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#8 REDUCING COST AND RISK IN CO_2 CAPTURE THROUGH REAL-PLANT OPERATION AND KNOWLEDGE SHARING

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MODERATOR

Dr. Svein Ingar Semb

SENIOR ADVISOR

GASSNOVA

Dr. Svein Ingar Semb is a senior advisor at Gassnova. He currently leads the state's ownership follow-up of the Technology Centre Mongstad (TCM) and serves as Chair of the Board of Directors, guiding the strategic development and governance of the world's largest and most flexible test centre for CO_2 capture technologies.

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Muhammad Ismail Shah

CEO

TECHNOLOGY CENTRE MONGSTAD (TCM)

Muhammad Ismail Shah has been working earlier in the same company as Technology Manager and Principle Process Specialist for Carbon Capture Technologies since 2016. Shah is seconded to TCM from Gassnova SF and have been working with TCM project since 2011.

Muhammad Ismail Shah has over 15 years of experience in CO_2 capture from industry, research, development and academia.

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TECHNOLOGY CENTRE MONGSTAD

– catching our future

TCM’s Role in CCS Deployment

Knowledge Sharing Summit (Norway)

15 April 2026

TCM bridges the gap between technology development and commercial deployment.

GASSNOVA

equinor

TotalEnergies

TECHNOLOGY CENTRE MONGSTAD

– catching our future

KEY FACTS

Industrial environment

Two flue gas sources (1–20% CO_2); 24/7 operation under emission permit

Post-combustion capture technologies

Amine capture plant

Site for Emerging Technologies

Capacity

Amine plant: 75,000 tCO_2/yr

Site for Emerging Technologies: up to 18,000 tCO_2/yr

Analytical & laboratory capabilities

Sophisticated data collection and analytical methods

State of the art laboratory

TECHNOLOGY CENTRE MONGSTAD

Tested 17 different Technologies

> 40,000 hrs
Proprietary Campaigns

Solvent Technologies

Start 2012

Capturi · ALSTOM · Cansolv 1st campaign · Carbon Clean Solutions · Cansolv 2nd campaign · ION CLEAN ENERGY · FLUOR · MITSUBISHI HEAVY INDUSTRIES · RTI INTERNATIONAL · Cansolv 3rd campaign · ION CLEAN ENERGY 2nd campaign · Honeywell

2026 >

Start 2020

Emerging Technologies

MTR · TDA · SAIPEM ACCSESS · PROSPIN ACCSESS · MOF4AIR · InnoSepra · Svante

Sponsored by TCM Owners, DOE, EC and CLIMIT

> 26,000 hrs
Non-proprietary Campaigns

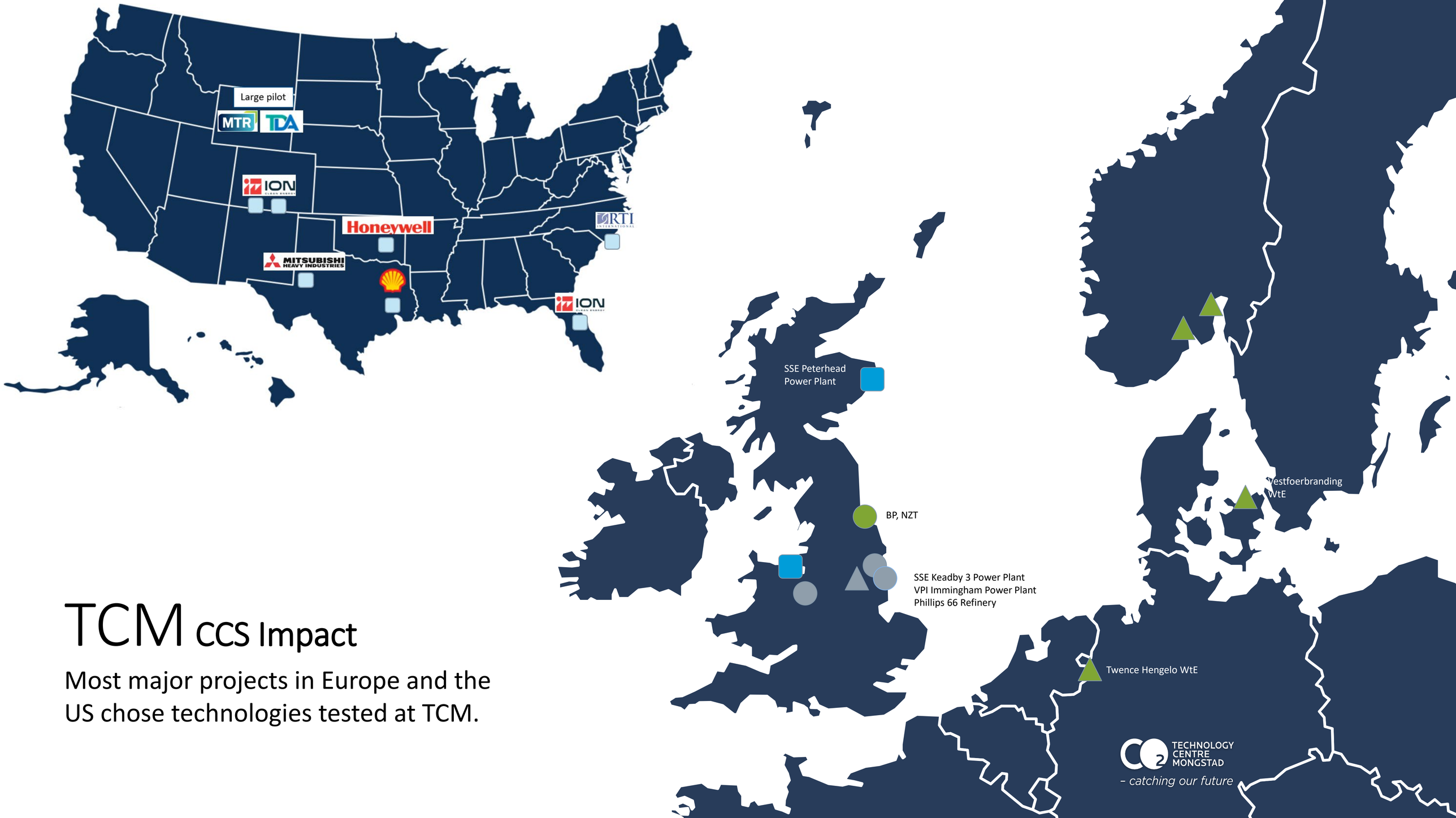
> 70
Scientific publications

2013

2026 >

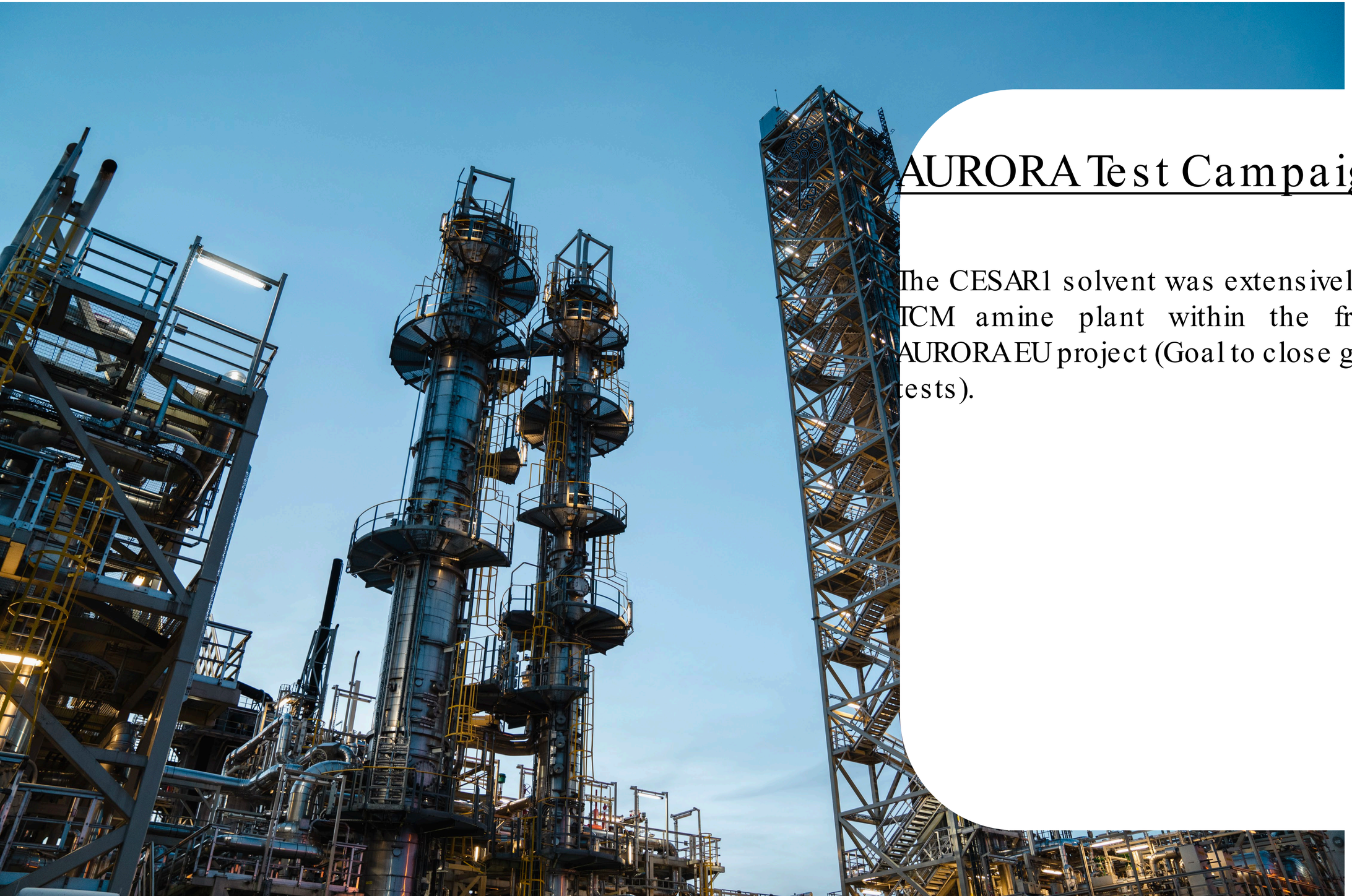
MEA-1 | MEA-2 | MEA-3 | MEA-4 | MEA-5 | Align-CCUS | CESAR-1 | AURORA | Owners Campaign

TECHNOLOGY CENTRE MONGSTAD



TCM CCS Impact

Most major projects in Europe and the US chose technologies tested at TCM.



AURORA Test Campaign 2025

The CESAR1 solvent was extensively evaluated at the TCM amine plant within the framework of the AURORA EU project (Goal to close gaps from previous tests).

TECHNOLOGY CENTRE MONGSTAD

Aurora – Key Outcomes of the Campaign

- Resolved solvent precipitation challenges, significantly extending the operational window.
- Assessed CO_2 product quality (Northern Lights specifications), including impacts from solvent degradation.
- Completed first CESAR1 testing with MHP flue gas, establishing a WtE-representative baseline.
- Pioneered testing at elevated CO_2 concentrations (up to 20 vol%) for cement and steel applications.
- Demonstrated CESAR1 operation at very low CO_2 concentrations (down to 1.5 vol%) for aluminum applications.
- Controlled exposure to high NO_2 levels in MHP flue gas to characterize degradation pathways.
- Assessed high-pressure regeneration as a potential operational enhancement for CESAR1.

TECHNOLOGY CENTRE MONGSTAD

CESAR1 – Open Campaign Sponsorship Opportunity

- What it is: Sector benchmarking campaign (Q4 2026)
  - Natural Gas Combined Cycle (NGCC)
  - Waste-to-Energy (WtE)
  - Cement, Steel, Refining, Aluminum
- KPIs
  - Capture efficiency and energy consumption
  - Solvent management and emissions
  - Dynamic and part-load operation
  - CO_2 product quality for transport and storage
- What you get
  - Access high-quality, large-scale benchmarking datasets
  - Engage directly with TCM experts during onsite visits
  - Contribute to and benefit from cross-industry technical discussions and lessons learned.


- catching our future

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Jim Stian Olsen

CHIEF TECHNOLOGY OFFICER

SLB CAPTURI

Jim Stian Olsen holds a PhD in mechanical engineering and has a strong background in research and innovation within several disciplines He has served as Chief Technology Officer at Aker Carbon Capture and later SLB Capturi, leading technology and product development as well as pilot-to-commercial deployment of advanced capture solutions.

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CARBON DIOXIDE REMOVAL MISSION

Operational experience from commercial carbon capture projects

Jim Stian Olsen, Chief Technology Officer

Gassnova Knowledge Sharing Summit 2026

slb Capturi

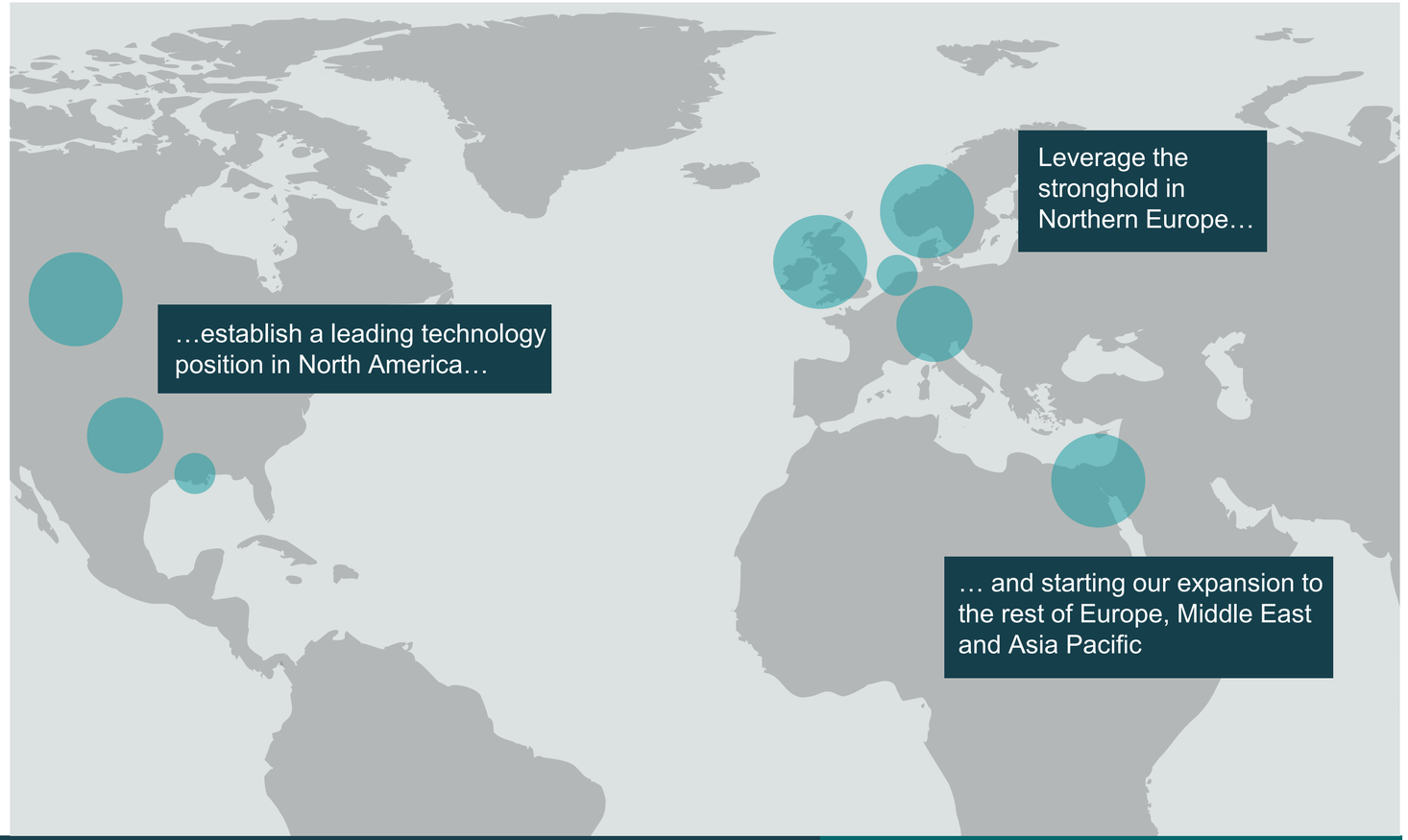
SLB Capturi in brief

Accelerating the industrial decarbonization through:

→ Leveraging our product platform with modular and configurable capture plants

→ Providing an environmentally friendly portfolio of proven and emerging technologies

→ Expanding our presence globally



Key segments

- Cement
- Bio/Waste-to-energy
- Pulp and paper
- Gas-to-power

Engaging with emitters such as refining and process industries

slb Capturi

Innovation from lab to proven operations

Solvent performance
- → Energy demand
- → Solvent degradation
- → Environmental impact

Energy optimization
- → Heat integration
- → Proprietary technology developed for optimal energy efficiency
- → Compressor waste heat recovery

Emission control
- → AntiMist™
- → Flue gas expertise

Screening of 80+ solvents

Industrial pilot testing

Full-scale validation at TCM

Delivered and commercially proven

90 000 hours of operational experience across 14 industrial flue gases

slb Capturi

Delivering carbon capture solutions today

TWENCE CCU

Waste-to-energy, Netherlands

Just Catch™ 100

Capacity: 100,000 TPA

BREVIK CCS

Cement plant, Norway

Big Catch™

Capacity: 400,000 TPA

KALUNDBORG CCS

Biomass Power stations, Denmark

5 x Just Catch™ 100

Capacity: 500,000 TPA

OSLO CCS

Waste-to-energy, Norway

Just Catch™ 400

Capacity: 400,000 TPA

slb Capturi

Lessons learned and key take aways – project execution

- Close cooperation with customer is key
- Right level follow-up of suppliers is important
- Timely maturation of engineering design
- Minimize site work and maximize pre-fabrication
- Modular approach in design, manufacturing and construction increases execution efficiency
- Insulation and scaffolding on site is complex
- CO_2 specific competency is important
- Operator training simulator for efficient training and commissioning debugging

Twence operational learnings

Challenges during commissioning:

- Challenges related to the interface between the carbon capture unit and the compressor and liquefaction unit
- Compensating measures to reduce noise levels at adjacent neighborhood

Operational performance

- Stable capture performance
- Key performance parameters well within design margins
- Operational performance is matching our process simulation models
- Producing food grade CO_2

slb Capturi

Brevik operational learnings

Challenges during commissioning:

- Several debottlenecking challenges, particularly in the CO_2 conditioning unit
- Equipment challenges
- Impact of dust and flue gas quality

Capture performance

- Good capture rate and capture capacity
- Successful implementation of heat integrated compressor solution delivered together with Everllence
- CO_2 at Northern Lights spec

slb Capturi

Summary

- Our capture technology works well, also in commercial plants
- We have to understand and consider the full system including external plant
- The devil is in the details
- Collaboration with customers and suppliers is crucial to solve the difficult problems
- We implement all learnings into our products and ongoing projects

slb Capturi

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Thank you!

Visit us at:
capturi.slb.com

Impact at scale

slb Capturi

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SPEAKER

15 April

#8 Reducing Cost and Risk in CO_2 Capture Through Real-Plant Operation and Knowledge Sharing

16:35-16:50

Marie Bysveen

Chief market developer., PhD

SINTEF

Dr. Marie Bysveen (57) holds a PhD in Marine/Mechanical engineering from NTNU/INRIA (France). Bysveen has research experience from NTNU in the field of environmental energy and transport technologies. Dr. Bysveen has also several years of experience from the oil & gas business and from energy consultancy. Since 2006 she has been working at SINTEF Energy Research, where she has been involved in a wide range of energy research, especially focusing on Carbon Capture and Storage (CCS), Bioenergy, Oil&Gas – and Smart Cities and Communities (SCC).

She is the director of the EERA Joint Programme on CCS since several years, and in charge for the CO2 capture work on the SET Plan Implementation working group 9. She is also co-chair Technical Working Group in ZEP. She has been the coordinator and chair of the board of several large R&D projects within the field of CCS.

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Redefining European R&I priorities for CO_2 capture in times of change

April 15th 2026

Marie Bysveen, dr.ing
Chief market director *SINTEF Energi*
Director EERA JP CCS
Co-chair ZEP Working Group Technology

CO_2 capture in a changing Europe

- Europe’s decarbonisation landscape shifting faster than expected
- Geopolitics, energy security, industrial competitiveness and climate policy intersect
- CO_2 capture is no longer a niche technology but a strategic industrial capability
- R&I priorities must evolve to match this new reality

Entering a decade where CO_2 capture becomes a structural part of Europe’s industrial system

EU & geopolitics: Why R&I priorities must shift

- Global competition accelerates need for EU innovation
- North Sea storage capacity a strategic asset for Europe
- Security of CO_2 infrastructure and cross-border transport is emerging as a policy concern

R&I must support a resilient, secure and scalable European CO_2 management system

European ICM policies: New signals for R&I

- EU Industrial Carbon Management Strategy (2024) sets clear
- Net-Zero Industry Act positions CCS as a strategic technology
- Innovation Fund and ETS revenues targeted at industrial decarbonisation
- Stronger focus on clusters, hubs, and cross-border CO_2 networks
- What about FP10 and partnerships ?

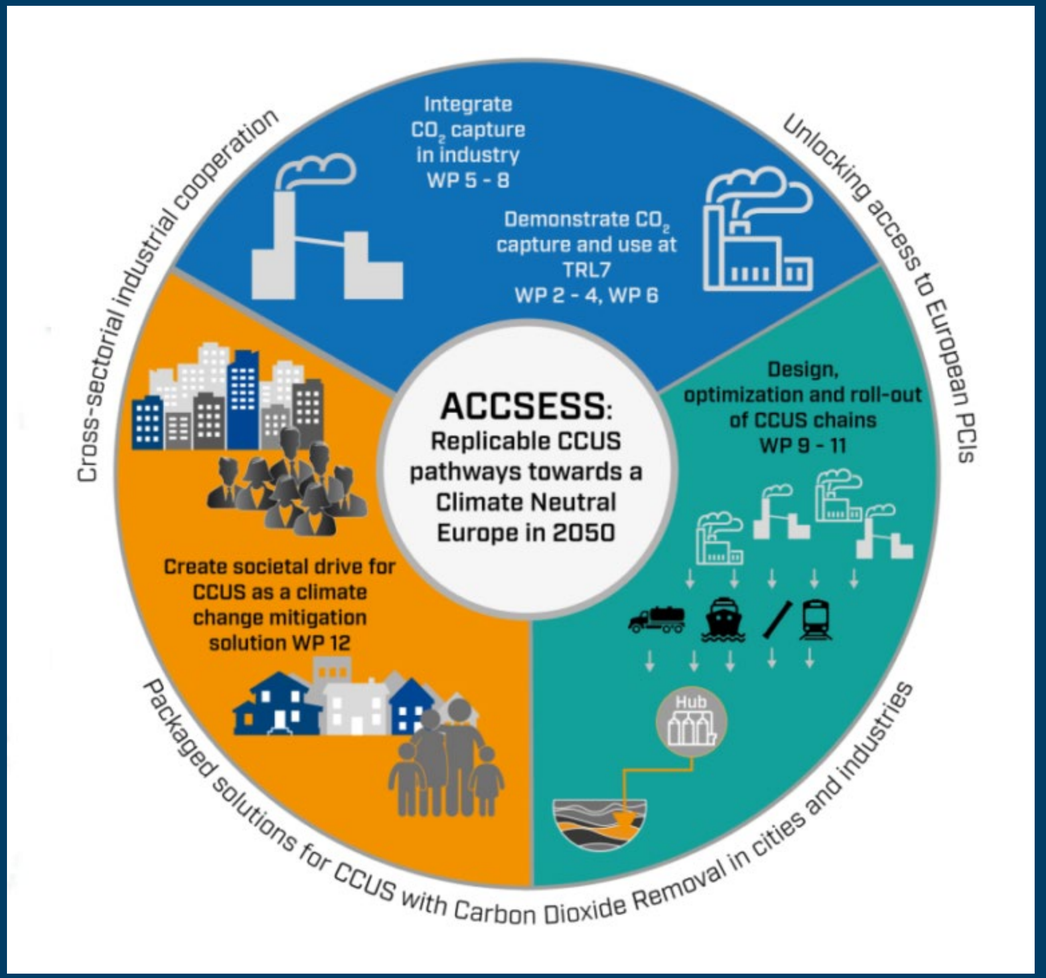
R&I must align with policy needs: faster deployment, lower costs, and system integration

R&I in industry-driven projects

What we learn from projectrs like ACCSESS & CCWaste4NetZero

- Innovation Actions reveal real-world barriers: permitting, integration, cost, logistics, public acceptance
- Industrial capture needs flexibility: variable flue gas, space constraints, operational realities
- Waste-to-energy and cement show the importance of tailored capture solutions
- Projects generate insights beyond technology: governance, city-industry interfaces, societal impacts

R&I must be informed by industrial practice — not only lab-scale innovation



European Strategic Energy Technology Plan (SET Plan)

A main instrument for R&I & Competitiveness for low-carbon technologies

Improving new technologies and bringing down costs through co-ordinated national research efforts

Helps promote and co-ordinate national R&I activities among EU countries and associated countries

–

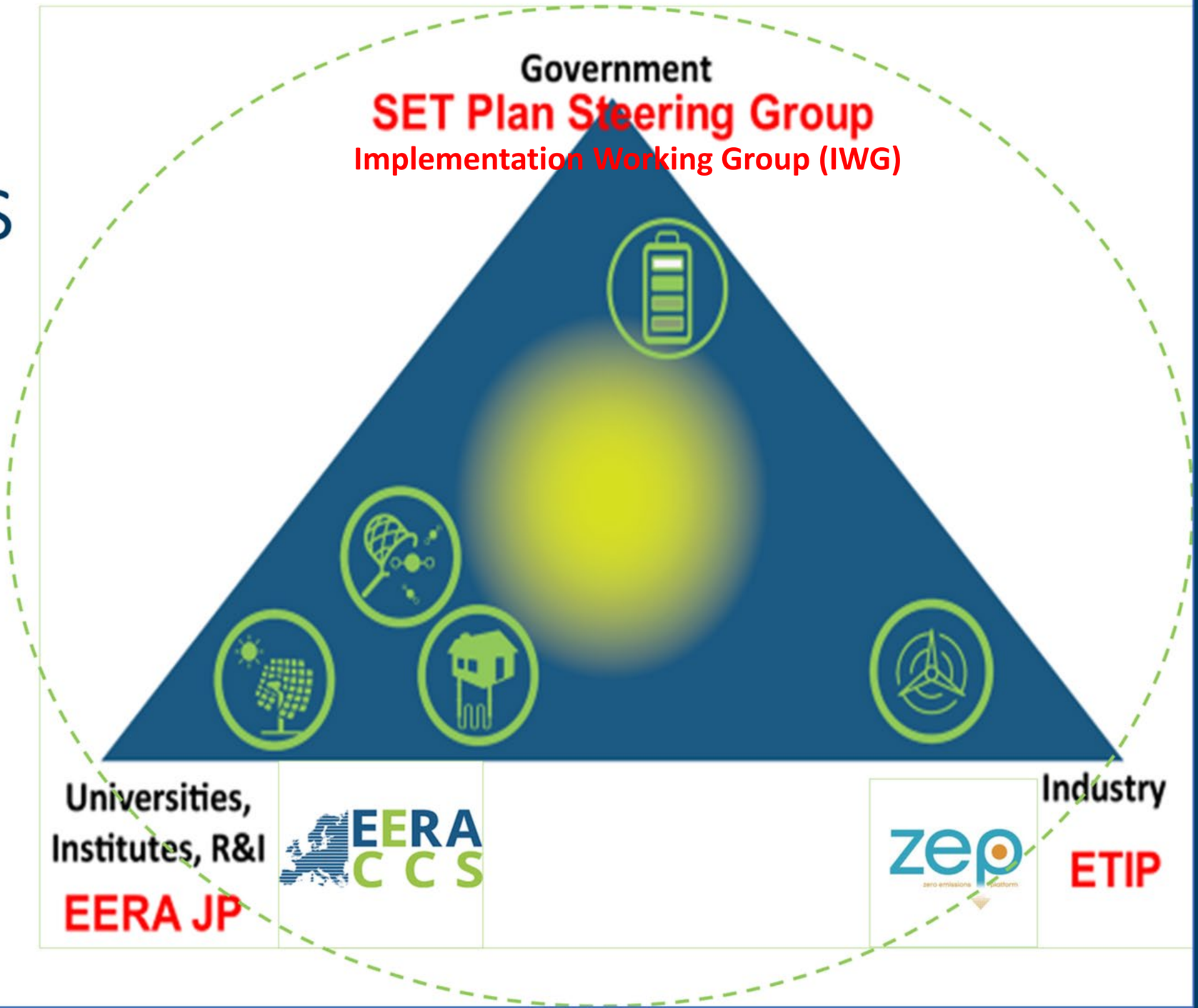
as well as aligning national R&I programmes

Co-chairs CCUS SET Plan IWG

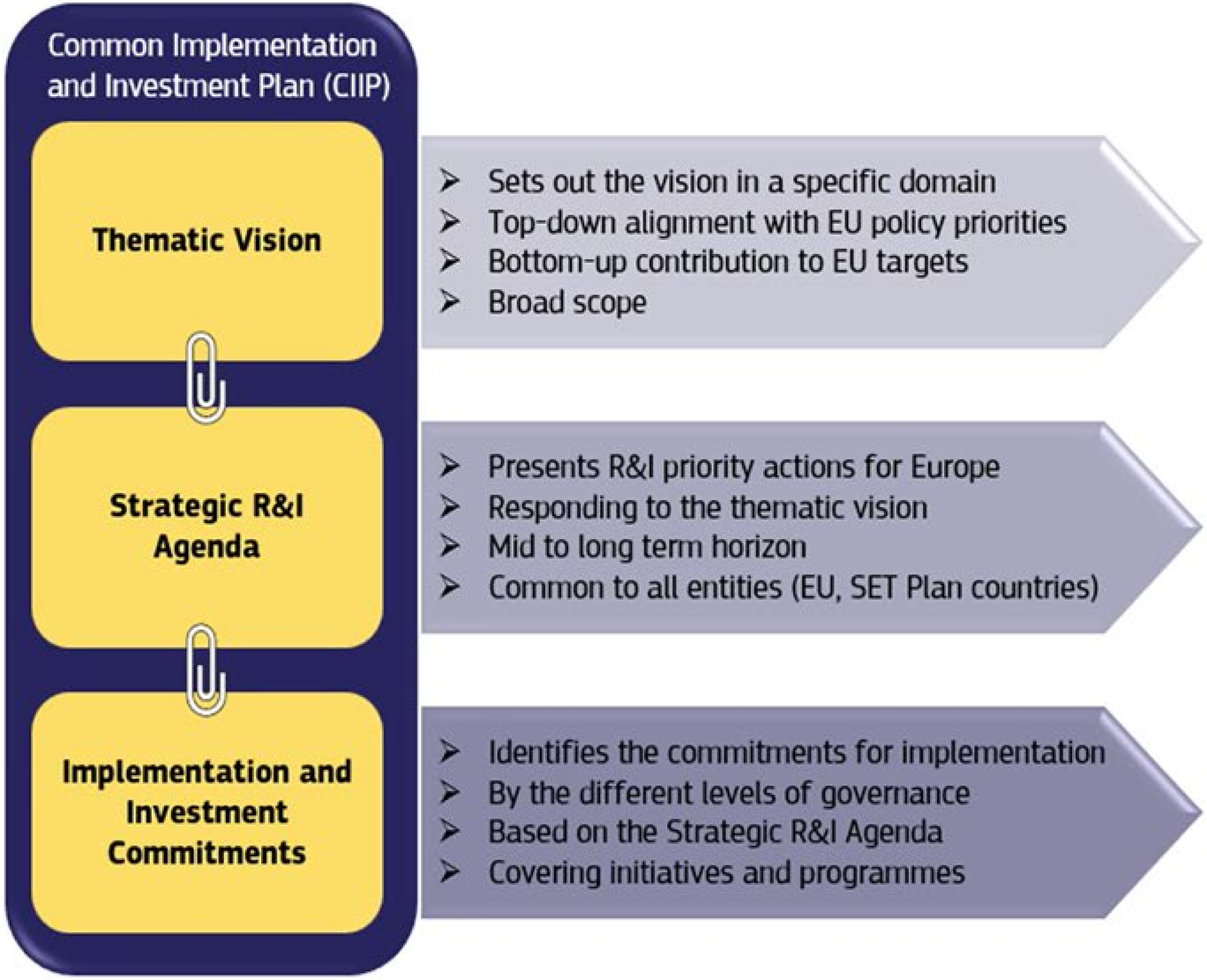
Formal

SET PLAN ACTORS

1. ETIPs: European Innovation and Technology Platforms
2. EERA: European Energy Research Alliance
3. Governments: National and EU COM



SET Plan governance deliverables



Common Implementation and Investment Plans (CIIPs) are comprehensive action plans developed by each Implementation Working Group (IWG) which set out

1. the Vision and goals for a specific technological or thematic area,
2. the Strategic Research and Innovation Agenda (SRIA) needed for achieving this vision with concrete priorities, and
3. the Implementation and Investment Commitments from governments, industry and stakeholders across Europe to help implement the SRIAs.

SET Plan timeline 2026-2027

SINTE
75 år

CCUS SET-PLAN

zep zero emissions platform

FROM REVISION 2024

Support stakeholders on Carbon Capture Utilisation and Storage of ETIP ZEP and IWG9

Deliverable 1.4 Review of the IWG9 R&I activities and targets

Author(s)/Editor:

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María Midón	Zero Emissions Platform

This project has received funding from the European Union's Horizon Europe research and innovation programme under the grant agreement 101075790

Contents

Report here – see page 19

Redefining R&I priorities for the next decade

Cost & performance

- Modular, low-CAPEX capture
- High-T and process-integrated solutions

Infrastructure & system integration

- CO_2 quality standards, digital monitoring, network optimisation
- Security and resilience of CO_2 transport systems

Cross-sectoral innovation

- Waste-to-energy, cement, chemicals, and urban emitters
- Integration with district heating, hydrogen, and circular economy

Societal and policy innovation

- Public acceptance, permitting, governance models
- Financing frameworks and risk-sharing mechanisms

NEW UPDATE underway 2026
PLEASE ENGAGE

Europe needs R&I that is faster, more integrated & connected to industrial and societal needs

SINTEF
75 år

EERA CCS

CCUS SET-PLAN

zep
ZERO EMISSIONS PLATFORM

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Tor Gautestad

CCS MANAGER

HEIDELBERG MATERIALS

As M.Sc. graduate from Faculty of machinery at NTH in Trondheim I joined Norcem Brevik in 1992. Since then, I have had a variety of positions and challenges within what has become Heidelberg Materials, and since 2018 I have been full time engaged in Brevik CCS project as Project Manager, Operational Manager and currently as CCS Manager.

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Brevik CCS
April 2026

Tor Gautestad, CCS Manager, HM Brevik

19/04/2026

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Cato Christiansen

CHIEF TECHNOLOGY OFFICER

CAPSOL TECHNOLOGY

More than 20 years' experience within CCUS from Shell, Ministry of Energy and now Capsol Technologies, including different roles during planning and operation of Technology Centre Mongstad and later also the Longship project. Cato is a former member of the CLIMIT program board and a current board member for CCUS Norway.

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capsol technologies

Licensor of point source carbon capture technology

Carbon capture and heat recovery in one system for energy production and hard-to-abate sectors

April 2026

Collaboration

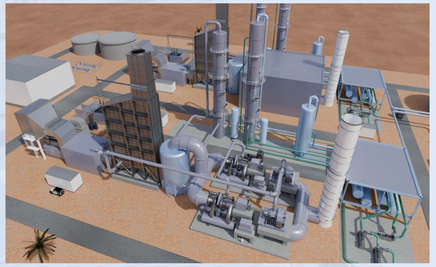
- **Equipment Manufacturers**
  - Rotating equipment
  - Column internals
  - Heat exchangers
- **Engineering EPCs**
  - Process Design Package
  - Modularization
- **Emitters**
- **Transport and storage**
- **Project developers**

HOLCIM
Munters
SAIPEM
Everllence
Sumitomo SHI FW
SIEMENS energy
GE VERNOVA
STOREGGA

Products for hard to abate industries & gas power

CapsolEoP®

CapsolGT®



Demonstration

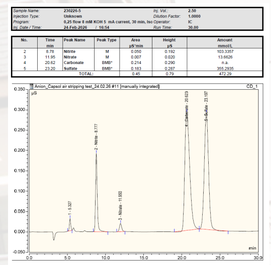
- **10 campaigns, 20 000 hours**
- **Different industries & fluegases**
- **BECCS /WtE/Cement**
- **Liquefaction – CO_2 quality**

CapsolGo®

capsol technologies

Core Technology – Innovation, R&D

- **Industrial applications**
- **Improved solvents**
- **Solvent management**
- **Process equipment**
- **Modelling**
- **Academic collaboration**
- **Joint Industry Projects**



capsol
technologies

7th floor, Thune Eureka Building
Drammensveien 126
0277 Oslo
Norway

capsoltechnologies.com

Our vision is to accelerate the worlds
transition to a net zero future

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Travis Brookson

LEAD, Global Storage Partnerships & Europe Project Development
SVANTE

Travis brings a unique perspective to Svante as a former geologist in the oil and gas sector. His geotechnical expertise, analytical approach, management experience and broad understanding of the sector from reservoir to end-user is a benefit to our Svante Development team.

Travis received his Bachelor of Science in Geology and his Master of Science in Sustainable Energy Development from the University of Calgary.

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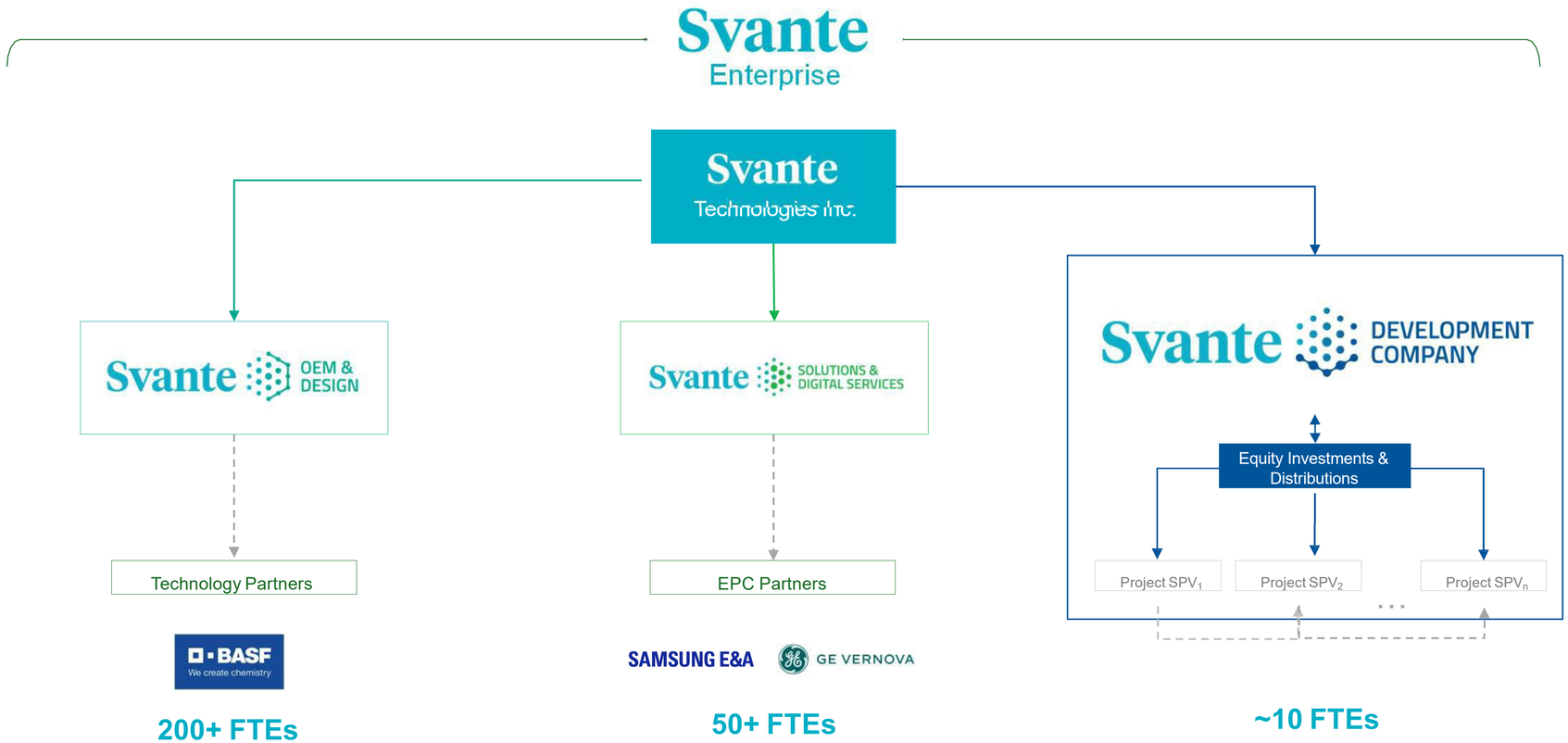
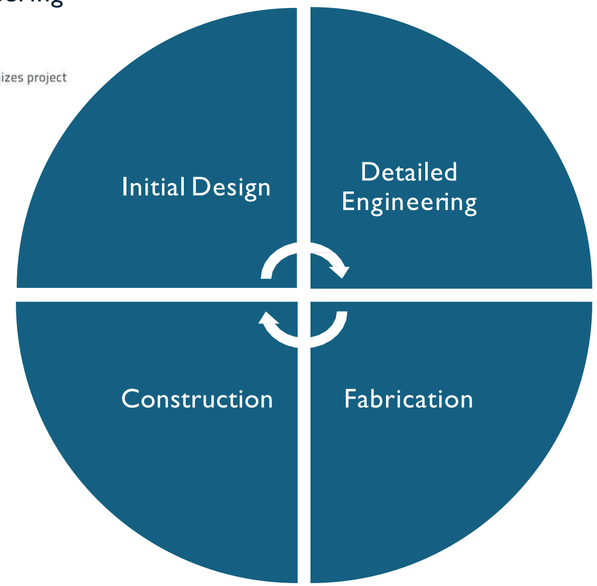
Svante – an OEM, Engineering, and Development Business



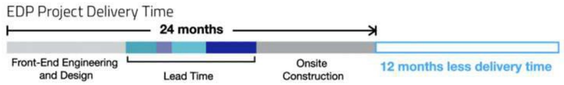
Why Standardized Modular CO_2 Capture Plant?

Automation & Data Integration for Engineering Deliverables.

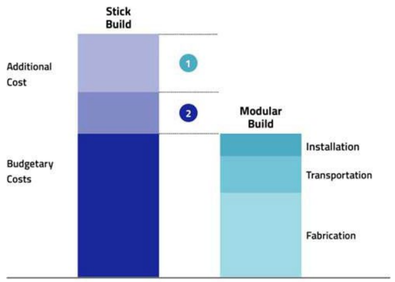
AHEAD® SAMSUNG E&A's proprietary AHEAD model revolutionizes project execution through automation and data integration.



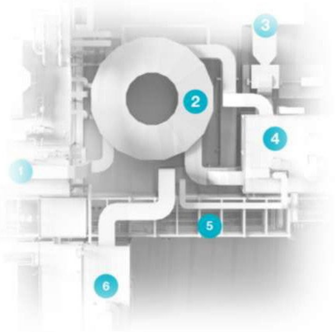
Shortened FEED schedule leveraging on the C-Ready joint effort = faster FID decisions. Bringing constructability into the early project phases =de-risk execution, lock in cost and schedule certainty



Faster construction schedule and less cost overruns than traditional stick build.



Modularized fabrication & optimized shipment = **20%-30% CAPEX reduction.**



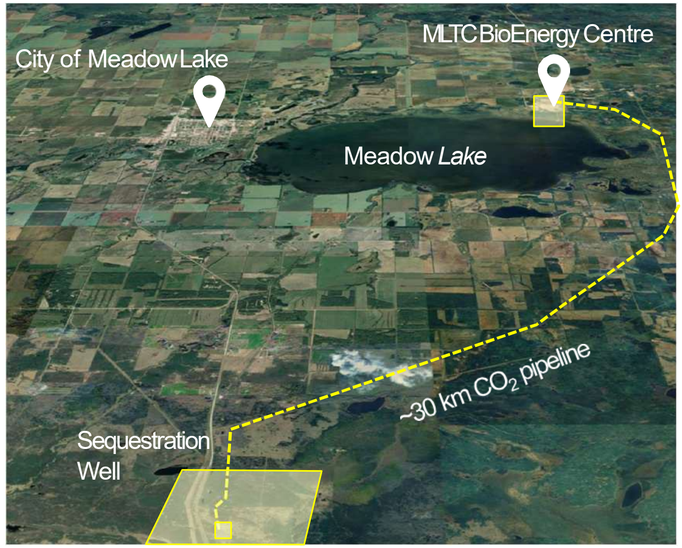
Svante

Saskatchewan, Canada Project – MLTC BioEnergy Centre

North Star Project Overview

- Svante acquired Carbon Alpha and their North Star project on March 1
  - North Star is 49% Carbon Alpha / **51% First Nations-owned (MLTC)**
- Carbon capture will be at installed at an **existing biomass CHP plant**
  - Deploying proven BASF amine technology
- Will soon start FEED engineering, with **target FID Feb 2027 and COD 2Q 2029**
- Will generate **~90,000 tpa of CDR credits**, based on biogenic CO_2 capture plus associated fossil CO_2 capture for a total of ~140,000 tpa of sequestration
  - Microsoft anchor offtake for ~50% of volume for 15-years, announced April 6th
- **Integrated project reduces schedule risk** and commercial complexity:
  - Project will build the full CCS value chain – capture plant, CO2 pipeline and sequestration well. Already has Saskatchewan lease of pore space agreement
  - MLTC owns the full biomass value chain – harvesting, sawmill and bioenergy
- **Sustainably sourced biomass** – high importance to MLTC; FSC/SFI certifications
- **Competitive CDR pricing** enabled by Canadian 50% CCUS ITC

Biomass CHP in Meadow Lake, SK



CDR marketing is underway, with target to finalize offtake in 2026.

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Panel session

Svein Ingar Semb,
Moderator

Cato Christiansen,
Capsol Technology

Jim Stian Olsen,
SLB Capturi

Muhammad Ismail Shah,
TCM

Marie Bysveen,
SINTEF

Tor Gautestad,
Heidelberg Materials

Travis Brookson,
Svante

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SUMMING UP

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17:30-17:40 BREAK

Walk to conference hall - “Parksalen”

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