Annual US-Norway Bilateral Meeting on CCUS

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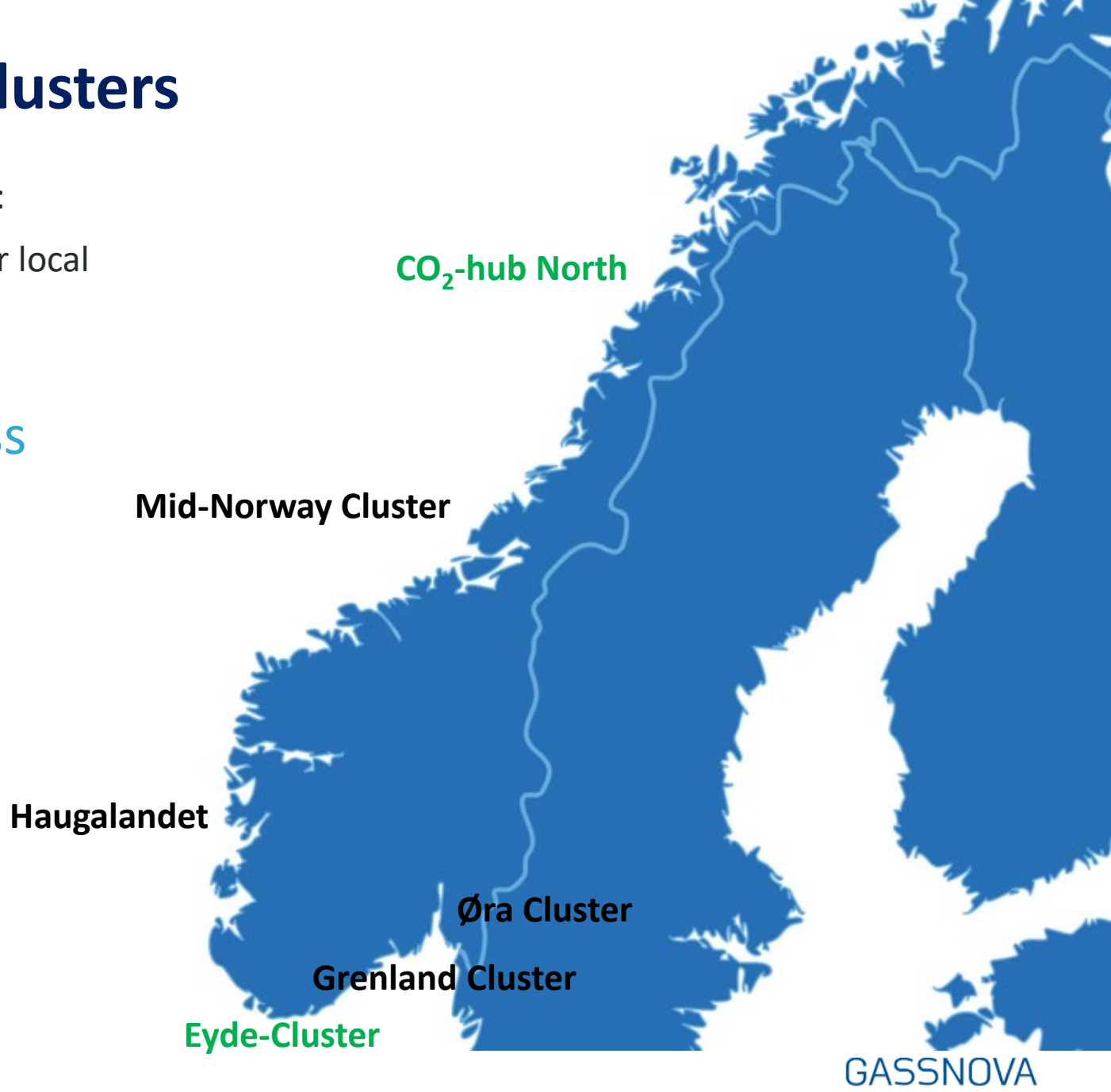
Washington, October 31, 2023

Norwegian CCUS Industry Clusters

An advantage for adjacent industry to collaborate:

- to establish sound solutions and share costs for local infrastructure, logistics and transport.
- to source larger volumes of CO_2 for storage
- each cluster with their own uniqueness

- **Aluminium**: Alcoa, Hydro
- **Biorefineries**: Borregaard
- **Cement**: Norcem (HeidelbergCement)
- **Ferro silicon & Silicon**: Elkem, Wacker
- **Ferro Manganese**: Eramet, Ferroglobe
- **Lime**: NorFraKalk, SMA Mineral
- **Paper**: Norske Skog Saugbruks
- **Petrochemicals**: Ineos, Inovyn, Equinor
- **Reinforcement steel**: Celsa
- **Waste-to-Energy**: Celsio, BIR, Forus, Statkraft, Returkraft, Kvitebjørn



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CO_2 Hub North, Northern Norway

Testing of Carbon Capture in Ferrosilicon/silicon and Lime Industry

- The world's first test of CO_2-capture in ferroalloy industry
- MTU from Aker Carbon Capture
- Capture from two different sources + combination
- Integration of energy systems and pretreatment of flue gas

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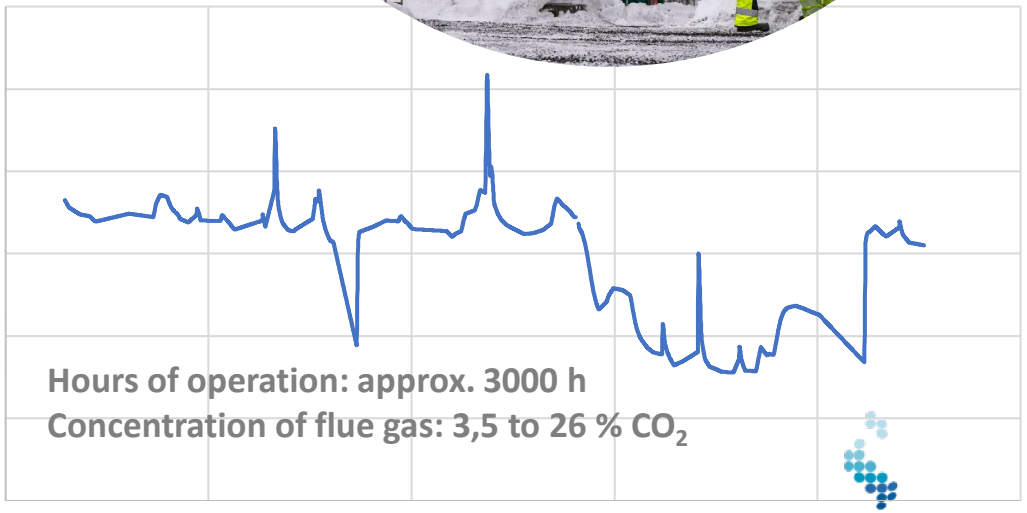
First results

- No showstoppers have been discovered
- High capture rate 90 to 95%
- Testing on flue gas with large dynamics
- Achieved good stability in the capture process
- Emission measurements – promising results



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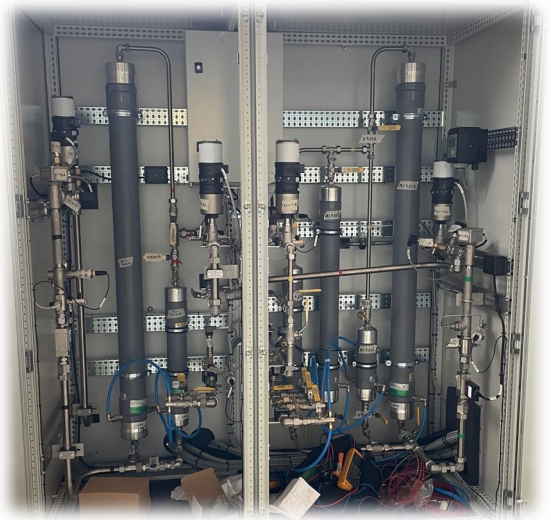
Returkraft

Waste-to-Energy

Southern part of Norway

Testing of Air Products PRISM membranes on flue gas from WtE

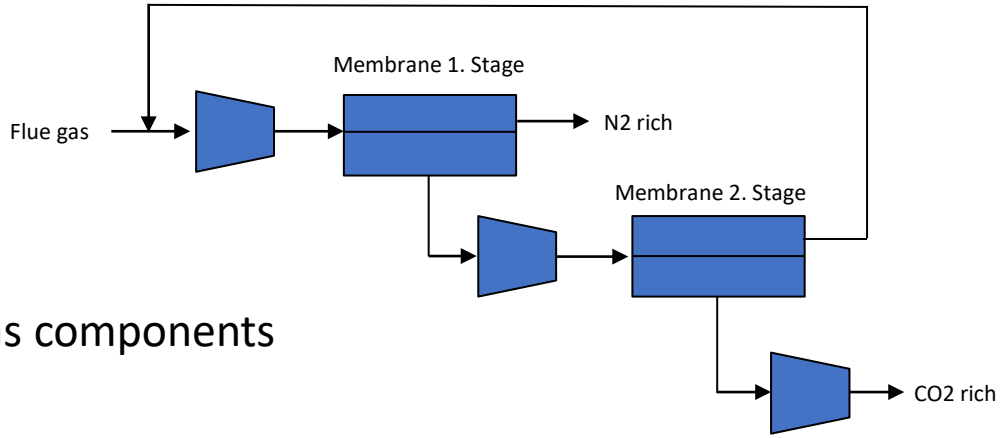


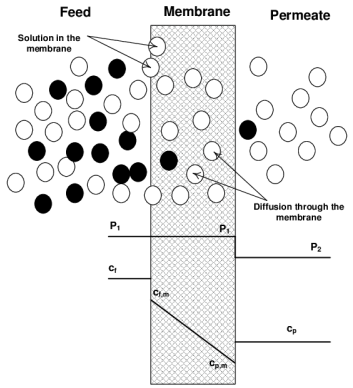
Project scope

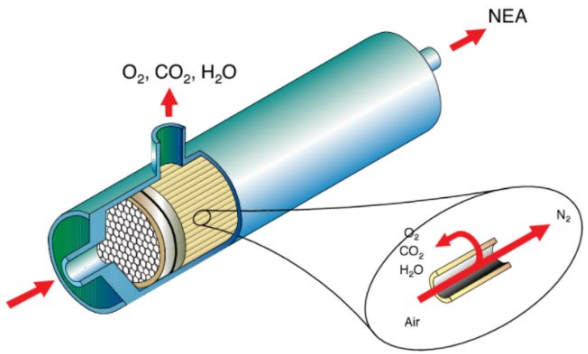
- Small-sized pilot; demonstrating one full scale membrane unit
- Start of testing May 2023 – end of testing May 2024
- Flexible pilot with possibilities to test different capture modes

Goals

- Demonstrating PRISM membrane in flue gas from WtE
- :Test different capture modes:
  - >50% capture rate (fossil-based share of waste at Returkraft)
  - 90% capture rate
- Evaluate membrane lifetime in exposure to SOx, NOx and other flue gas components
- Demonstrating full scale process design







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Results

Status after six months
- Initial performance results:

Very promising results:

- Capture rate above 55%
- CO_2 permeance - better results than expected
- Selectivity (CO_2/O_2 and CO_2/N_2) - better results than expected
- Membrane Advantage: No emissions

Next steps:

- Test two membrane stages (goal: 90% capture rate)
- Evaluate membranes after long time exposure to SOx, NOx and other flue gas components

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Thank you for your attention!

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We share our CCS knowledge

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