
NCCS
NORWEGIAN CCS RESEARCH CENTRE
Industry-driven innovation for fast-track CCS deployment
fme
CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
The Research Council of Norway

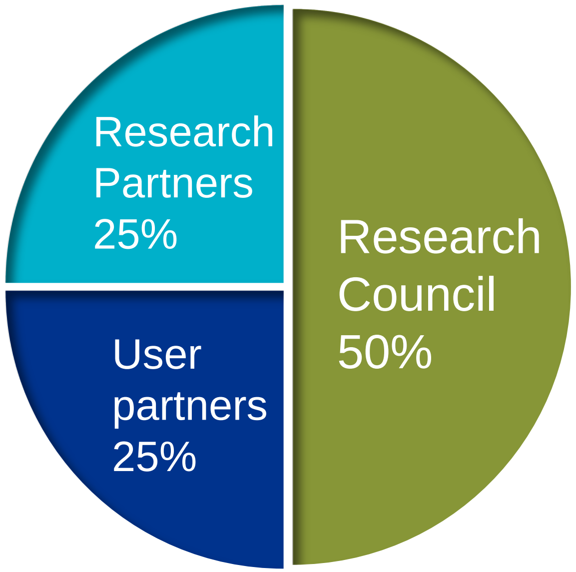
From NCCS kick-off November 4, 2016

*-To **fight climate change** we need to both consume and produce more efficiently, have **more renewables**, replace coal with gas and **make CCS a reality**.*

*-We need thousands of CCS projects, global deployment and cost reduction. In order to achieve this, **NCCS will be an important instrument***

Opening of FME NCCS,
Trond Lien, Minister of Petrolium and Energy, Norway

Funding model



- **Duration:** 8 years (5+3 years) (2016-2024)
- **Budget: NOK 464** million (€48.8 mill.)

About the Centre

38 millions

8 years

2016

2022

26 partners

7 associated partners

NCCS objective

Full-scale CCS chain in 2022

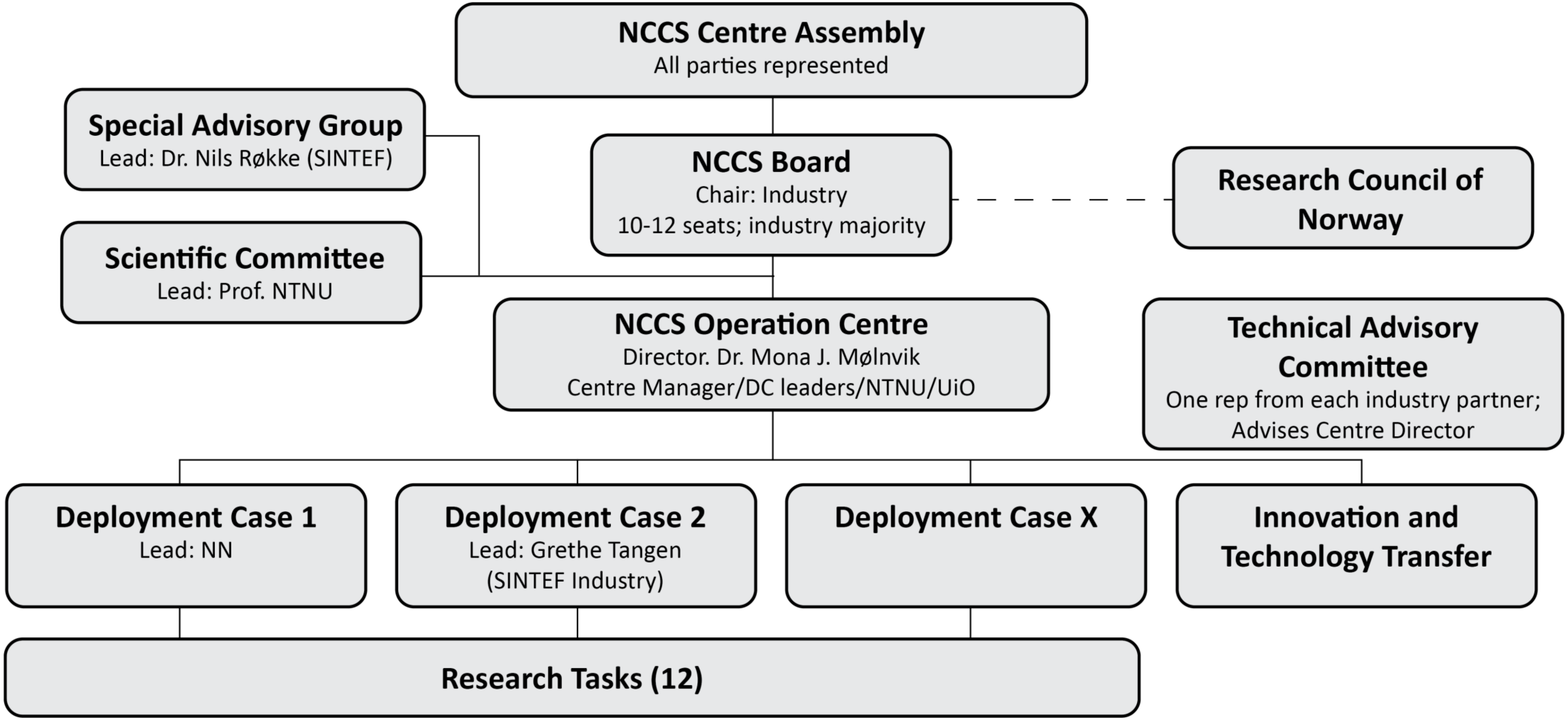
EU energy and climate targets

NCCS will enable fast-track CCS deployment through industry-driven science-based innovation, addressing the major barriers identified within demonstration and industry projects, aiming at becoming a world-leading CCS centre

IEA's two-degree scenario

UN Framework Convention on Climate Change

NCCS Governance Structure



Operations Centre

Centre Director

SINTEF Energy Research

Mona J. Mølnvik

Research Director

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Centre Manager
Research Scientist
SINTEF Energy Research

Jon Magne Johansen
Business Developer
SINTEF Energy Research

Rune Aarlien
Consultant
SINTEF Energy Research

Deployment Case Leaders

NN
SINTEF Industry

Grethe Tangen
Senior Research Scientist
SINTEF Industry

Academia

Professor Alvar Braathen
UiO Representative

Professor James Dawson
NTNU Representative

NCCS facilitates close working relationships

between industry, universities and research institutes to generate innovation and high quality R&D

Industry

Product development and the application of research results

The universities

Strategic research and education

Research institutes

Multidisciplinary strategic research

vendor, in-kind

CoorsTek, AkerSolutions, Ansaldo Energia, Quad Geometrics, KROHNE, NORCEM HeidelbergCement Group, LarvikShipping, OSLO KOMMUNE

users

GASSCO, Shell, Statoil, TOTAL

university

NTNU, UNIS, MIT, UiO: University of Oslo, Ruhr Universität Bochum RUB, Universität Zürich, TUM

research inst.

TNO innovation for life, British Geological Survey (Natural Environment Research Council), NIST National Institute of Standards and Technology, NGI, SINTEF, Lawrence Livermore National Laboratory

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World-leading partnerships

Users

GASSCO
Shell
Statoil
TOTAL

Vendor, In-kind

CoorsTek
AkerSolutions™
ANSALDO ENERGIA
QUAD GEOMETRICS
KROHNE
NORCEM HEIDELBERGCEMENT Group
LarvikShipping
OSLO KOMMUNE

University

NTNU
RUHR UNIVERSITÄT BOCHUM RUB
UNIS
MIT
UiO: University of Oslo
University of Zurich[UZH]
TUM

Research inst.

TNO innovation for life
BGS 1835 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL
NIST National Institute of Standards and Technology
NGI
SINTEF
Lawrence Livermore National Laboratory

Associated

eccsel
Norges Rederiforbund Norwegian Shipowners' Association
Norsk olje&gass
U.S. DEPARTMENT OF ENERGY
UKCCS RESEARCH CENTRE
GASSNOVA
SCCS

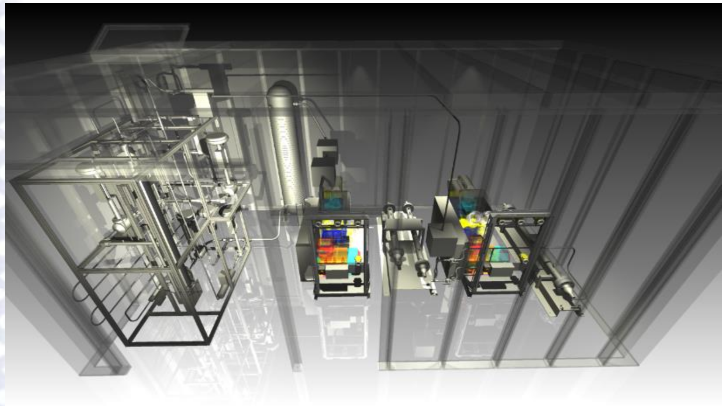
FME
NCCS

Our role in EU

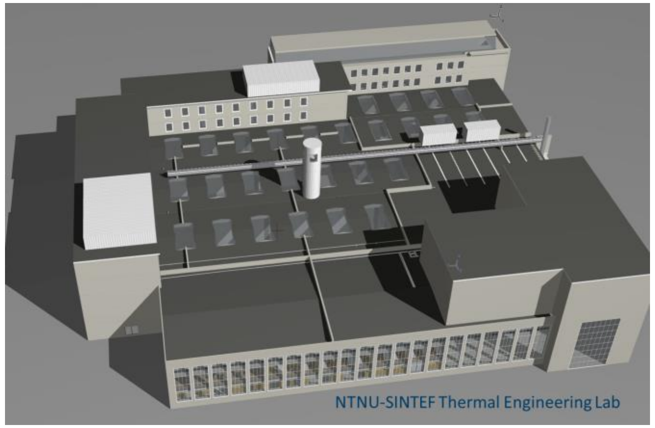
- Chair in EERA: Dr. Nils Røkke
- Lead in EERA JP CCS: Dr. Marie Bysveen
- Coordinates and participates in EU-projects
- Strategic Energy Technology (SET) plan
- Technical Working Group 9 for Framework program 9

EERA: European Energy Research Alliance

ECCSEL infrastructure and NCCS R&D



CO_2 *liquefaction facility*



CO_2 *depressurization facility*

Solvent degradation

eccsel NCCS

Deployment Cases - NCCS approach

We want NCCS to:

- Have strong industry ownership
- Overcome critical barriers identified in demo and industry projects
- Align research across disciplines
- Provide targeted research in areas that contribute to large-scale CCS deployment

Deployment Case 1:
CCS for Norwegian industry

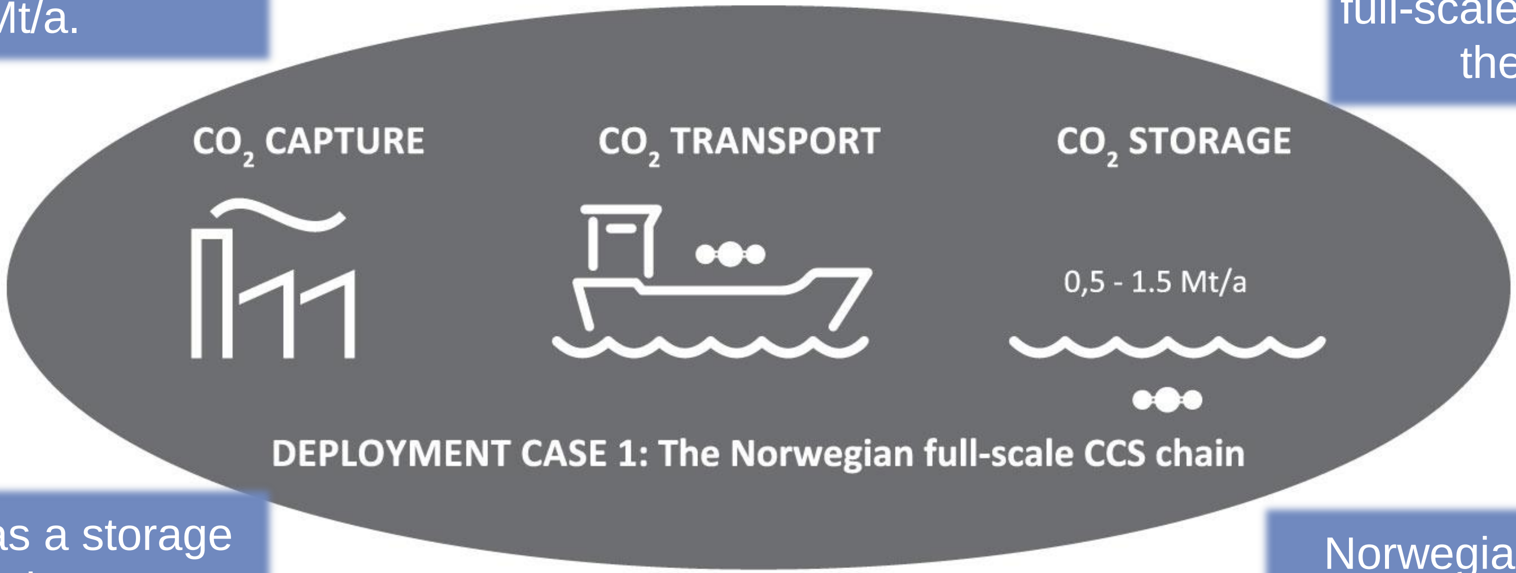
Deployment Case 2:
Storing Europe's CO_2 in the North Sea basin

Deployment case 1

Complements and support the plans for a Norwegian full-scale CCS project within 2022

Single-sink CCS chain, few industry CO_2 sources, 1-5 Mt/a.

Additional CO_2 sources in Norway and Europe can link up to the Norwegian full-scale project –focus on the next phase



Smeaheia aquifer has a storage capacity large enough to store more of Norway's (and potentially Europe's) captured CO_2.

Norwegian industrial CO_2 sources, in the current full-scale chain and beyond 2022

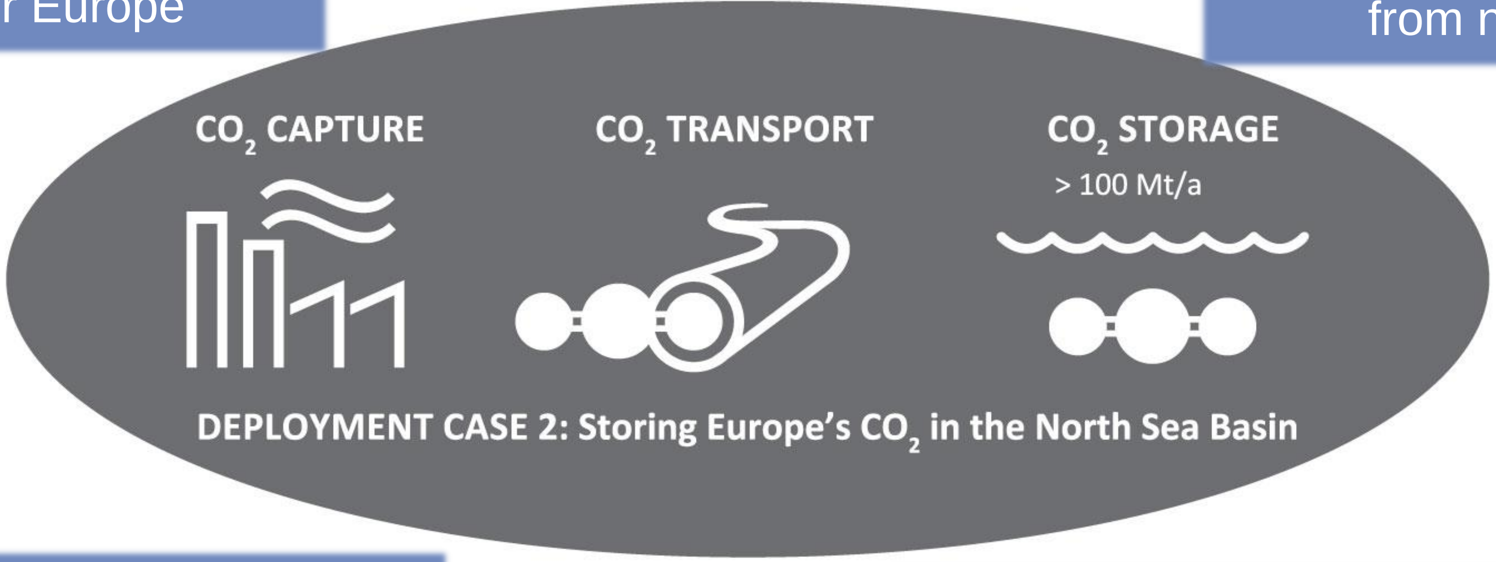
Build on the Sleipner, Snøhvit, and Boundary Dam projects, align with ROAD, and will seek synergies with TCM.

Deployment case 2

CO_2 volumes in the order of 100 Mt/a will be considered for transport via safe and flexible pipe-line infrastructure

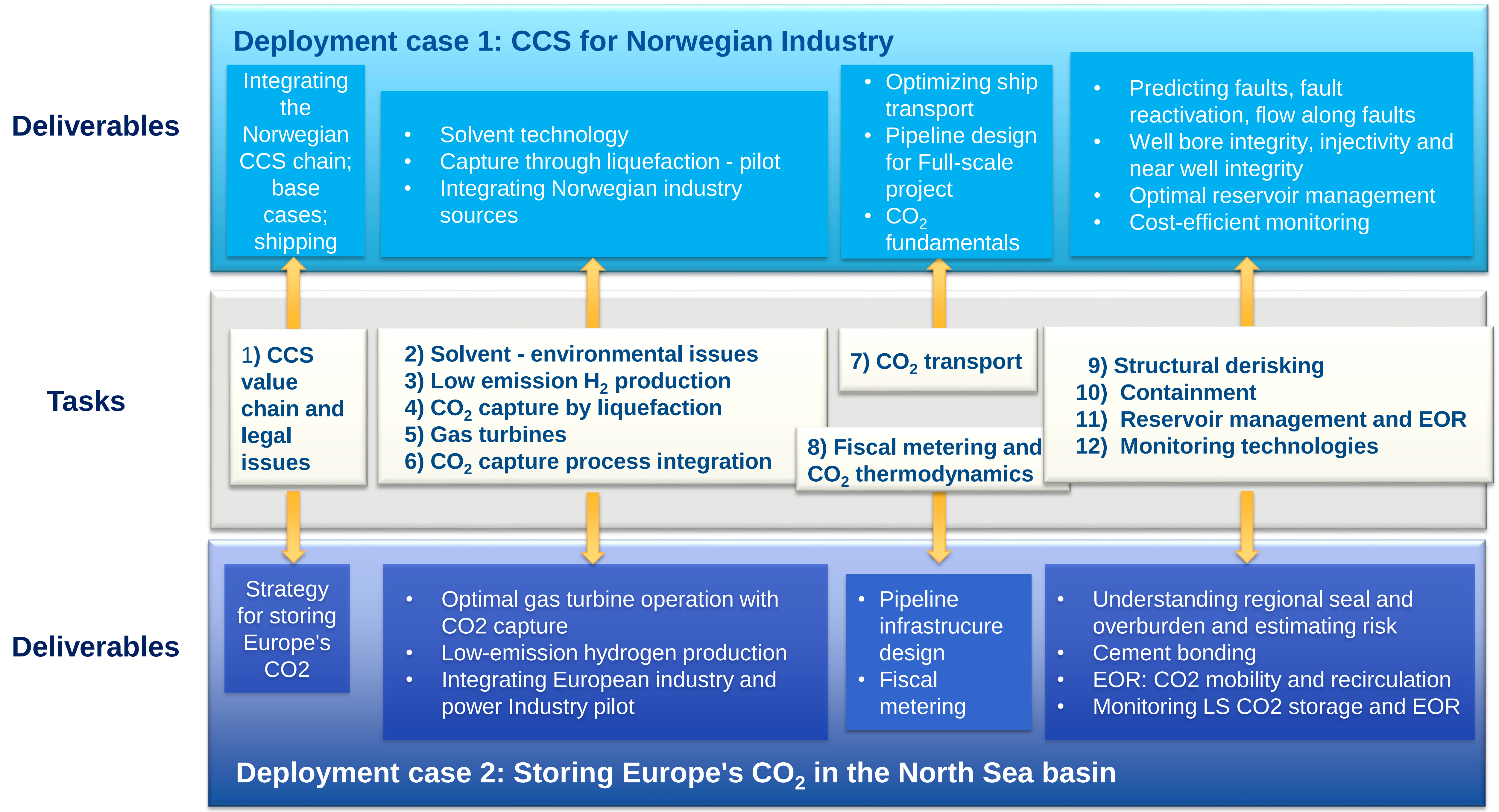
Capturing CO_2 from power and industry sources from all over Europe

Potential to improve the CCS business case by enabling H_2 production with CO_2 capture from natural gas



Enabling development of commercial-scale CO_2-EOR

Cross-border CCS infrastructure, terms and need for change under international and EU/EEA-law

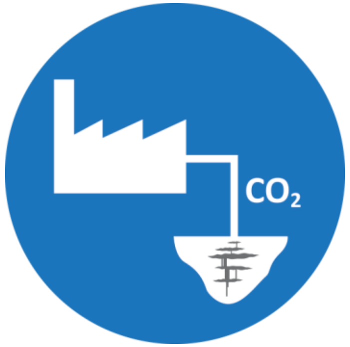

Deployment case 1: CCS for Norwegian Industry
Deliverables
Integrating the Norwegian CCS chain; base cases; shipping
• Solvent technology
• Capture through liquefaction - pilot
• Integrating Norwegian industry sources
• Optimizing ship transport
• Pipeline design for Full-scale project
• CO_2 fundamentals
• Predicting faults, fault reactivation, flow along faults
• Well bore integrity, injectivity and near well integrity
• Optimal reservoir management
• Cost-efficient monitoring
Tasks
1) CCS value chain and legal issues
2) Solvent - environmental issues
3) Low emission H_2 production
4) CO_2 capture by liquefaction
5) Gas turbines
6) CO_2 capture process integration
7) CO_2 transport
8) Fiscal metering and CO_2 thermodynamics
9) Structural derisking
10) Containment
11) Reservoir management and EOR
12) Monitoring technologies
Deliverables
Strategy for storing Europe's CO2
• Optimal gas turbine operation with CO2 capture
• Low-emission hydrogen production
• Integrating European industry and power Industry pilot
• Pipeline infrastrucure design
• Fiscal metering
• Understanding regional seal and overburden and estimating risk
• Cement bonding
• EOR: CO2 mobility and recirculation
• Monitoring LS CO2 storage and EOR
Deployment case 2: Storing Europe's CO_2 in the North Sea basin

Task 1: CO_2 value chain and legal aspects

- Demonstrate the importance of CCS to decarbonize the energy and industrial sector to reach the Paris agreement target

- Provide recommendations on the best measures to cut CCS costs and assess shortcomings in the current legal framework applicable to CCS operations at the national and international levels.

- Help enable a faster and cheaper deployment of CCS technology.

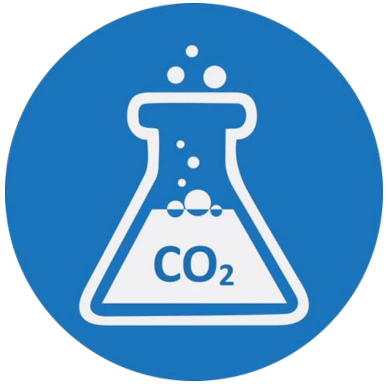


Task leader: Simon Roussanaly
Research Scientist, SINTEF Energy Research AS

Task 2: Solvent technology – environmental issues

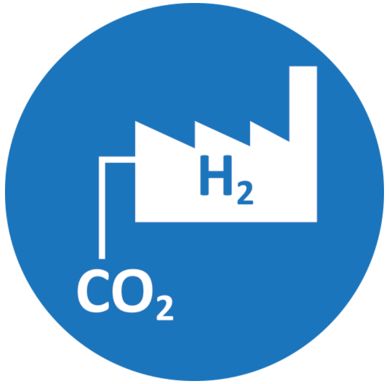
- Work to understand degrading of solvents better by investigating which factors has the highest impact on the stability of amines (organic compound derived from ammonia).
- Contribute to reduction of operational- and investment cost by indicating amines with higher stability and developing technologies to control and monitor solvent stability.

Task leader: Solrun Vevelstad
Research Scientist, SINTEF Industry



Task 3: Low emission H_2 production

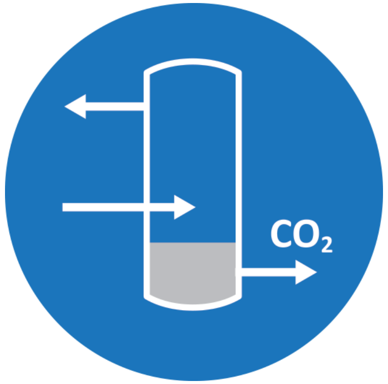
- Develop hydrogen production technology with an efficiency higher than 75% (Currently 60-70%) including capture of CO_2 to lower emissions from the H_2 industry.



Task leader: Jonathan Polfus
Senior Research Scientist, SINTEF Industry

Task 4: CO_2 capture and transport-conditioning through liquefaction

- Make liquification a mandatory processing stage in the interface between capture and transport.
- An efficient CO_2 liquefier process will be derived.



Task leader: David Berstad
Research Scientist, SINTEF Energy Research AS

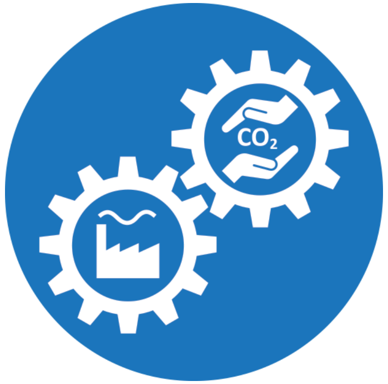
Task 5: Gas turbines

- Enable deployment of carbon storage on the Norwegian continental shelf through O&G rigs, and throughout Europe with gas turbine engines.
- Assess the stability and operability of gas turbine combustion systems.
- Evaluate gas turbine impact on power generation, thermodynamic efficiency and pollutants emissions.

Task leader: Andrea Gruber
Senior Research Scientist, SINTEF Energy Research AS

Task 6: CO_2 capture process integration

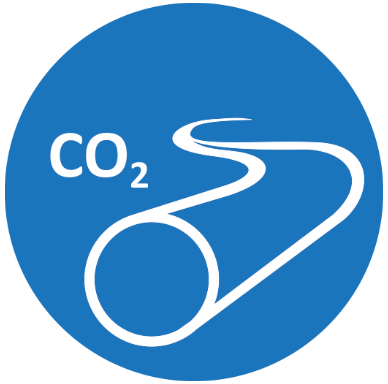
- Investigate how to best integrate the capture process in the CCS value chain.
- Develop generic methodology for post-combustion CO_2 capture in waste to energy plants
- Develop a systematic approach to link solvent properties and cost reduction in end-of-pipe CO_2 capture.



Task leader: Rahul Anantharaman
Research Scientist, SINTEF Energy Research AS

Task 7: CO_2 transport

- Provide knowledge to ensure safe and efficient CO_2 transport.
- E.g. running-ductile fractures in CO2 pipelines, ship transport, impurities and non-equilibrium flow of CO2 will be investigated.



Task leader: Svend Tollak Munkejord
Cheif Scientist, SINTEF Energy Research AS

Task 8: Fiscal metering and thermodynamics

- Provide improved experimental data and models on properties of CO_2-rich fluids relevant for CCS

- Facilitate fiscal metering of the same fluids.

Task leader: Sigurd Løvseth
Senior Research Scientist, SINTEF Energy Research AS

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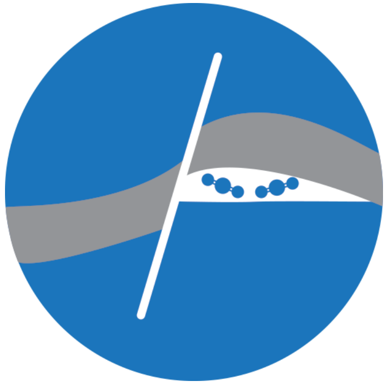
Task 9: Structural derisking

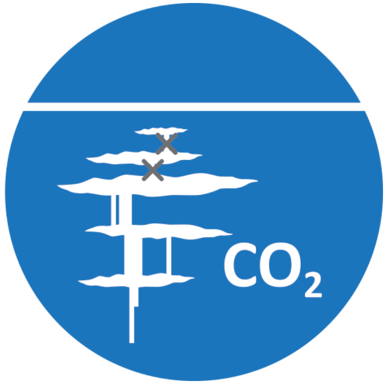
- Reduce risk related to injecting and storing CO_2 in the continental shelf
- Contribute to maximize the CO_2 injection volume for the Smeaheia region
- Develop techniques to address fault-sealing and integrity



Task leader: Elin Skurtveit
Senior Engineer, Petroliumsgeomatikk og geofysikk (PGG)

Task 10: CO_2 storage site containment

- Focus on leakage issues affecting sub-sea wells and near-well area.
- Maximise storage capacity with minimum risk of significant leakage.
- Through the research an atlas will be developed. The atlas will contain a check-list of well integrity issues compromising CO_2 storage success.



Task leader: Pierre Rolf Cerasi
Senior Research Scientist, SINTEF Industry

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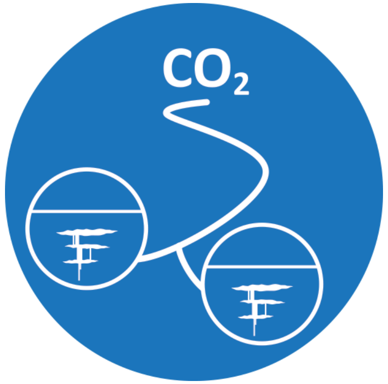
Task 11: Reservoir management and EOR

- Reduce net cost for overall CCS chain to enable enhanced oil recovery (EOR).



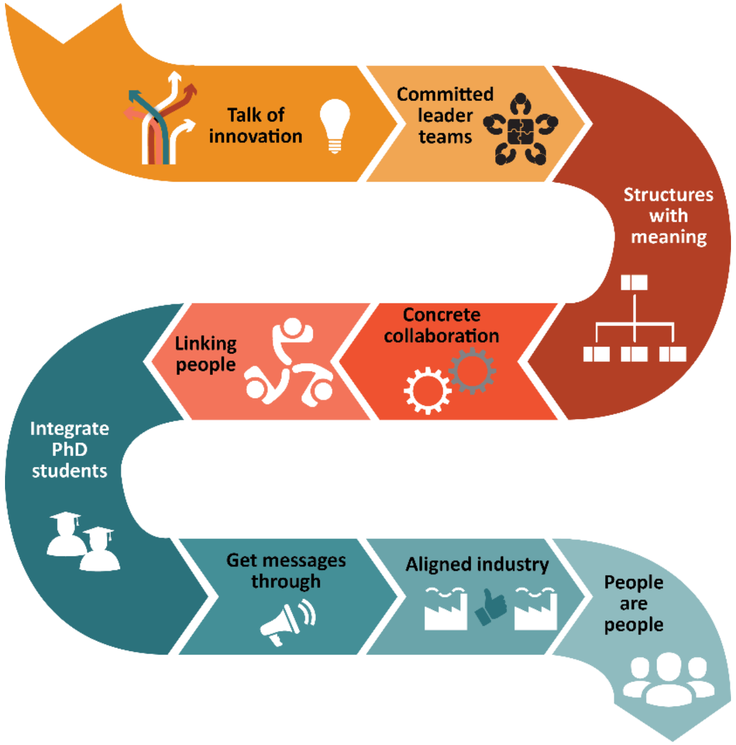
Task leader: Alv Arne Grimstad
Senior Research Scientist, SINTEF Industry

Task 12: Cost-efficient CO_2 monitoring technology

- Develop and demonstrate monitoring technology which will enable safe operation in compliance with laws and regulations in the most cost-efficient manner.

Task leader: Jon Peder Eliasson
Research Scientist, SINTEF Industry

ITT: Innovation and technology transfer



ITT will facilitate innovation through five key roles:

- **Reminder** of innovation potential
- **Facilitator** for engaged cooperation between research and industry
- **Identifier** of research with potential for innovation
- **Support** for IAM and IP management
- **Communicator** towards stakeholders

Leader: Sigmund Størset
Research Manager, SINTEF Energy Research AS

NCOOS

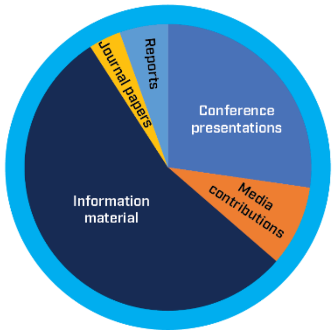
NCCS Communication

Internal communication channels

- eRoom
- Task leader meetings
- Task family meetings
- Operation Center meetings
- Workshops
- Consortium days
- TAC meetings
- Board meetings
- Email, phone, skype

External communication channels

- Newsletter
- Webinars
- Blog
- SoMe
- Media/Op-eds
- Events
- Annual reports
- Webpage
- Scientific dissimination



15 Conference presentations
5 Media contributions
30 Information material
2 Journal papers
3 Reports

Acknowledgement

FME NCCS - The scheme of the Centres for Environment-friendly Energy Research (FME) seeks to develop expertise and promote innovation through focus on long-term research in selected areas of environment-friendly energy.

There are today 11 centres within renewable energy, energy efficiency, social sciences and CO_2-management. The research activity is carried out in close cooperation between prominent research communities and users. The centres will operate for eight years (2016 – 2024).

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Thank You!