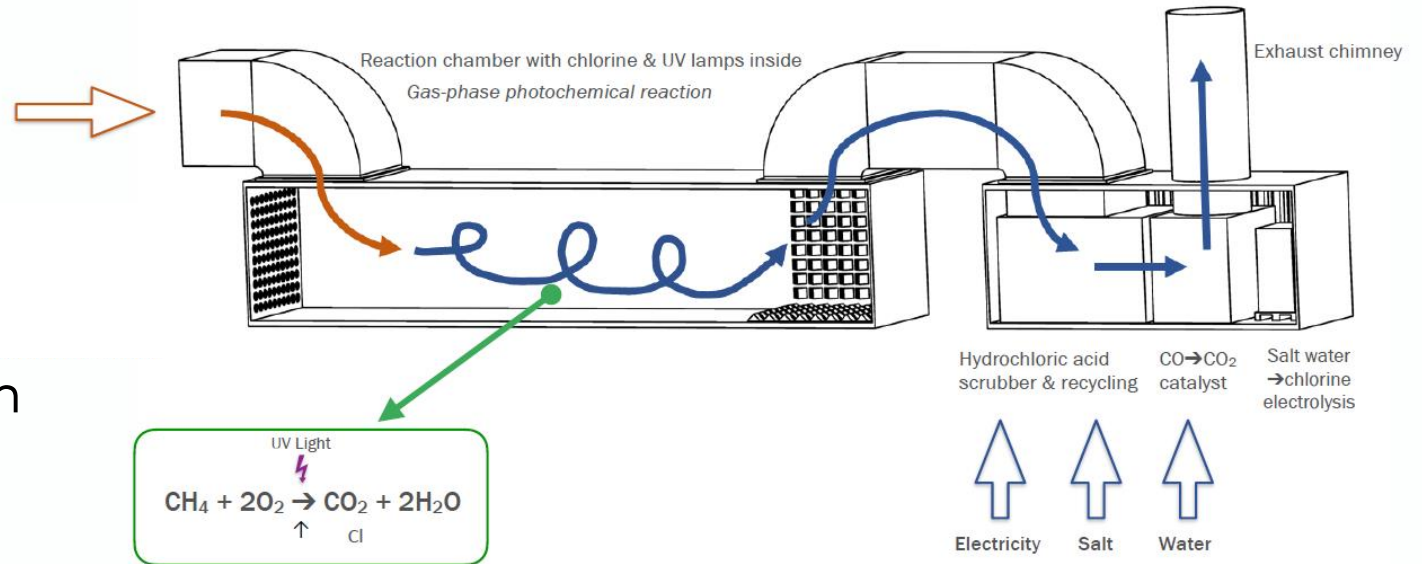
Primary goal: To demonstrate and assess technology in realistic environment with co-contaminants; dust, NH₃, VOC, H₂S

Assessment of **implementation potential** and **mitigation cost**



WORK PACKAGES

1. Process Modelling
2. Configuration of MEPS prototype
3. Ventilation and Control Systems
4. Process Optimization
5. Design Criteria and Implementation (incl. CFD simulations)



Workflow:

- Develop model for process simulation ⇒ Develop and optimize lab prototype
⇒ Test and evaluate lab scale prototype in experimental pig facility (AU)
⇒ Finalize design of large prototype ⇒ Develop ventilation and control Systems
⇒ Test and optimize ⇒ Validate models ⇒ How to implement in a cattle farm?

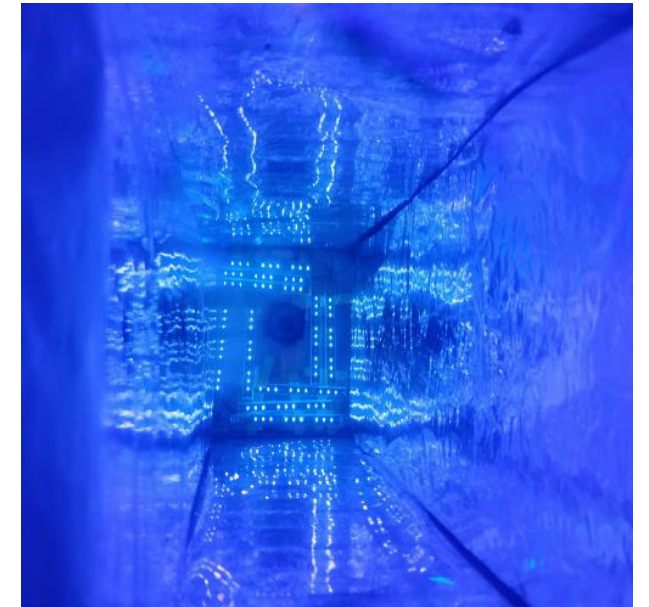
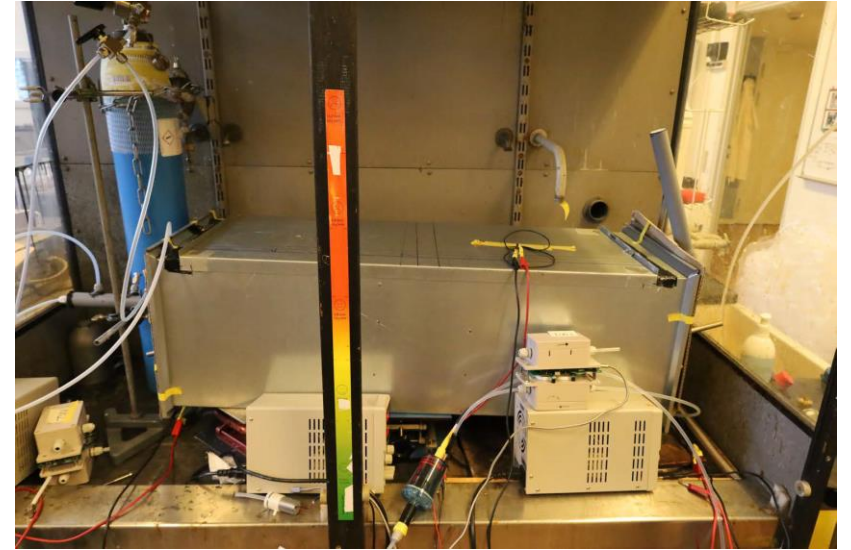


CURRENT STATUS

- Start-up delayed → Nov 2022 (budget issues resolved)
- Model framework ready in 1st version
- Lab-scale prototype in version 4:
 - Improved material selection and lamp configuration
 - Removal Efficiency 50%
Target: 90%
Not expected in lab scale due to shorter optical path

Next stages:

- Scrubber design incl. modelling
- Development of Cl₂ generation system
- First test at pig facility (AU Viborg)





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