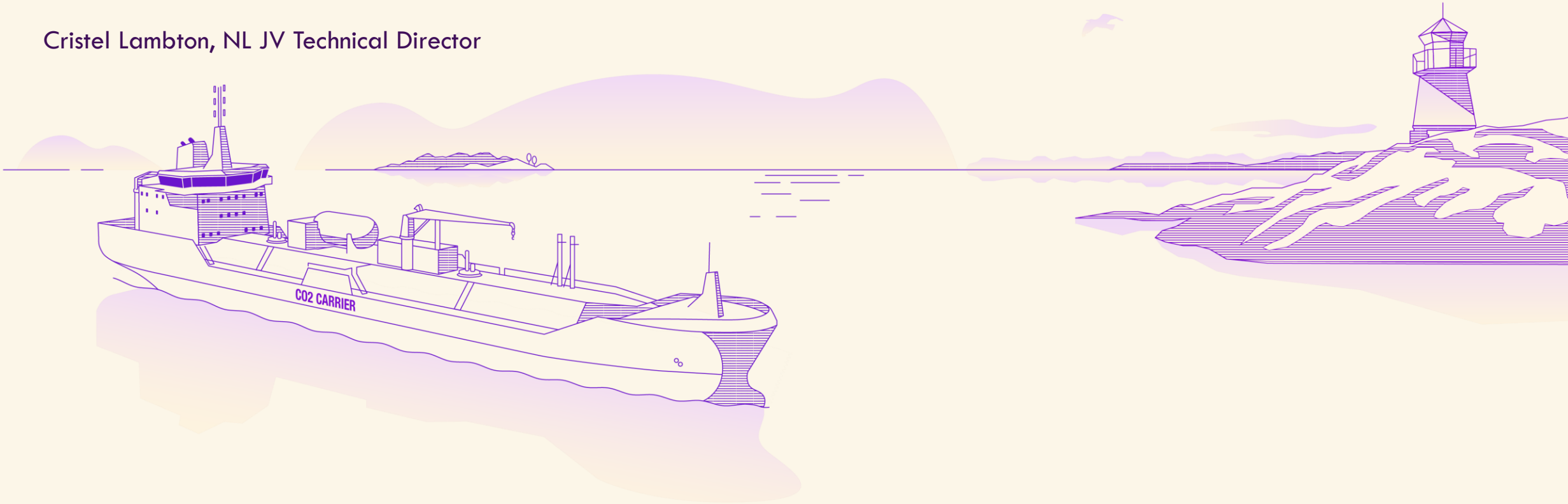
Northern Lights – Presentation and status update

CSLF – 27.06.2022

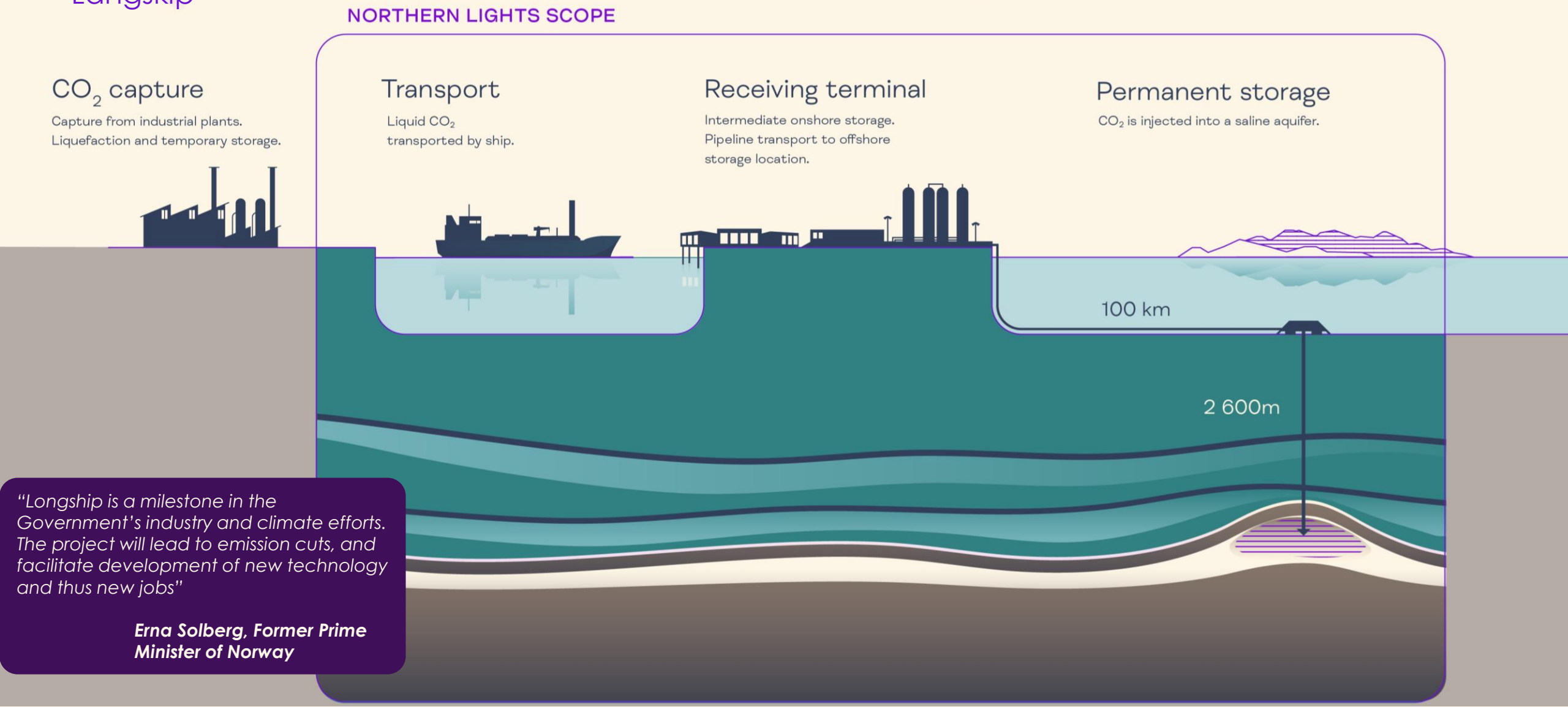
Cristel Lambton, NL JV Technical Director



CO_2 transport & storage at scale

Northern Lights

Langskip

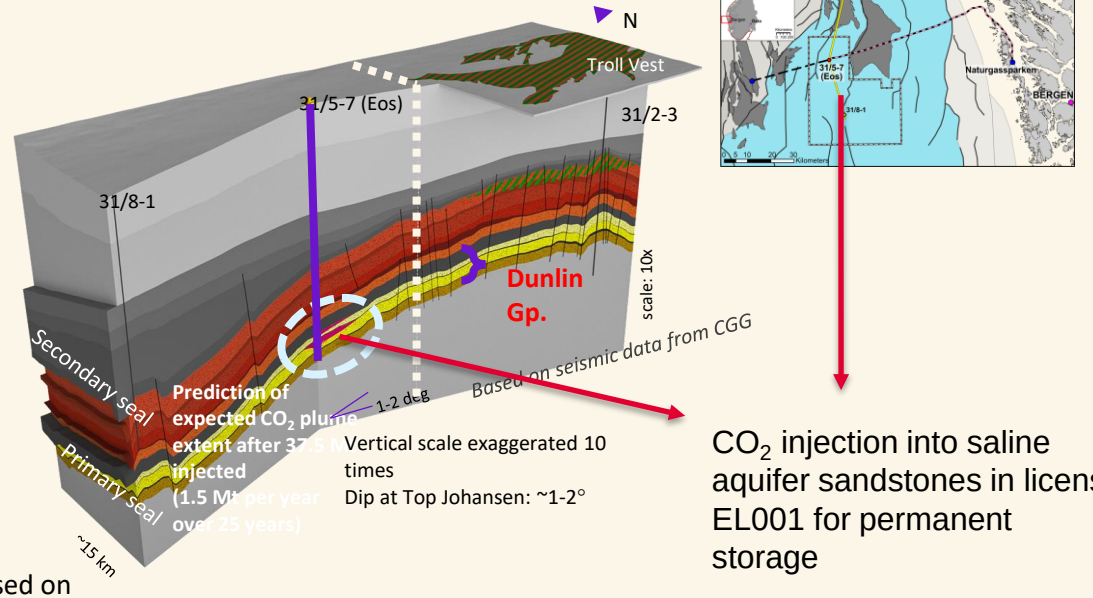


"Longship is a milestone in the Government's industry and climate efforts. The project will lead to emission cuts, and facilitate development of new technology and thus new jobs"

Erna Solberg, Former Prime Minister of Norway

Northern Lights project

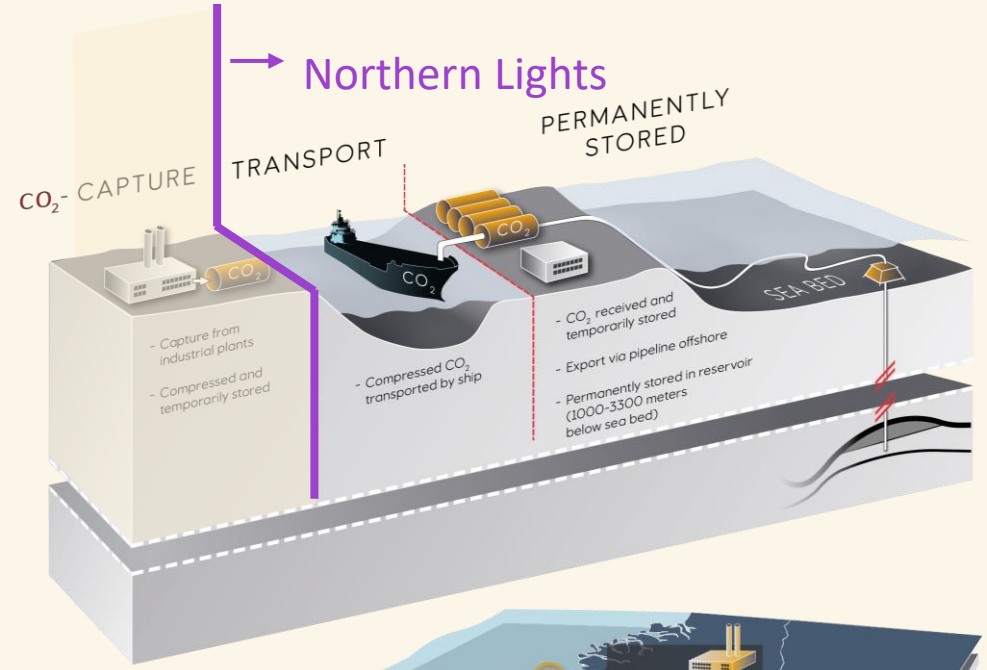
Transport, injection and permanent storage of CO_2

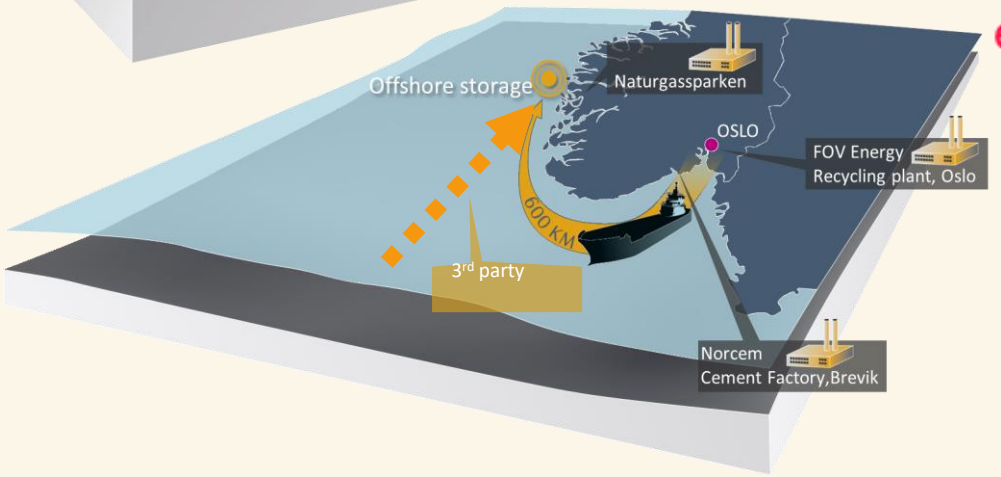


Vertical scale exaggerated 10 times
Dip at Top Johansen: ~1-2°

Based on seismic data from CGG

CO_2 injection into saline aquifer sandstones in license EL001 for permanent storage





GASSNOVA

equinor

TotalEnergies

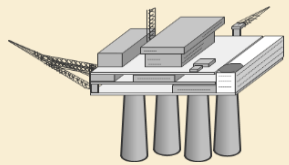
Target injection capacity

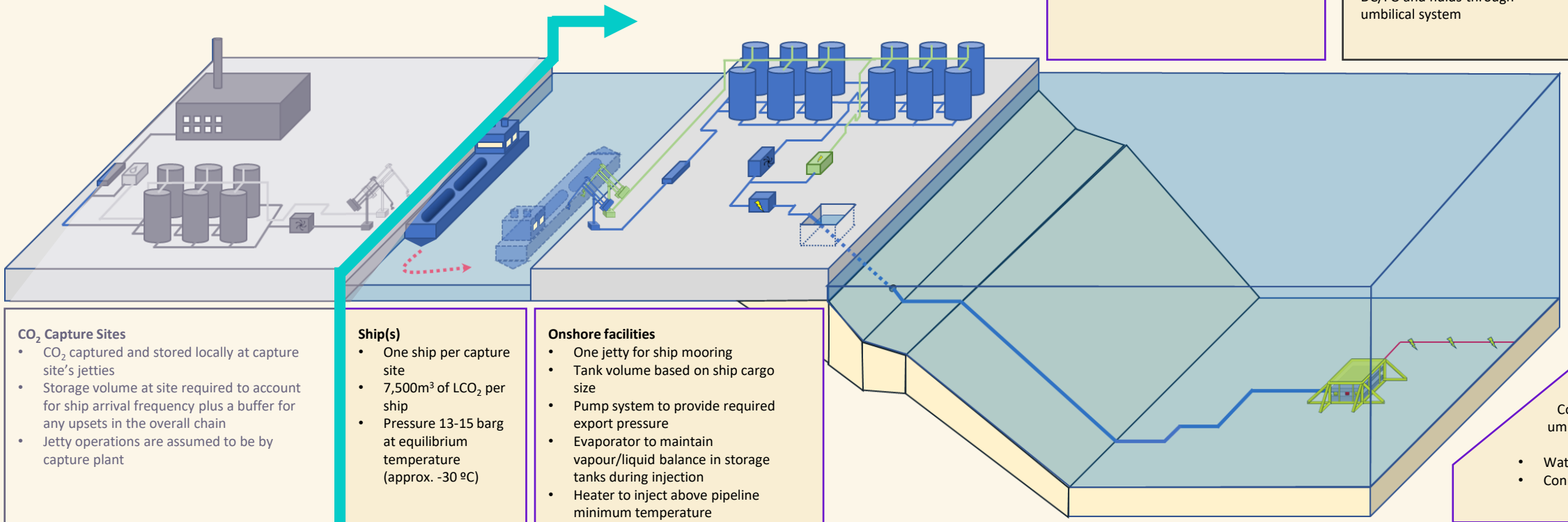
- Phase 1 – 1.5 Mtpa
- Phase 2 – up to 6-7 Mtpa

Northern Lights Scope of Work

Pipeline
- 100km un-insulated pipeline
- 12 ¼ inch
- Single phase (liquid) CO_2

Umbilical to Oseberg
Connection from Oseberg-field providing power and signal from DC/FO and fluids through umbilical system





Subsea injection well
- Injection of CO_2 into reservoir at ~2-3000m depth
- Pressure in reservoir ~2-300bar
- Temperature in reservoir ~100 ºC

CO_2 Capture Sites
- CO_2 captured and stored locally at capture site's jetties
- Storage volume at site required to account for ship arrival frequency plus a buffer for any upsets in the overall chain
- Jetty operations are assumed to be by capture plant

Ship(s)
- One ship per capture site
- 7,500m³ of LCO_2 per ship
- Pressure 13-15 barg at equilibrium temperature (approx. -30 ºC)

Onshore facilities
- One jetty for ship mooring
- Tank volume based on ship cargo size
- Pump system to provide required export pressure
- Evaporator to maintain vapour/liquid balance in storage tanks during injection
- Heater to inject above pipeline minimum temperature

Subsea facilities

Connecting pipeline, umbilical and well(s)
- Water depth ~300m
- Connection for future step-out

Storage complex
- Planned in the Johansen formation South of Troll ("Aurora") with an expected capacity of at least 100 Mt of CO_2

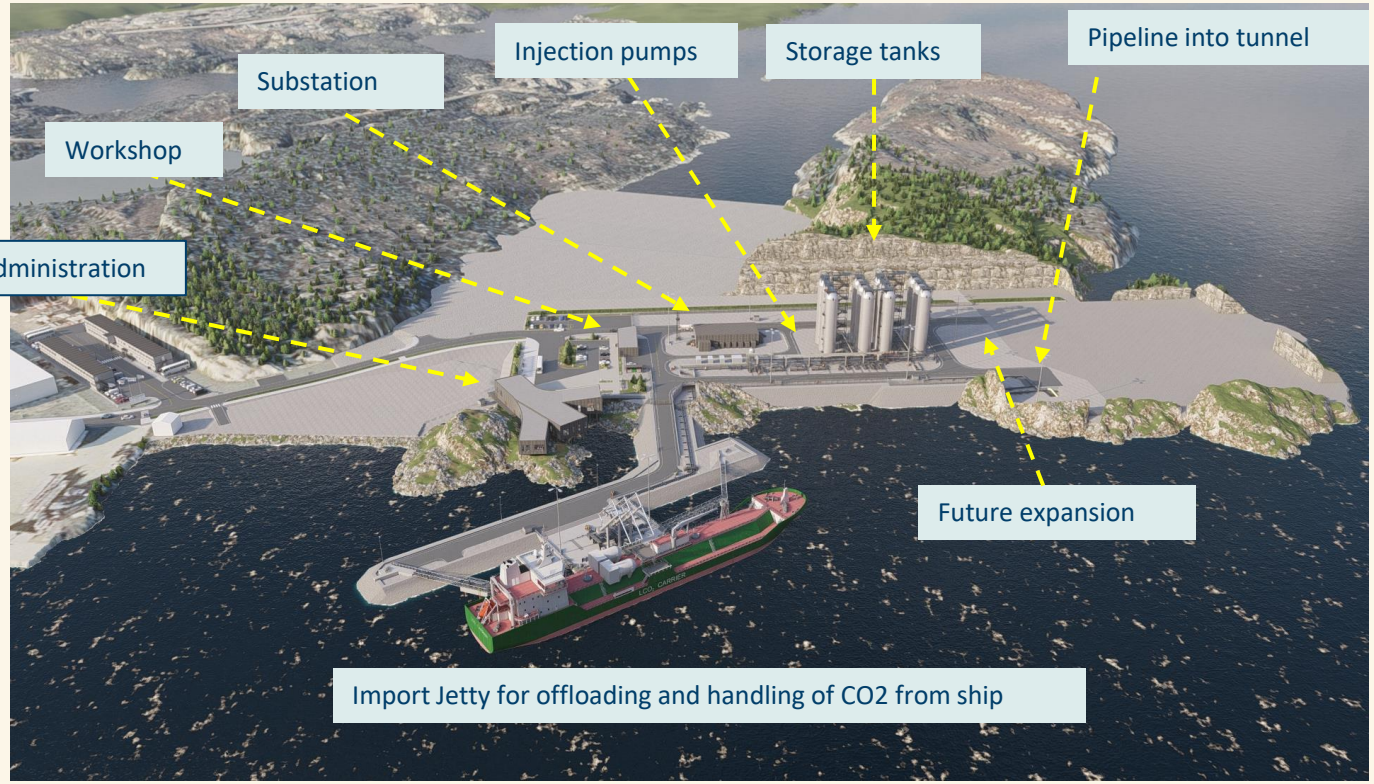
Scope capture site ← → Scope Northern Lights

Northern Lights shipping solution

- → **Ship building contracts awarded October 2021 (two ships)**
- → **Cargo size: 7 500m³ (8000t$_{CO_2}$) - Length: 130m**
- → **Medium Pressure cargo containment**
  - 15 barg and -26°C operational conditions
- → **Purpose-built pressurised cargo tanks but based on LPG standard design and size**
- → **Cruising range of +3000nm**
- → **Powered by HP LNG primary fuel 2-stroke engines + electric shore power supply**
- → **Wind assisted propulsion system and air lubrication installed (single rotor sail) + air lubrication under hull**
  - Will reduce carbon intensity by around 34% compared to conventional systems
- → **Ready for delivery by mid-2024**
- → **To be registered in Norway (NOR)**
- → **Additional vessels needed. Study ongoing for 12 000m³ ships. Investment subject to FID and customers requirements**

Onshore facilities

Northern



Onshore facilities Øygarden

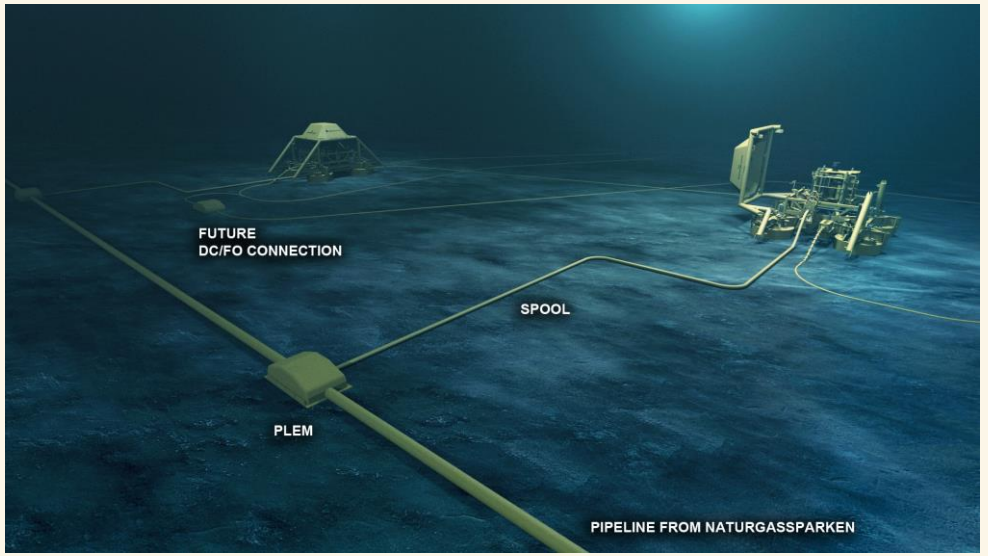
May 2022

Key milestones – Onshore – End May 2022

- → **HDD tunnel 380 of 680 m drilled**
- → **3 (of 12) tank foundations completed**
- → **Admin and workshop progressing**
- → **Substation progressing**
- → **Pre-fabrication ongoing at Stord for Plant EPC**

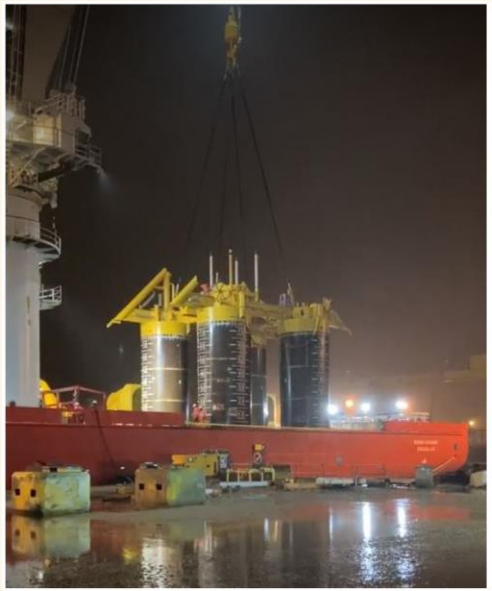
Pipeline & subsea facilities

- → 2 wells planned for start-up (1 contingent)
- → 100 km 12" pipeline
- → Fluid umbilical and DCFO cable between well and Oseberg Field Centre (36 km)
- → Connections for future extension to additional wells



Subsea facilities

- → Linepipe deliveries to Norway for installation in 2023
- → Preparatory works ongoing at Oseberg
- → Well#1 & 2 satellite structures installed subsea
- → Drilling campaign for well#2 this summer
- → Start of steel cutting last month for onshore terminal
- → Phase 2 preparatory work proceeding
- → Started drilling of HDD



Key milestone – Offshore – End May 2022

- → **Linepipe fabrication complete**
  - Lot 1 and 2 of linepipe received at coating yard in Orkanger
  - Lot 3 being loaded in Italy
- → **Well#2 satellite structure installed**
- → **Rock installation campaign for 2022 complete**
- → **Umbilical complete and delivered to Norway**
- → **4D baseline survey completed**

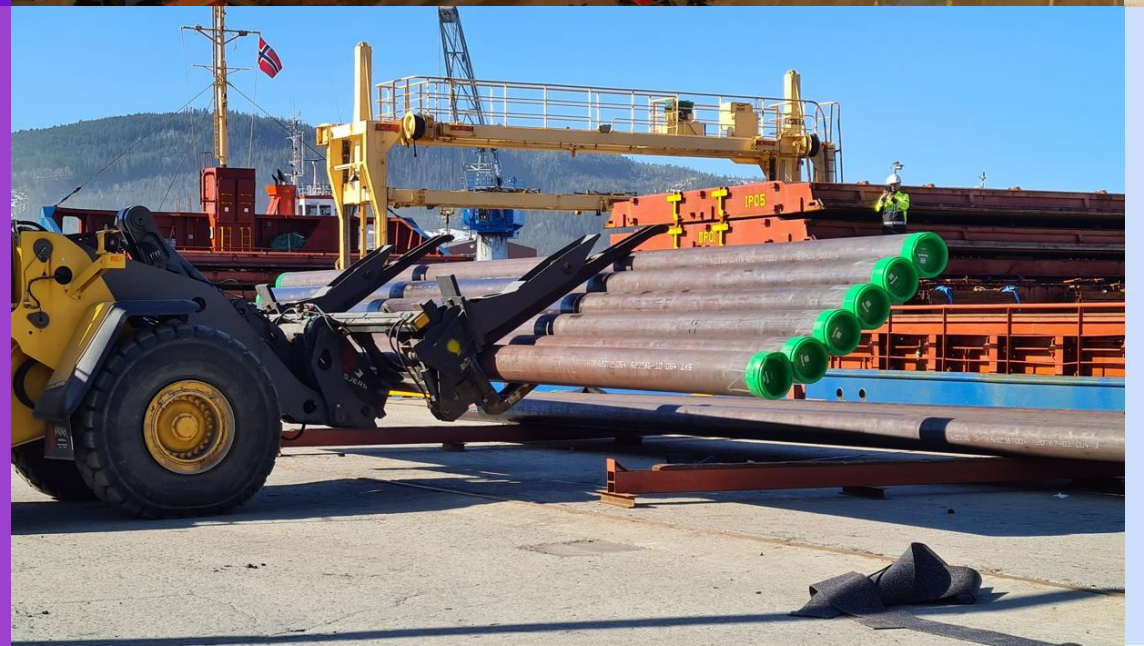
Fabrication activities

Northern Lights

Fabrication of storage tanks by Idesa, Spain

Fabrication of subsea satellite by Aker Solutions, Egersund

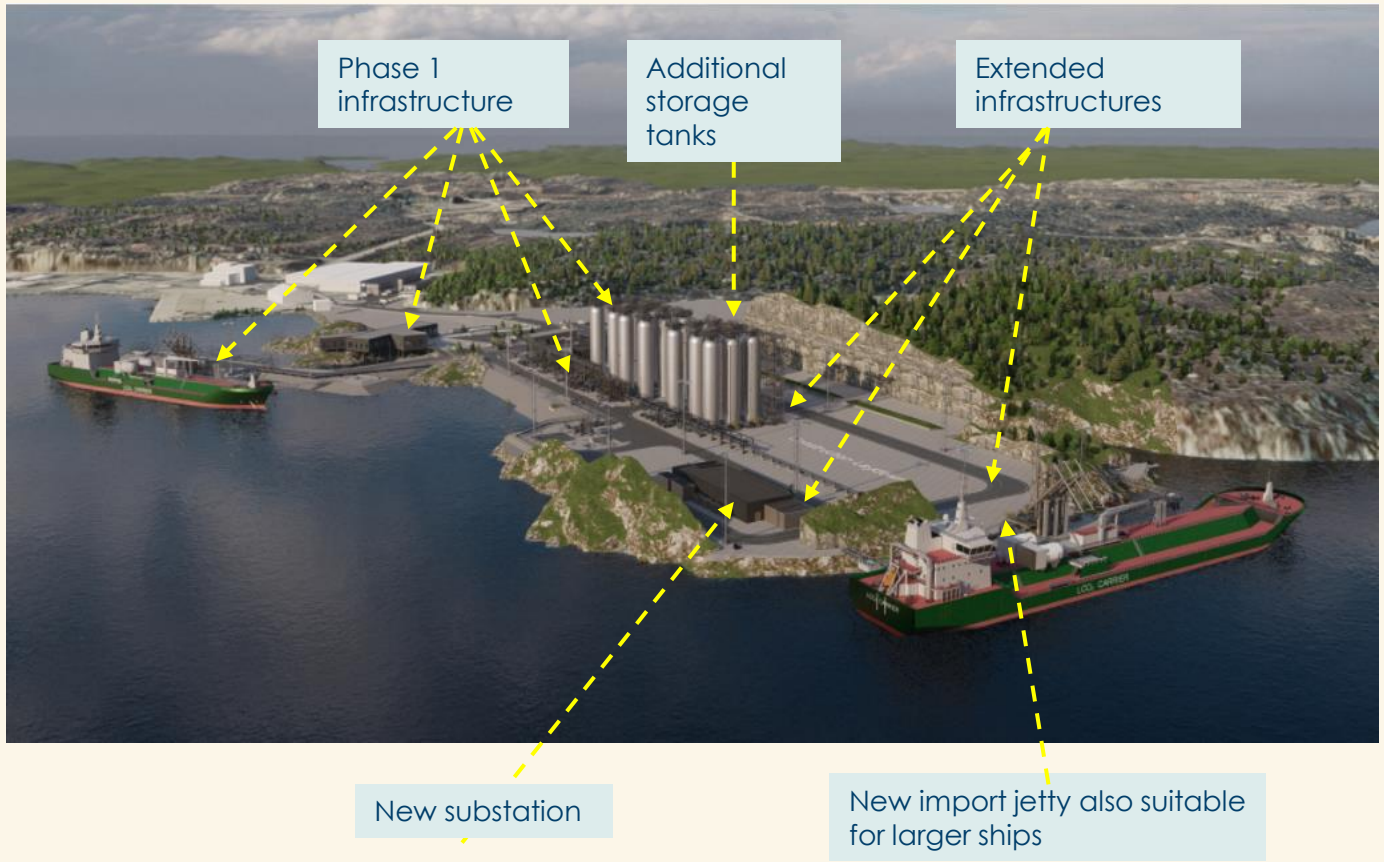
Fabrication of linepipe by Tenaris, Italy. Coating by Shawcor, Orkanger



Detailed engineering ongoing (STASCO/Dalian, China)

Phase 2 study – scope of work

- → **Additional area for expansion included and prepared**
- → **Integration with Phase 1**
- → **Additional connected storage with Phase 1 (temporary storage tanks)**
- → **New pumping unit, new substation, control system update**
- → **New/extended utilities**
- → **New jetty**
- → **SURF expansion (additional structures for additional wells)**
- → **Drilling & completion wells 3,4,5**
- → **Phase 2 FEED phase has been sanctioned and started end May 2022**



Co-financed by the Connecting Europe Facility of the European Union

Building a market for CO_2 storage

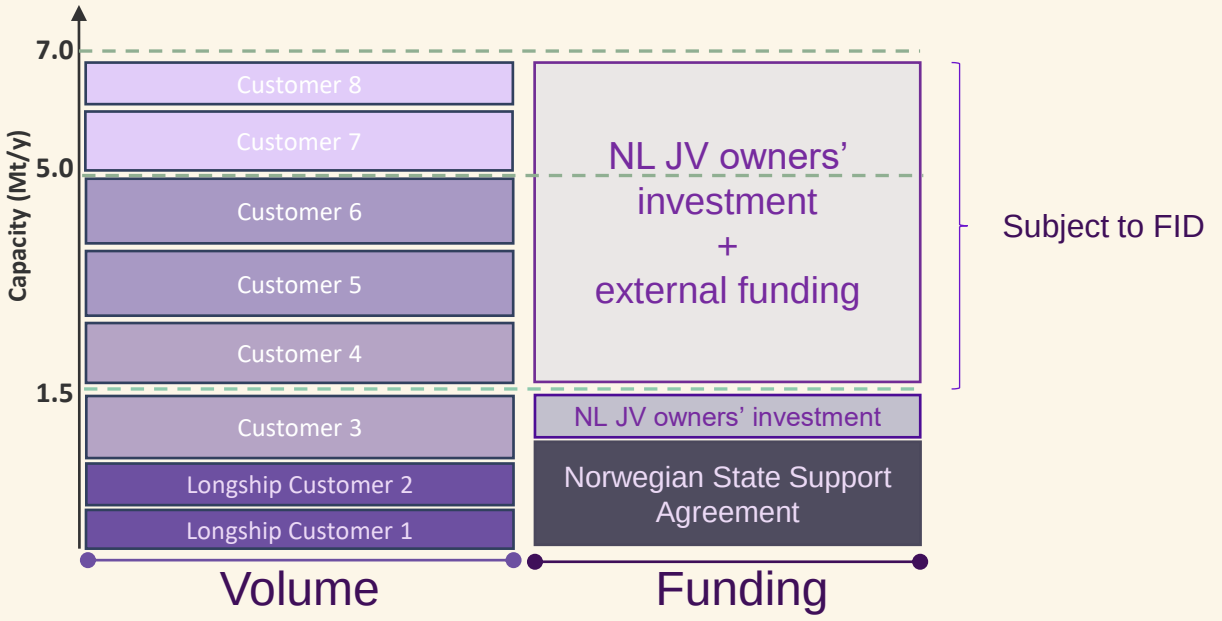
Significant demand for storage capacity

→ European Commission concern:
- not sufficient storage capacity being developed

→ Overcoming challenges:
- Everything we do is new
- First contracts of this type
- LCO_2 ships are new
- Little/no operational experience
- Risks management
- Costs
- De-risking subsurface is expensive
- Regulatory requirements – many firsts
- Northern Lights – Test Pilots

→ Northern Lights Phase 1
- capacity to transport, inject and store up to 1.5 Mtpa of CO_2

→ Northern Lights Phase 2
- capacity to transport, inject and store 5-7 Mtpa of CO_2



Key customer sectors

Strong potential but different levels of experience and maturity in respect to CCS

- Cement
- Chemicals/ refineries
- Waste incineration
- Biofuels/bioenergy
- Direct air capture
- Steel

Northern Lights

norlights.com

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How to accelerate CCS

Northern Lights

These are five significant lessons that are already transforming the discussion over how to accelerate the commercialisation of CCS in Europe and globally:

1. Temporary government support can overcome the chicken-and-egg problem
2. Large-scale demonstration projects facilitate learning by doing and remove hurdles
3. Shipping redefines the whole concept of access to CO_2 storage
4. CO_2 storage is an enabler for a net zero ecosystem beyond CCS
5. CCS value chains can be a cost-effective decarbonisation solution