

The Norwegian CCS Experience

New CO₂ transportation R&D projects

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Longship is a first-of-a-kind CCS project

- Demonstration of a full-scale CCS chain, based on hard-to-abate industries
- Application of EU - and Norwegian regulations on industrial scale CCS projects
- Including both biogenic– and fossil-based CO₂
- **Establishing flexible transport (ship based) and an open-source infrastructure**
- Aimed at catalyzing CCS market development in Europe, including cross-border CCS chains

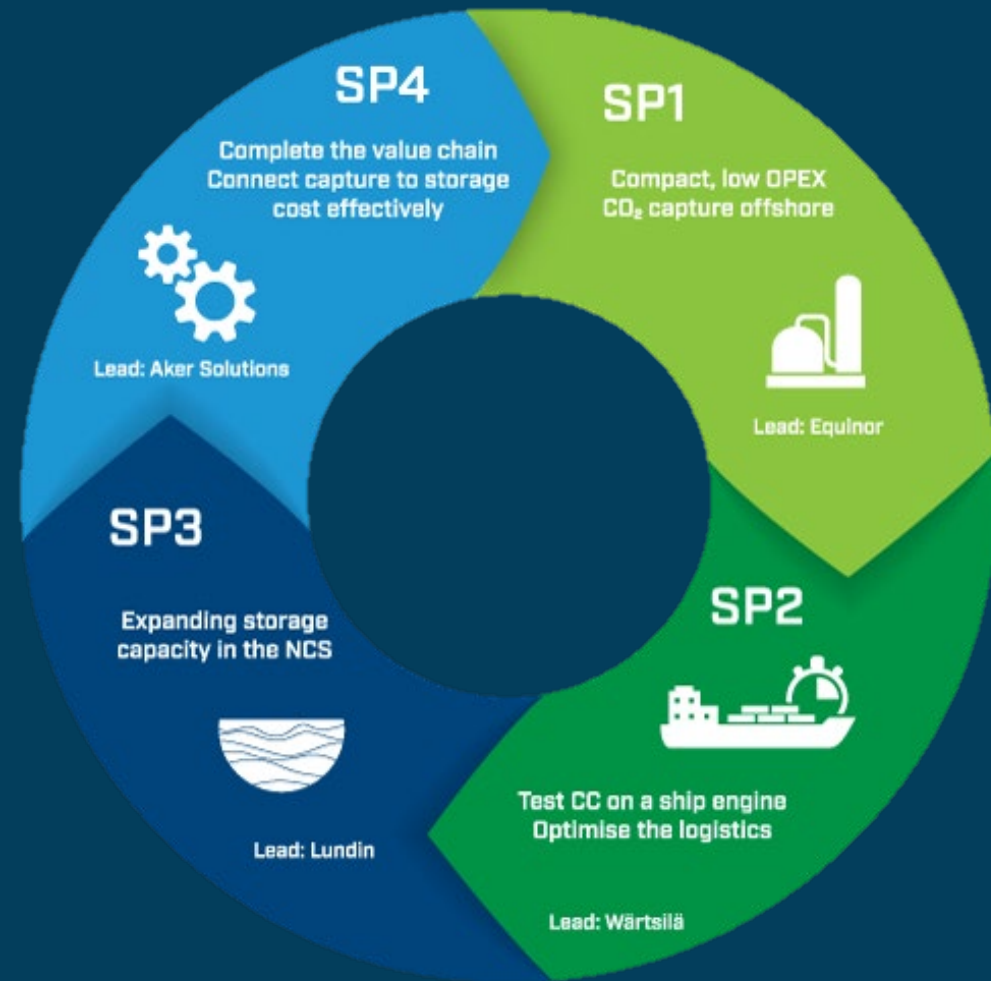


LINCCS

Linking large-scale, cost-effective, permanent offshore CO₂ storage across the CCS value chain

Norway, thanks to its sustained support for CCS (through projects like *Longship*), is in a strong position to lead this development.

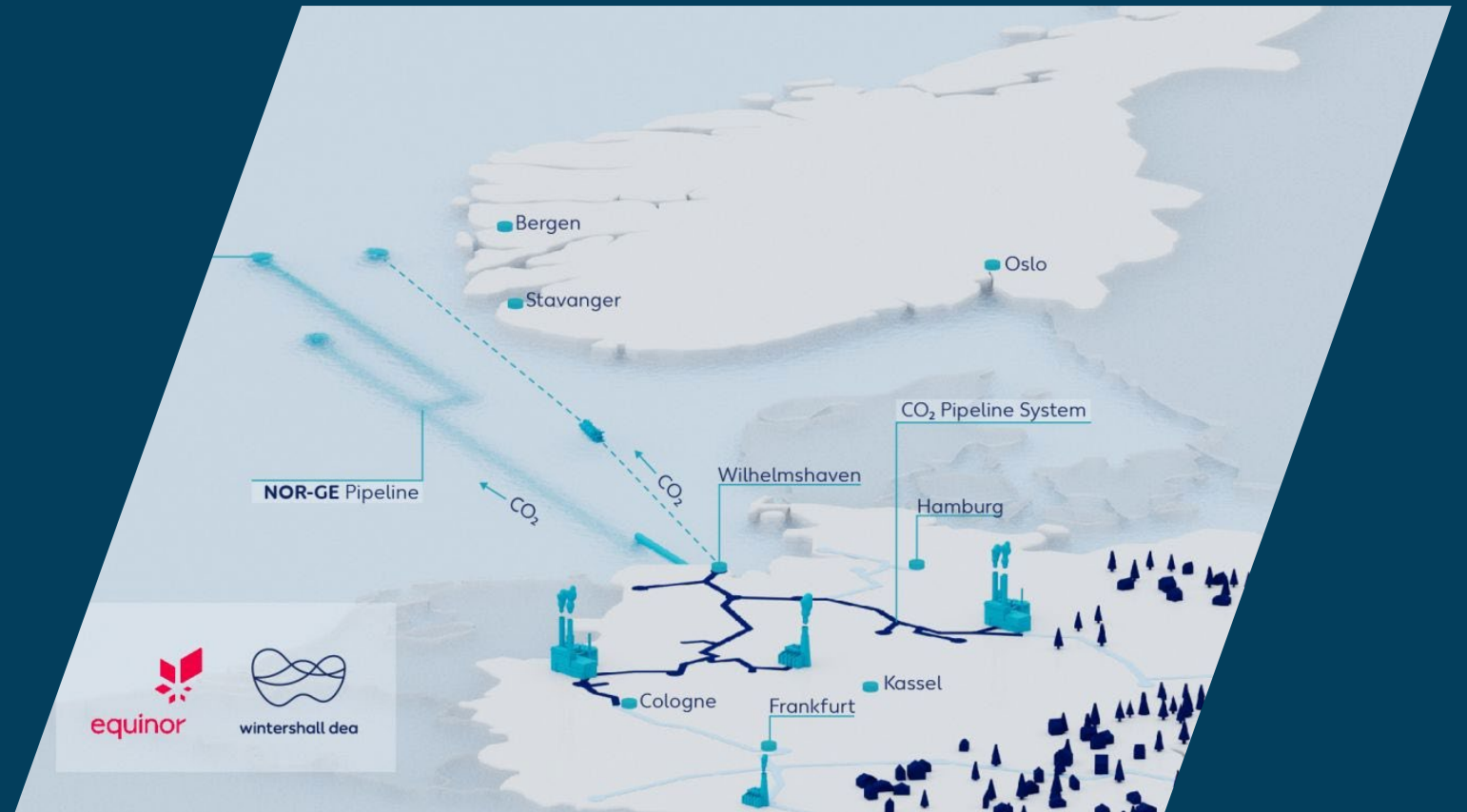
LINCCS will repurpose existing offshore installations, competencies and technologies for new, sustainable business opportunities in line with the EU taxonomy.



Wintershall Dea and Equinor partner up for large-scale CCS value chain in the North Sea

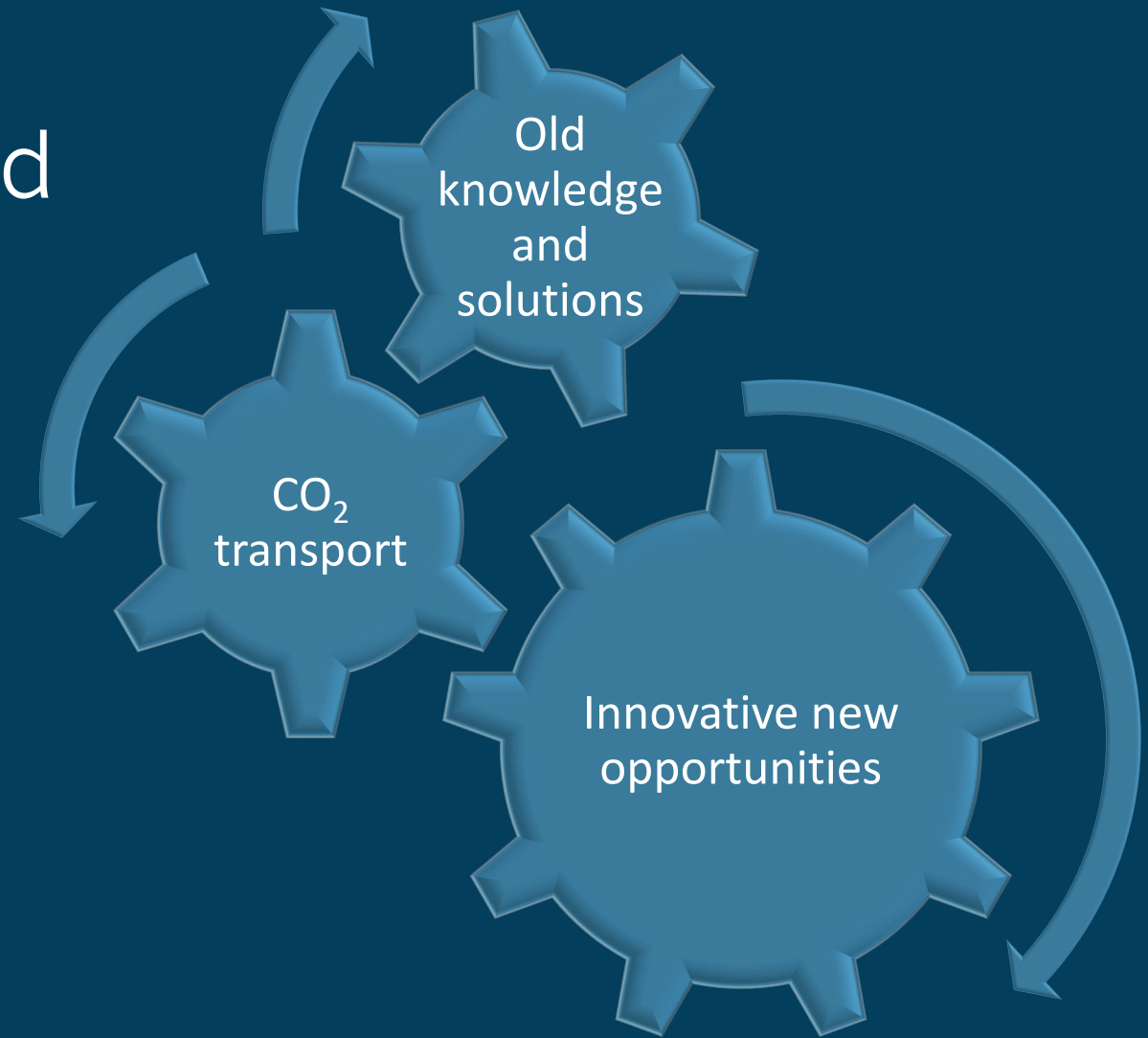
CO₂ transportation from continental Europe and storage on the Norwegian Continental Shelf.

Estimated pipeline capacity of 20 to 40 million tonnes per year by 2037.



Research, development and demonstration within the following four themes are prioritized


- Ship
- Corrosion
- Flow assurance
- Simulations



CO₂LOS

CCS logistics

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CO₂ Logistics by Ship Phase III

Calculation mode
 Full CCS logistics case Single module calculation

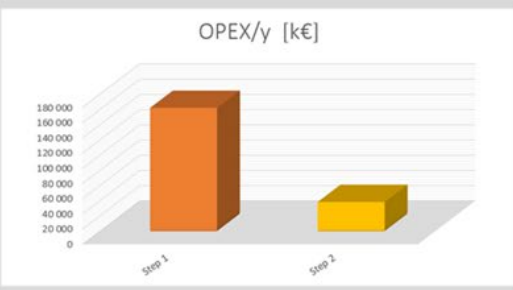
Inputs
CO₂ stream: Mty/y
Ship transport pressure: barg

Build your CCS case
Area:
Capture site:
Transport steps: one two three
Step 1: to
Step 2: to

Map



Graph



Results summary

OPEX/y [k€]	
Step 1:	162 302 k€
Step 2:	38 492 k€
Step 3:	0 k€
Sum:	200 794 k€

Graph options
 Modules
 Steps

Show results
 CAPEX
 OPEX/y

Capture
Location: Brevik
CAPEX: 394 241 k€
OPEX/y: 120 733 k€
Details/Edit

Capture to ship
Location: Brevik
CAPEX: 77 800 k€
OPEX/y: 4 598 k€
Details/Edit

Ship terminal
Location: Brevik
CAPEX: 222 609 k€
OPEX/y: 32 101 k€
To: Rotterdam
Details/Edit

Ship transport
Location: Rotterdam
CAPEX: 84 598 k€
OPEX/y: 4 869 k€
Details/Edit

Ship terminal
Location: Rotterdam
CAPEX: 385 037 k€
OPEX/y: 32 771 k€
To: Acorn
Details/Edit

Ship to injection
Location: Acorn
CAPEX: 17 739 k€
OPEX/y: 5 722 k€
Details/Edit

Storage
Location: Acorn
Details/Edit

620320 DNV «Technology Qualification of LP-CO₂ ship transportation»

- Volume and cost-effectiveness.
- Transportation networks and hubs from various sources.
- Risk reduction.

Aspects to be covered:

Sizes, availability, standardization, residual value, relocation of ships and terminals, CO₂ emissions and zero emission operations, preparedness and redundancy, flexibility etc



TotalEnergies



equinor



Shell



GASSCO



CLIMIT



DNV



Worley



HERIOT WATT UNIVERSITY



mossmaritime



WÄRTSILÄ



Liquefaction Storage tanks CETO Storage tanks

Corrosion in CO₂ transport systems

- Impurities from various CO₂ sources can create a corrosive environment in transport systems.
- Projects supported by CLIMIT have contributed to the CO₂ specification for the Northern Lights.
- The projects examine which impurities (combinations) create a corrosive environment.

Project examples:

- 618094 IFE Kjeller Dense Phase CO₂ Corrosion III (KDC III)
- 621269 DNV H₂S Challenges in CO₂ Pipelines
- 623312 IFE Kjeller Dense Phase CO₂ Corrosion IV (KDC IV)

Northern Lights CO₂ spesifikasjon

Component	Concentration ppm (mol)
Water, H ₂ O	≤ 30
Oxygen, O ₂	≤ 10
Sulphur oxides, SO _x	≤ 10
Nitric oxide/Nitrogen dioxide, NO _x	≤ 10
Hydrogen sulfide, H ₂ S	≤ 9
Carbon monoxide, CO	≤ 100
Amine	≤ 10
Ammonia, NH ₃	≤ 10
Hydrogen, H ₂	≤ 50
Formaldehyde	≤ 20
Acetaldehyde	≤ 20
Mercury, Hg	≤ 0.03
Cadmium, Cd	≤ 0.03
Thallium, Tl	(sum)



Software for simulation of CO₂ flow

- Multiphase flow of CO₂ in the transport system is challenging but can contribute to reduced costs.
- "Flow assurance" is used in the design of transport systems to reduce the risk of unwanted phase changes and precipitation of CO₂ in solid form (dry ice and hydrate).
- OLGA and Ledaflow are software developed for the simulation of multiphase oil & gas flow. CLIMIT supports the development of CO₂ functionality in OLGA and Ledaflow



Thank you for your attention!

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We share our CCS knowledge

gassnova.no/en

