



# NCCS

NORWEGIAN CCS RESEARCH CENTRE

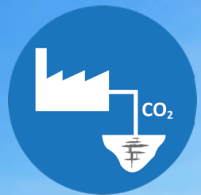
CCS in Norway

Mona Mølsvik, Director FME NCCS, SINTEF

2024-03-20



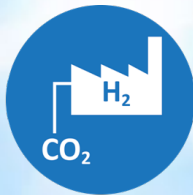




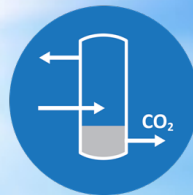
CO<sub>2</sub> value chain and legal aspects



Solvent technology – environmental issues



Low emission H<sub>2</sub> production



Conditioning through liquefaction



Gas turbines



CO<sub>2</sub> capture process integration



CO<sub>2</sub> transport



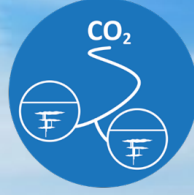
Fiscal metering and thermodynamics



Structural derisking



CO<sub>2</sub> storage site containment



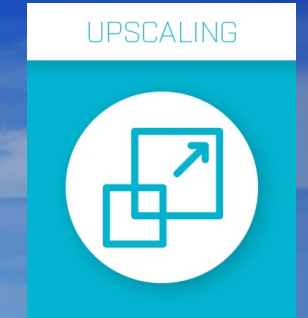
Reservoir management and EOR



Cost-efficient CO<sub>2</sub> monitoring technology

## Norwegian CCS Research Center

a Centre for Environment-friendly Energy Research (FME)

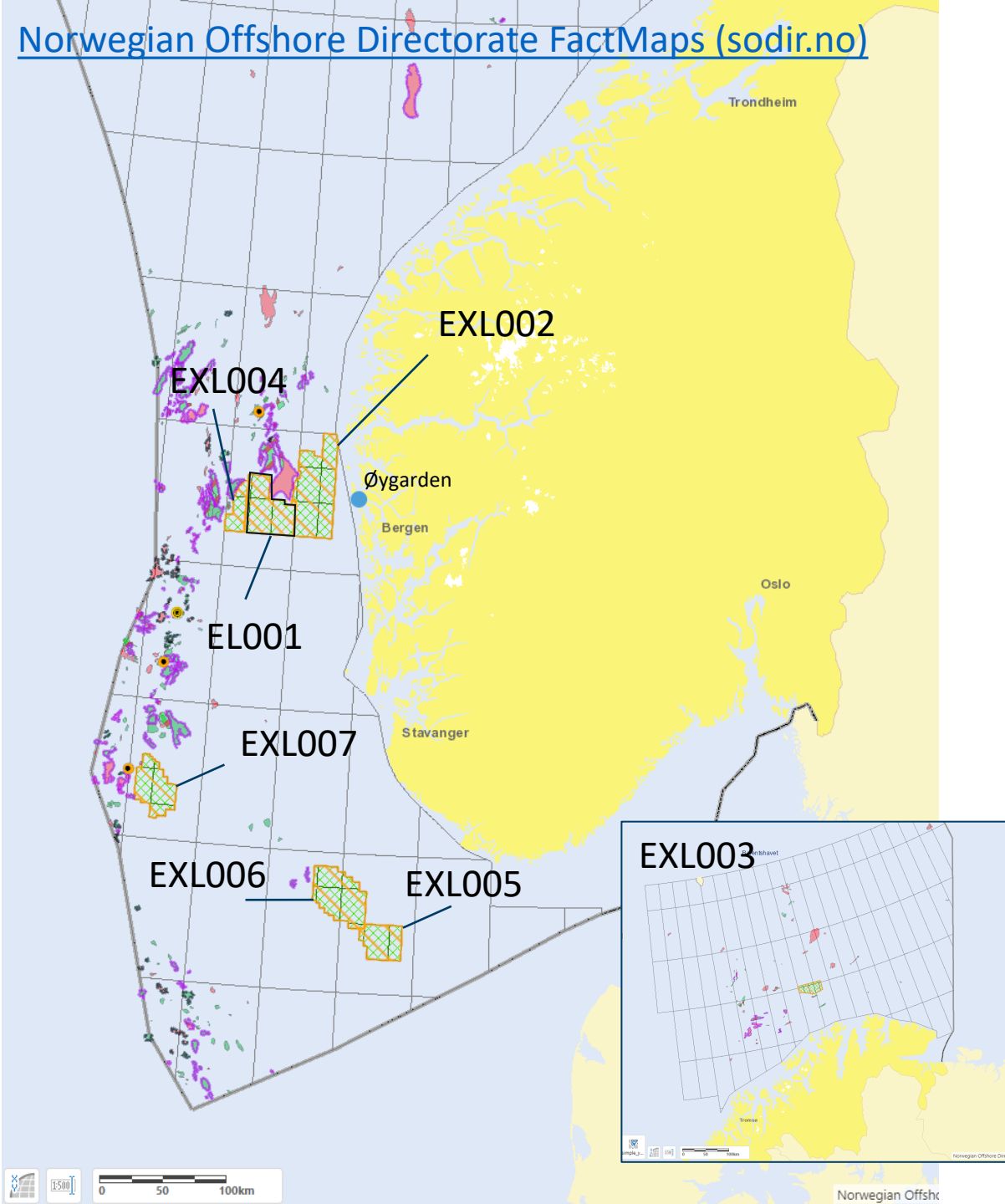


- Budget 690 MNOK, 2016 - 2024
- FME NCCS with its predecessor BIGCCS has contributed to the realization of full-scale CCS in Norway
- Extremely strong partnership, 13 spin-in KSP projects and key spinouts: COREu, ACCESS and LINCCS
- 28 ph.d. and 11 postdoc and 55 MSc

# CO<sub>2</sub> Storage Licences

7 licences awarded to date:

- EL001: *Northern Lights JV* (Equinor, Shell, TotalEnergies)
- EXL002: *Smeaheia* (Equinor)
- EXL003: *Polaris* (Horizont Energy, PGNiG)
- EXL004: *Luna* (Wintershall DEA, TotalEnergies)
- EXL005: *Poseidon* (Aker BP, OMV)
- EXL006: *Havstjerne* (Wintershall, Stella Maris)
- EXL007: *Trudvang* (Sval Energi, Vår Energi, Storegga)



# The Impact of FME NCCS in the green transition

NCCS FME proposal, 2015-11-25

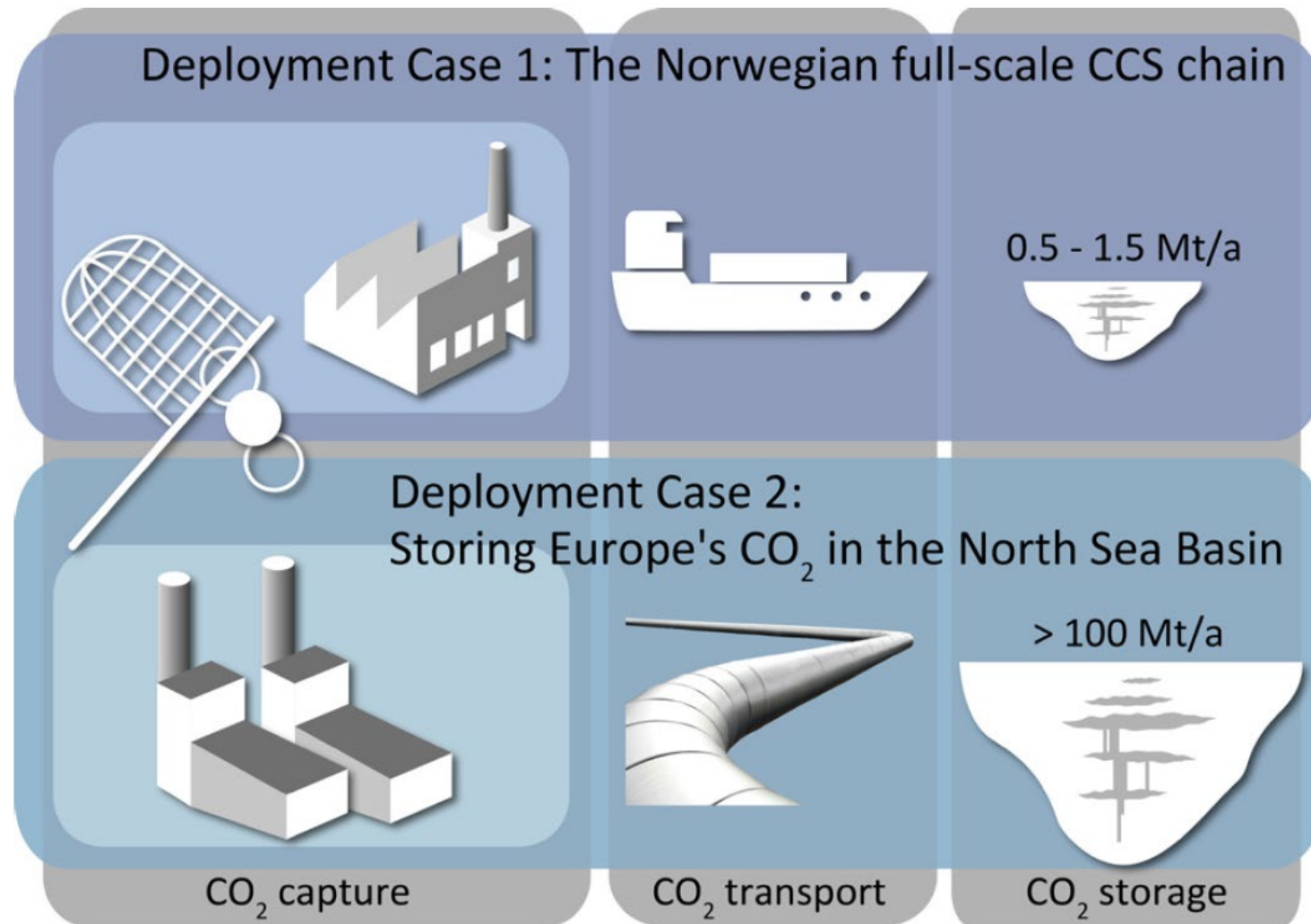


Figure 1: NCCS Industry-driven deployment-case concept.



# Timeline

2015

2019

2016

2021

2020

2017

2018

2022

mandag 21. september 2020

Meld. St. 33 (2019–2020) Langskip – fangst og lagring av CO2



mandag 21. september 2020

Regjeringa lanserer "Langskip" for fangst og lagring av CO2 i Noreg



tirsdag 15. desember 2020

Støtter gjennomføring av Langskip og Northern Lights



tirsdag 9. mars 2021

Langskip: Godkjenner utbyggingsplan for CO2-lagring



tirsdag 9. mars 2021

Northern Lights-lansering



fredag 10. september 2021

Utlysning av områder knyttet til CO2-lagring



onsdag 15. desember 2021

Fem søknader for lagring av CO2 på sokkelen



tirsdag 15. februar 2022

Norcems CO2-fangstprosjekt: kostnadsestimater bekreftet, mulig forsinket oppstart

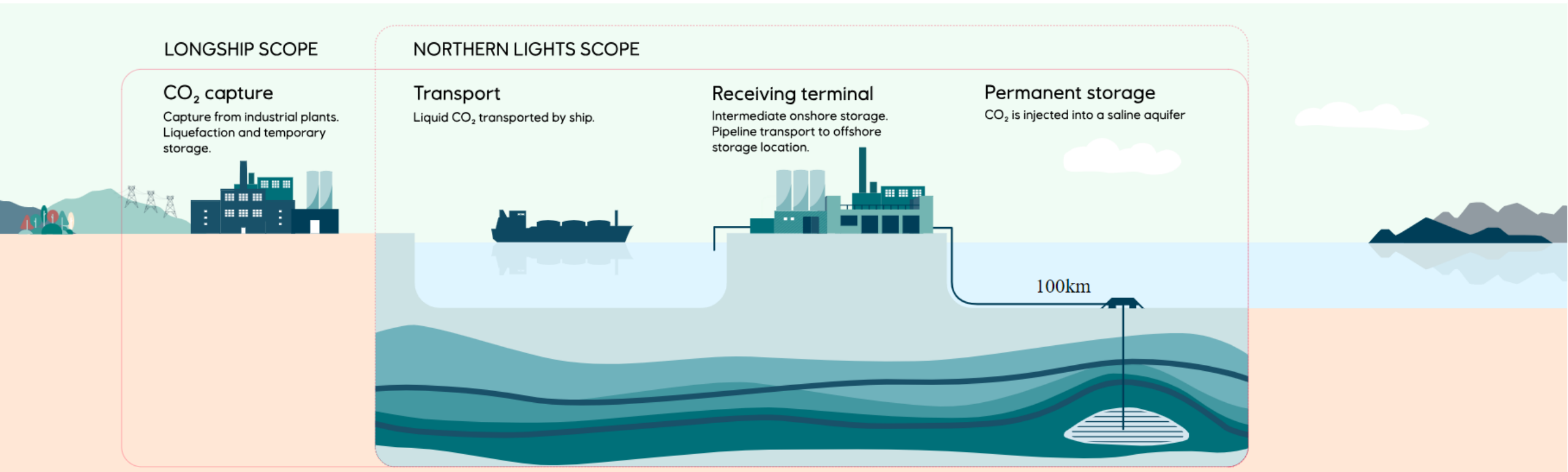


tirsdag 5. april 2022

Tildeling av letetillatelser etter lagringsforskriften



# Longship and the Northern Lights projects



Picture from Equinor

# Heidelberg Materials Cement plant Brevik



Photo: Heidelberg Materials



# Northern Lights Receiving Terminal in Øygarden



Photo: Northern Lights JV

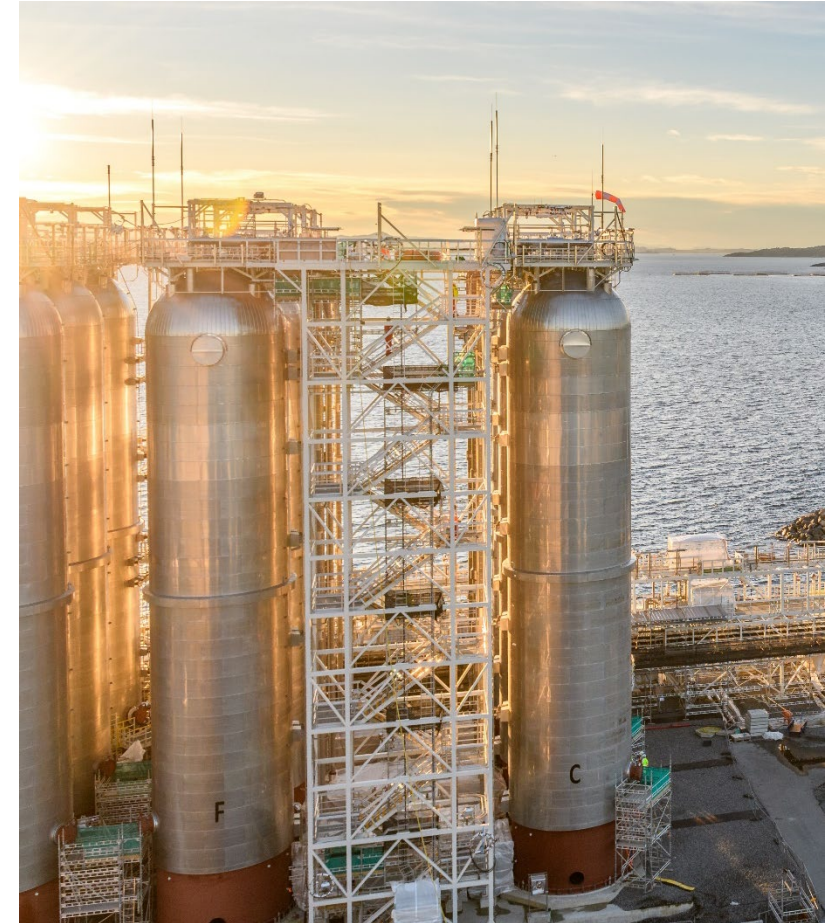


Photo: Northern Lights JV

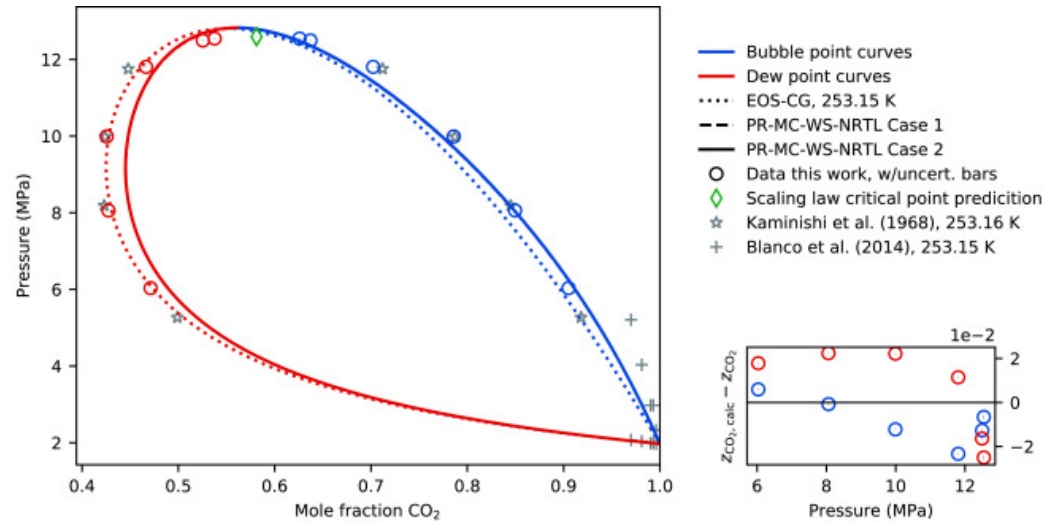


# Results from research creates value for business and society

DEPRESS (NO2.5) | ECCSEL



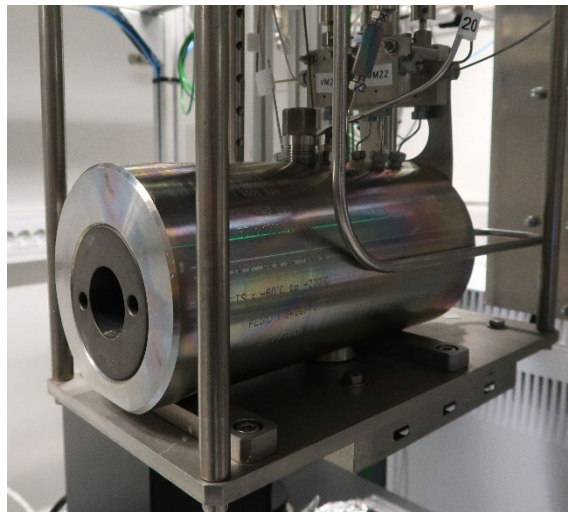
**NCOS**




(a) Mean temperature of measurements and models in present work 253.153 K. VLE data from literature Kaminishi et al. [28], Blanco et al. [29].

Westman, S.F., Austegard, A., Stang, H.G.J., Løvseth, S.W. Vapor-liquid equilibrium data for the carbon dioxide and carbon monoxide ( $\text{CO}_2 + \text{CO}$ ) system at the temperatures 253, 273, 283 and 298 K and pressures up to 13 MPa (2018) Fluid Phase Equilibria, 473, pp. 37-49.

HPC-PE (NO2.7) | ECCSEL






**eccsel**  
ERIC





 Applied Energy  
 Volume 169, 1 May 2016, Pages 499-523



Review


## CO<sub>2</sub> transport: Data and models – A review

Svend Tollak Munkejord  , Morten Hammer, Sigurd W. Løvseth





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<https://doi.org/10.1016/j.apenergy.2016.01.100>  Get rights and content 


 Fluid Phase Equilibria  
 Volume 409, 15 February 2016, Pages 207-241

## Vapor-liquid equilibrium data for the carbon dioxide and nitrogen ( $\text{CO}_2 + \text{N}_2$ ) system at the temperatures 223, 270, 298 and 303 K and pressures up to 18 MPa

Snorre Foss Westman<sup>a</sup>  , H.G. Jacob Stang<sup>b</sup>, Sigurd W. Løvseth<sup>b</sup>  ,  
 Anders Austegard<sup>b</sup>, Ingrid Snustad<sup>b</sup>, Sigmund Ø. Størset<sup>b</sup>, Ivar S. Ertesvåg<sup>a</sup>



 Available online at [www.sciencedirect.com](http://www.sciencedirect.com)  
**ScienceDirect**  
 Energy Procedia 51 (2014) 392 – 401



7th Trondheim CCS Conference, TCCS-7, June 5-6 2013, Trondheim, Norway

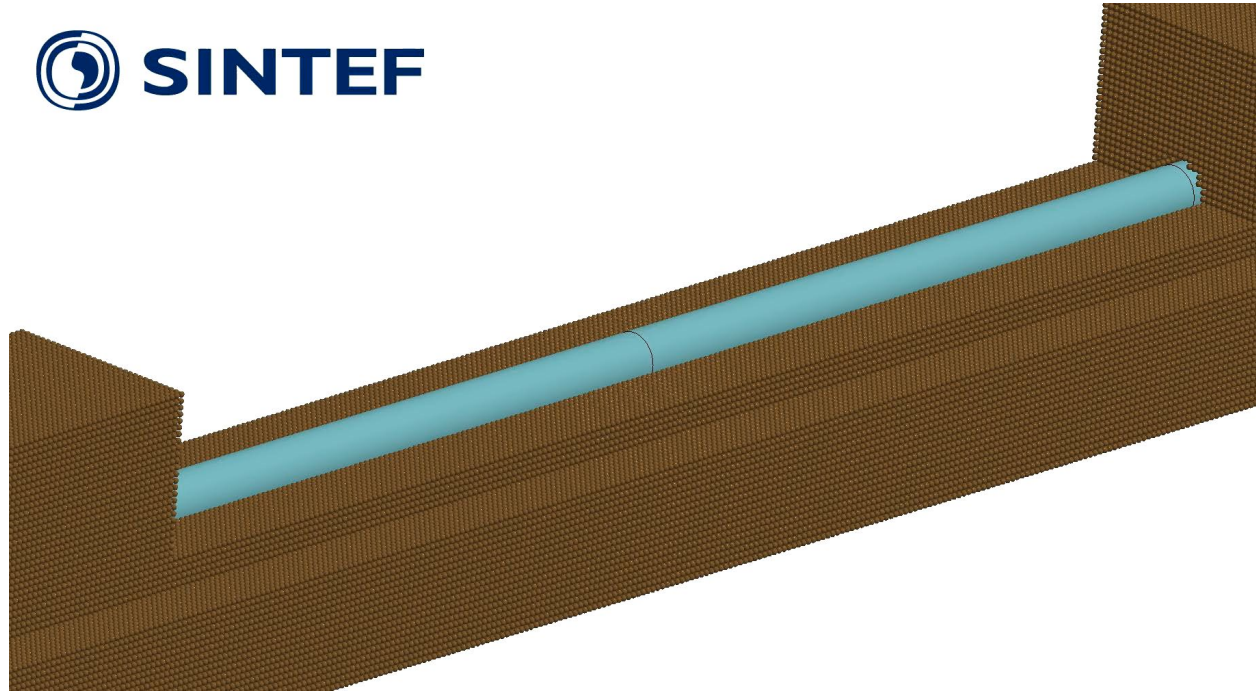
### Accurate phase equilibrium measurements of CO<sub>2</sub> mixtures

Snorre F. Westman<sup>a,b</sup>, H. G. Jacob Stang<sup>a</sup>, Sigmund Ø. Størset<sup>a</sup>,  
 Håvard Rekestad<sup>a,b</sup>, Anders Austegard<sup>a</sup>, Sigurd W. Løvseth<sup>a,\*</sup>

<sup>a</sup>SINTEF Energy Research, Trondheim, Norway  
<sup>b</sup>Norwegian University of Science and Technology, Trondheim, Norway



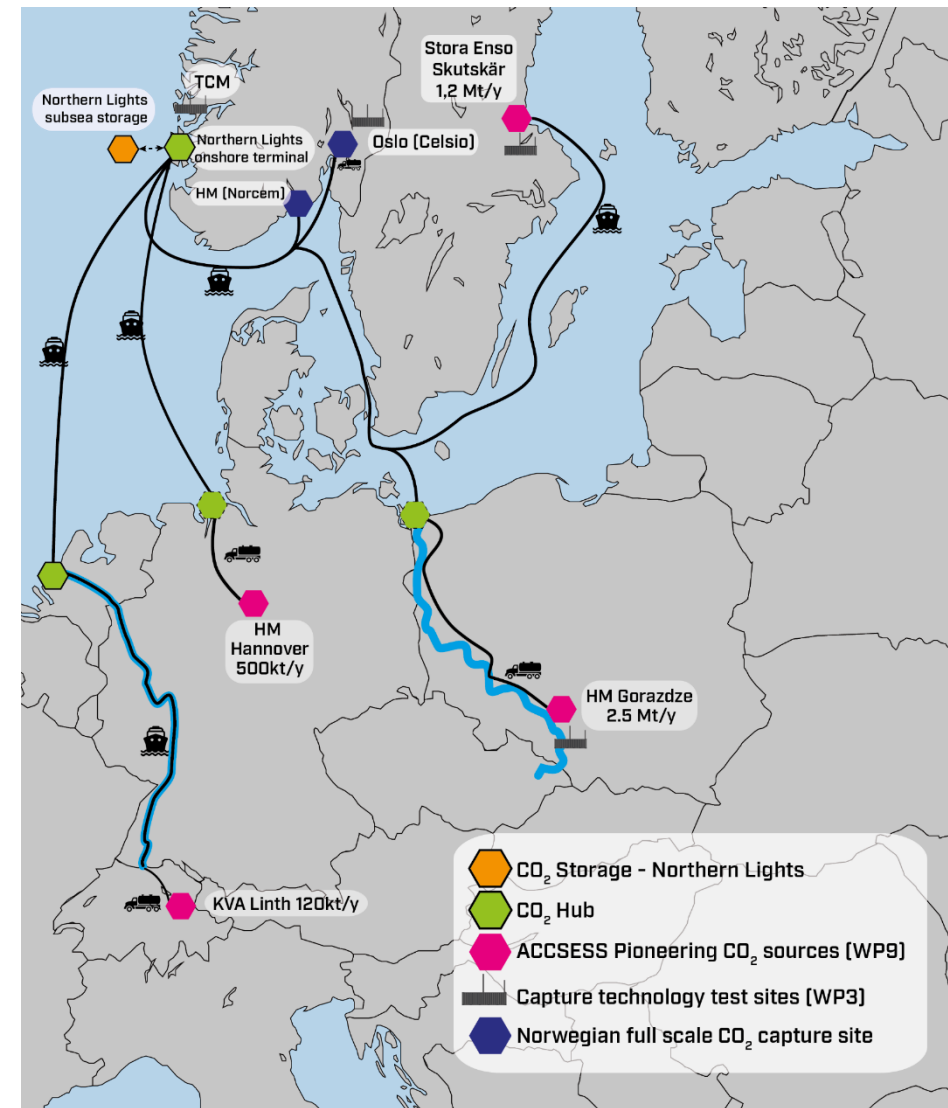
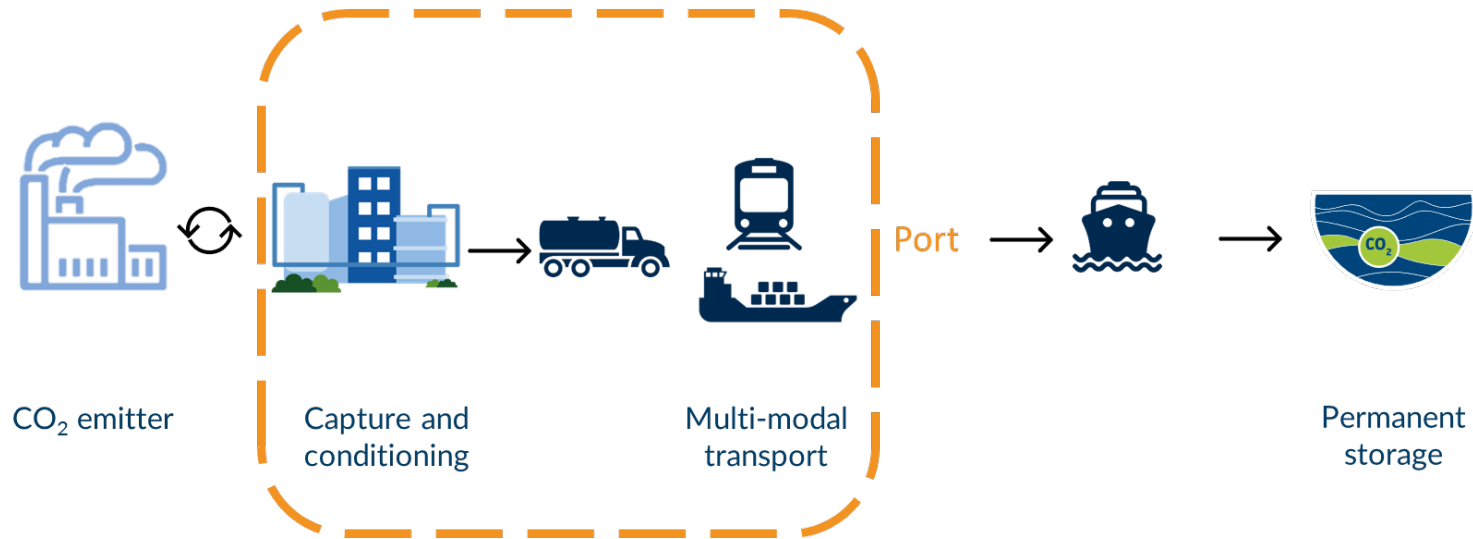
# Running Ductile fraction SINTEF's coupled fluid-structure model





# H2020 ACCESS Pioneering Chains

- Reference pioneering CCS chains in ACCESS
  - Cement plant in Germany, transport to Wilhelmshaven
  - Cement plant in Poland, transport to Szczecin
  - Pulp mill in Sweden with access to port
  - Waste-to-energy plant in Switzerland, transport to Rotterdam





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