Northern Lights

A European CO_2 transport and storage network

https://northernlightsccs.eu/

Northern Lights (Equinor, Shell og Total)
Geological storage in Aurora licence via pipeline from the onshore facility

Longship

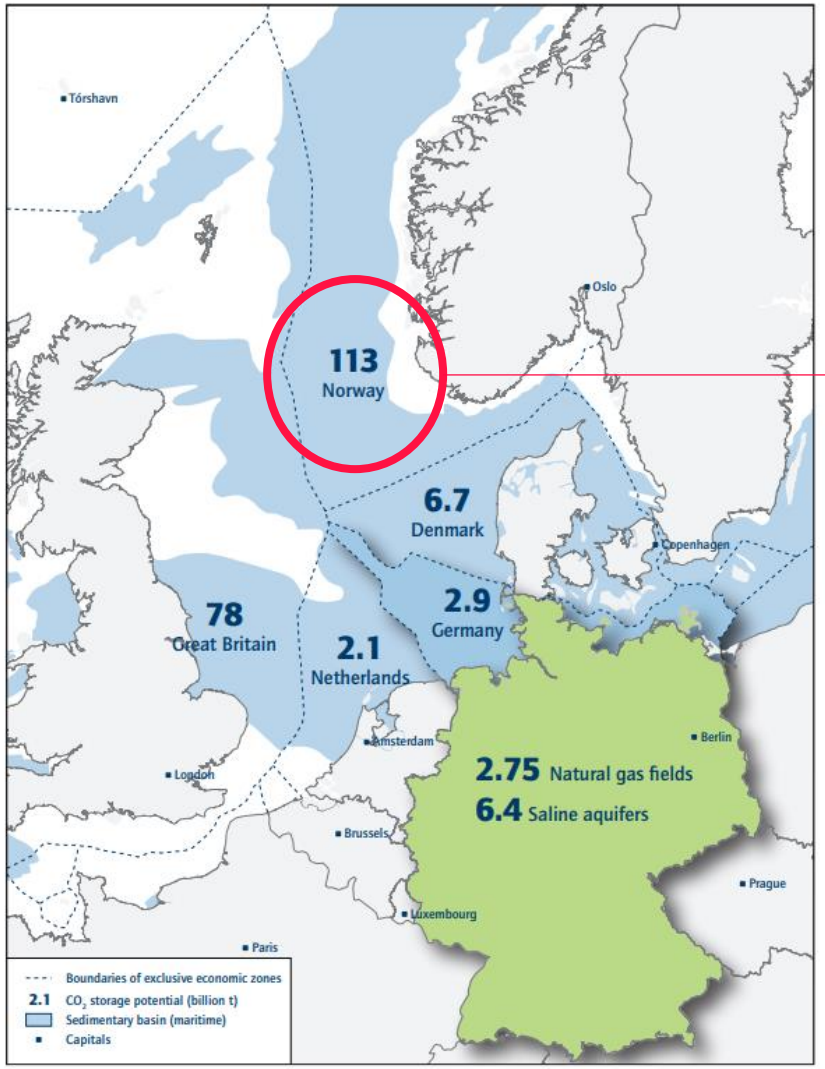
Northern Lights
Intermediate storage of CO_2 onshore

Fortum Oslo Varme AS
Capture of CO_2 from waste-to-energy plant

Norcem AS, Brevik
Capture of CO_2 from cement plant

Northern Lights
Transport of CO_2 by ship

Storage potential beneath the North Sea and Norwegian Sea



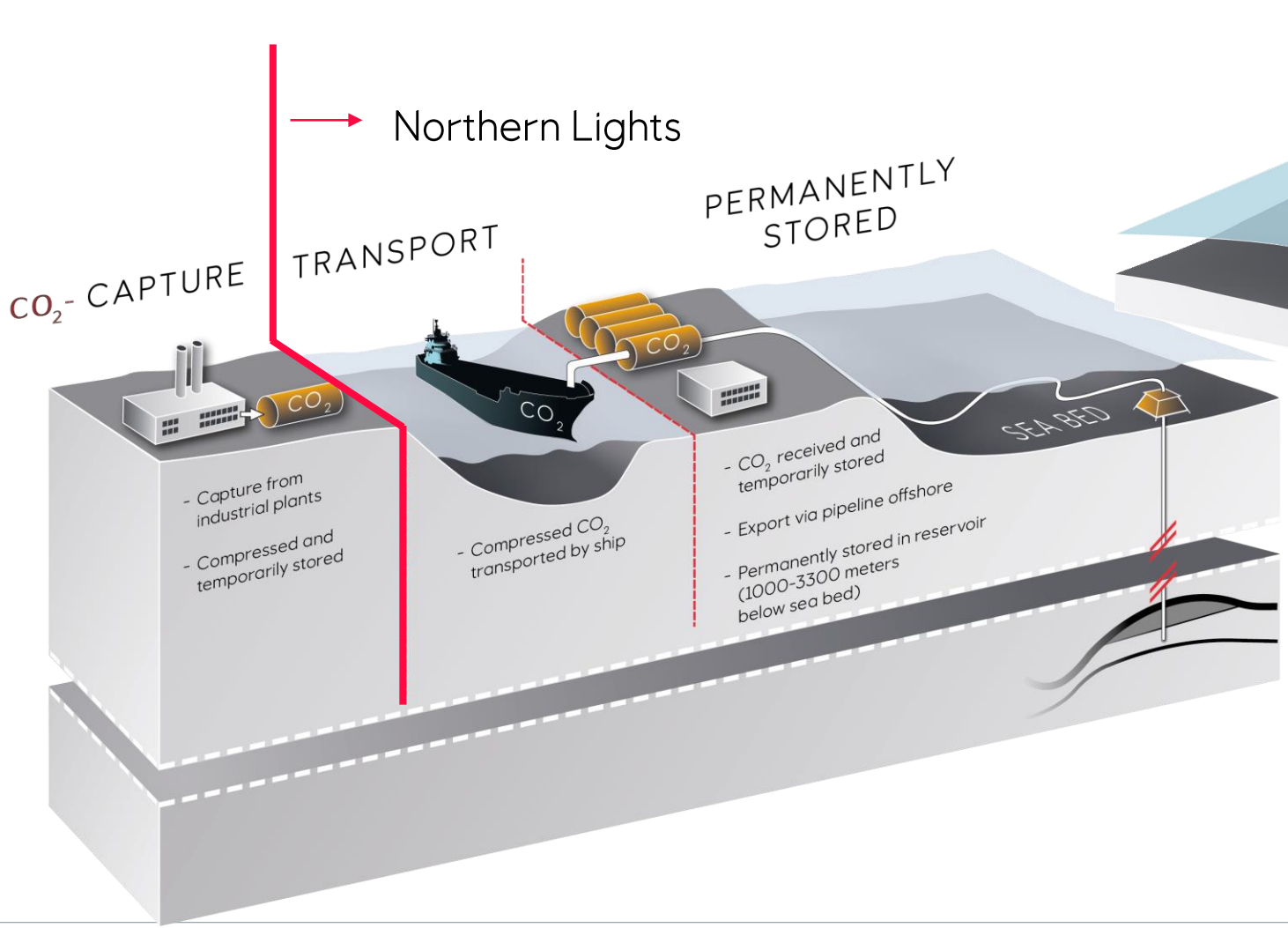
113

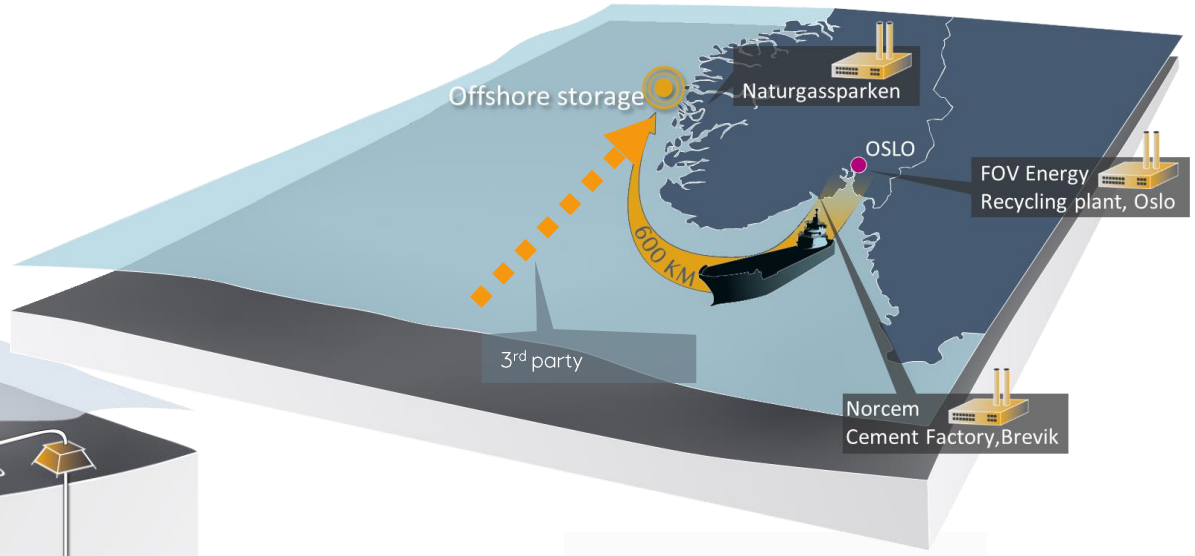
billion tonnes of CO_2 capacity

Source: Acatech, 2019; CCU and CCS - Builing Blocks for Climate Protection in Industry

Langskip - "Longship"

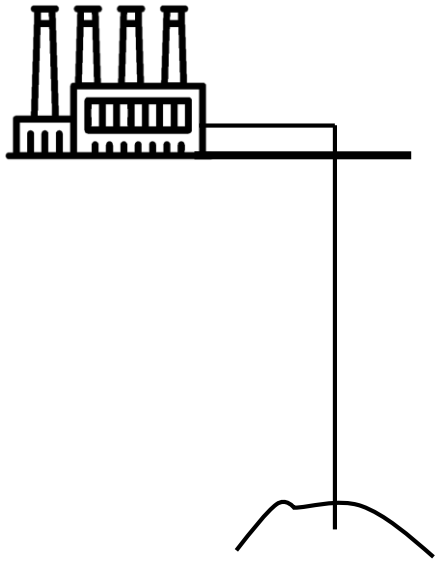
Capture, transport, injection and permanent storage of CO_2



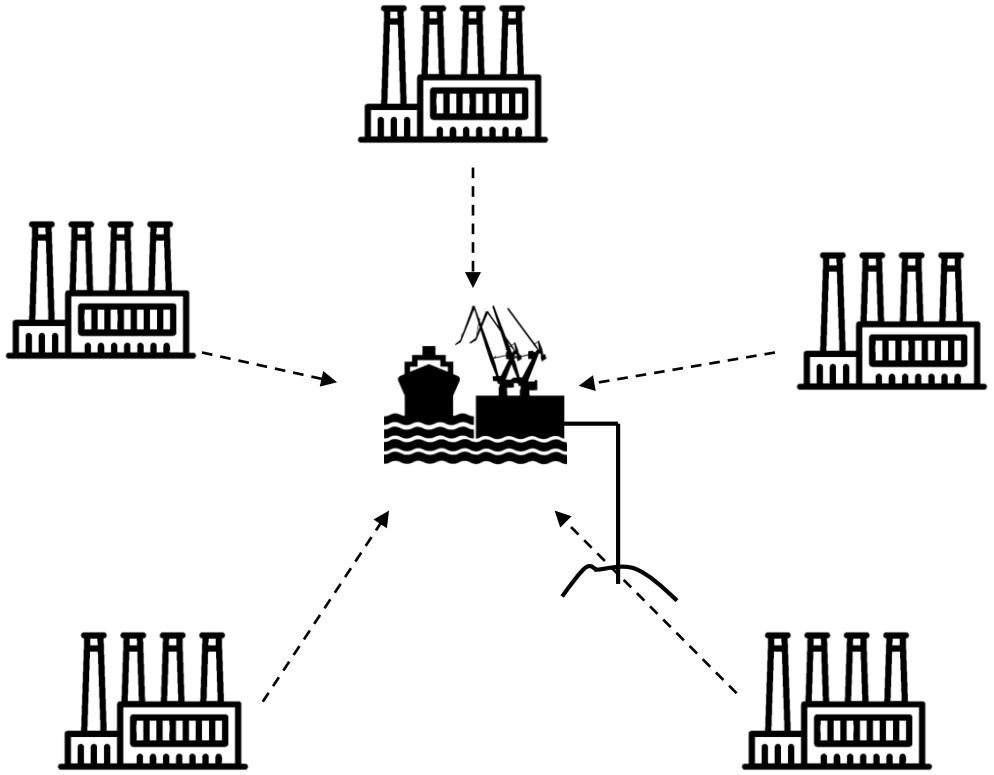


GASSNOVA

Northern Lights innovates the value chain: Separating source and sink - open source business model - open innovation



Traditional



Northern Lights

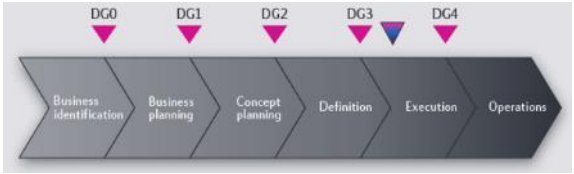
Northern Lights seen from normal oil & gas project perspective

Normal oil & gas

Regulatory framework exists

Business case

Resource is known, permanent, validated



Markets existing and predictable

Develop project to harvest business case
- Technical maturation with DGs
- Risks identified
- Concept freeze early
- Not schedule driven

Northern Lights

Regulatory framework not in place

No business

Resource is NOT known, validated:
- Not reservoir
- Not CO2

No normal markets

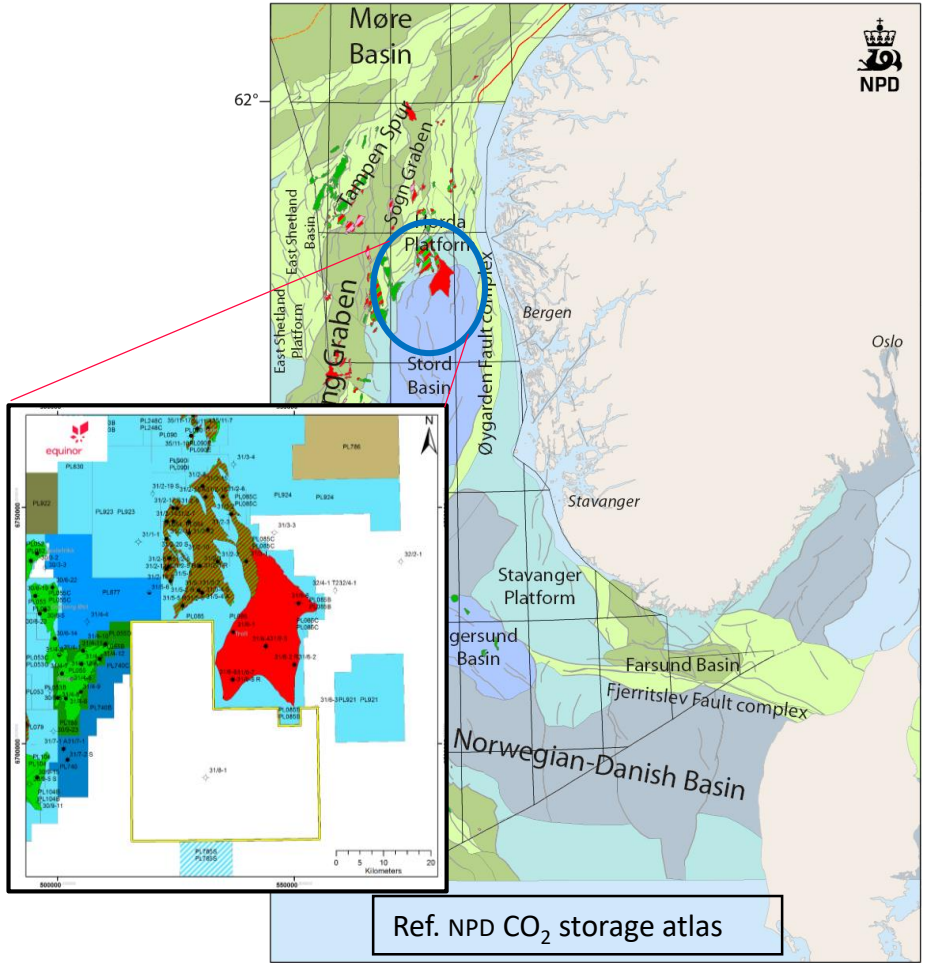
Develop project *to build future markets*
- Technical maturation with DGs
- Identified risks, ***and many***
- Concept ***partly*** frozen early ***(not SSV)***
- ***Schedule driven***

Geological storage

- The basic concept is to store CO_2 in reservoirs that would otherwise contain water, oil or gas

- Key storage issues for reservoir selection:
  - Capacity
  - Injectivity
  - Containment

- EL001, the first licence for CO_2 storage on NCS, was granted to Northern Lights in 2019
  - Large area
  - Injection in saline aquifer



Plan for development and operation delivered in May 2020

Historic investment decision for transport and storage of CO2

May 15, 2020 16:01 CEST | Last modified May 15, 2020 17:28 CEST

Equinor, Shell and Total have decided to invest in th
project in Norway's first exploitation licence for CO
Norwegian Continental Shelf. Plans for developmer
been handed over to the Ministry of Petroleum and

(Førebels utgåve)

DET KONGELEGE
OLJE- OG ENERGIDEPARTEMENT

Meld. St. 33

(2019–2020)

Melding til Stortinget

Langskip – fangst og lagring av CO_2

ESA | EFTA Surveillance Authority

ESA at a glance | Internal Market | State aid | Competition | Newsroom | Careers

en no 17 JUL 2020 · STATE AID

ESA approves Norwegian Full-Scale Carbon Capture and Storage: up to €2.1bn in aid to meet climate goals

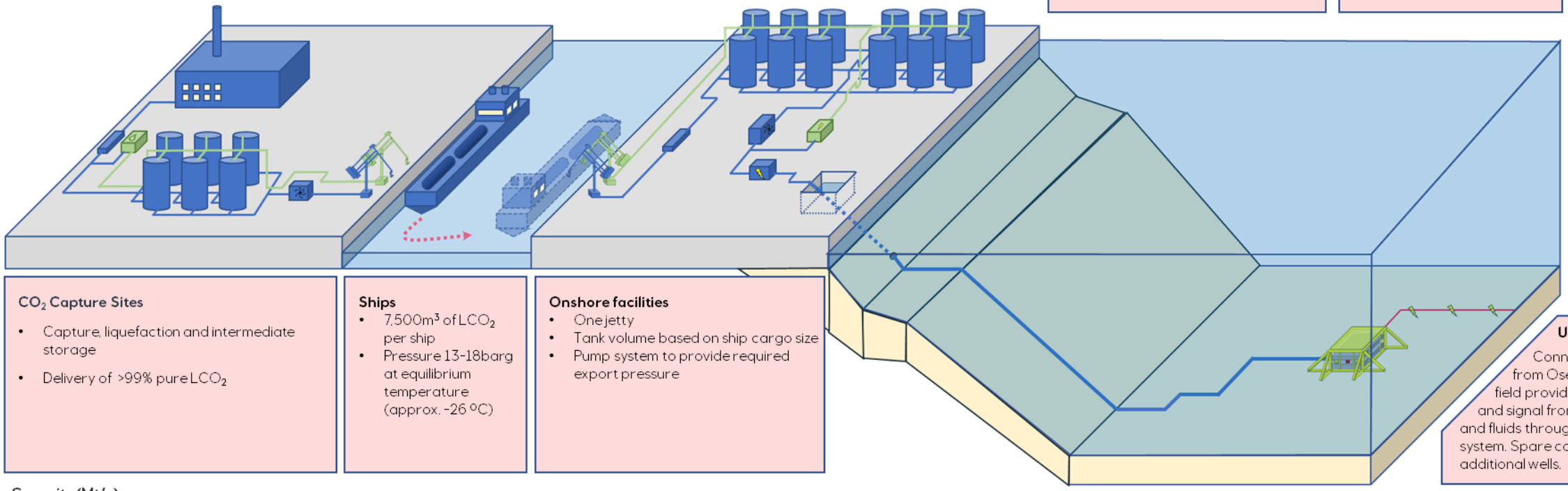
The CCS Full-Scale project is a central part of Norway's efforts to reduce its carbon footprint and meet the European goal of climate-neutrality by 2050. It is the largest single state aid award ever approved by the EFTA Surveillance Authority (ESA).

Carbon Capture and Storage (CCS) has been recognised by the European Union as key to reducing the harmful environmental effects of carbon-intensive sectors (such as construction), where emissions are difficult to avoid.

Northern Lights – concept overview

Pipeline
- 100km un-insulated pipeline
- 12 ¾ inch
- Single phase (liquid) CO_2

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



Subsea injection well
- Injection of CO_2 into reservoir at ~2700m depth
- Pressure in reservoir ~270bar
- Temperature in reservoir ~107°C

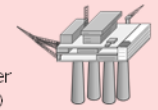
CO_2 Capture Sites
- Capture, liquefaction and intermediate storage
- Delivery of >99% pure LCO_2

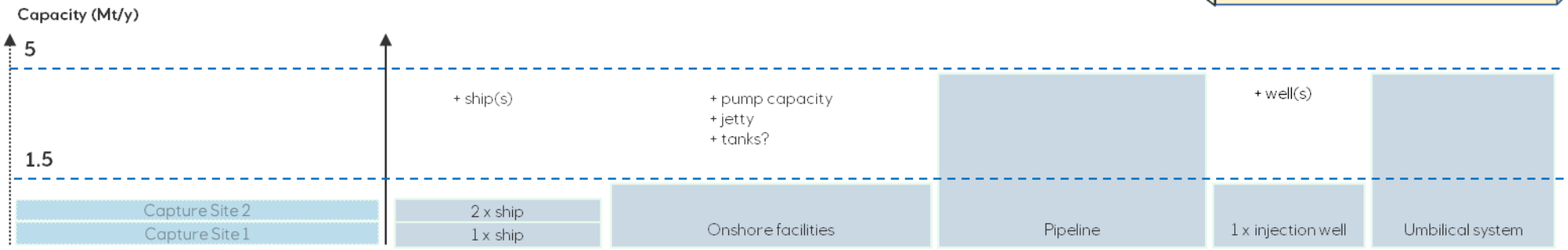
Ships
- 7,500m³ of LCO_2 per ship
- Pressure 13-18barg at equilibrium temperature (approx. -26 °C)

Onshore facilities
- One jetty
- Tank volume based on ship cargo size
- Pump system to provide required export pressure

Umbilical

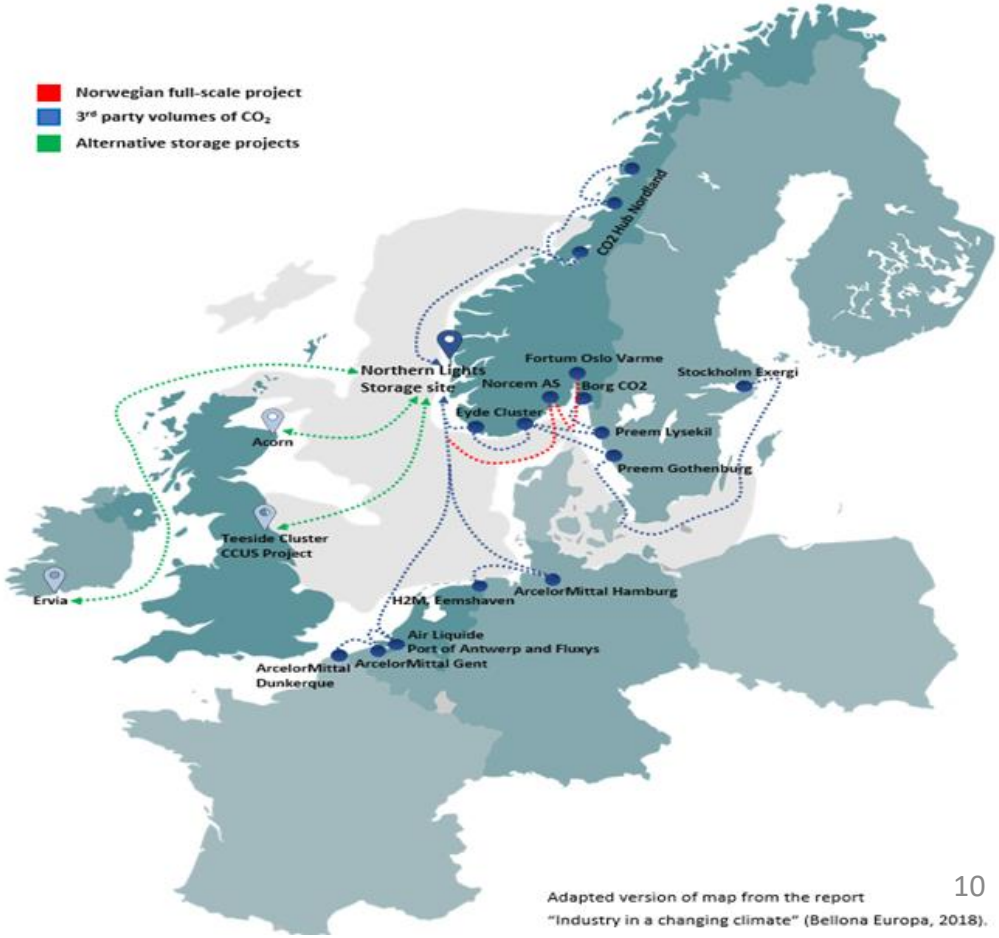
Connection from Oseberg-field providing power and signal from DC/FO and fluids through umbilical system. Spare capacity for additional wells.





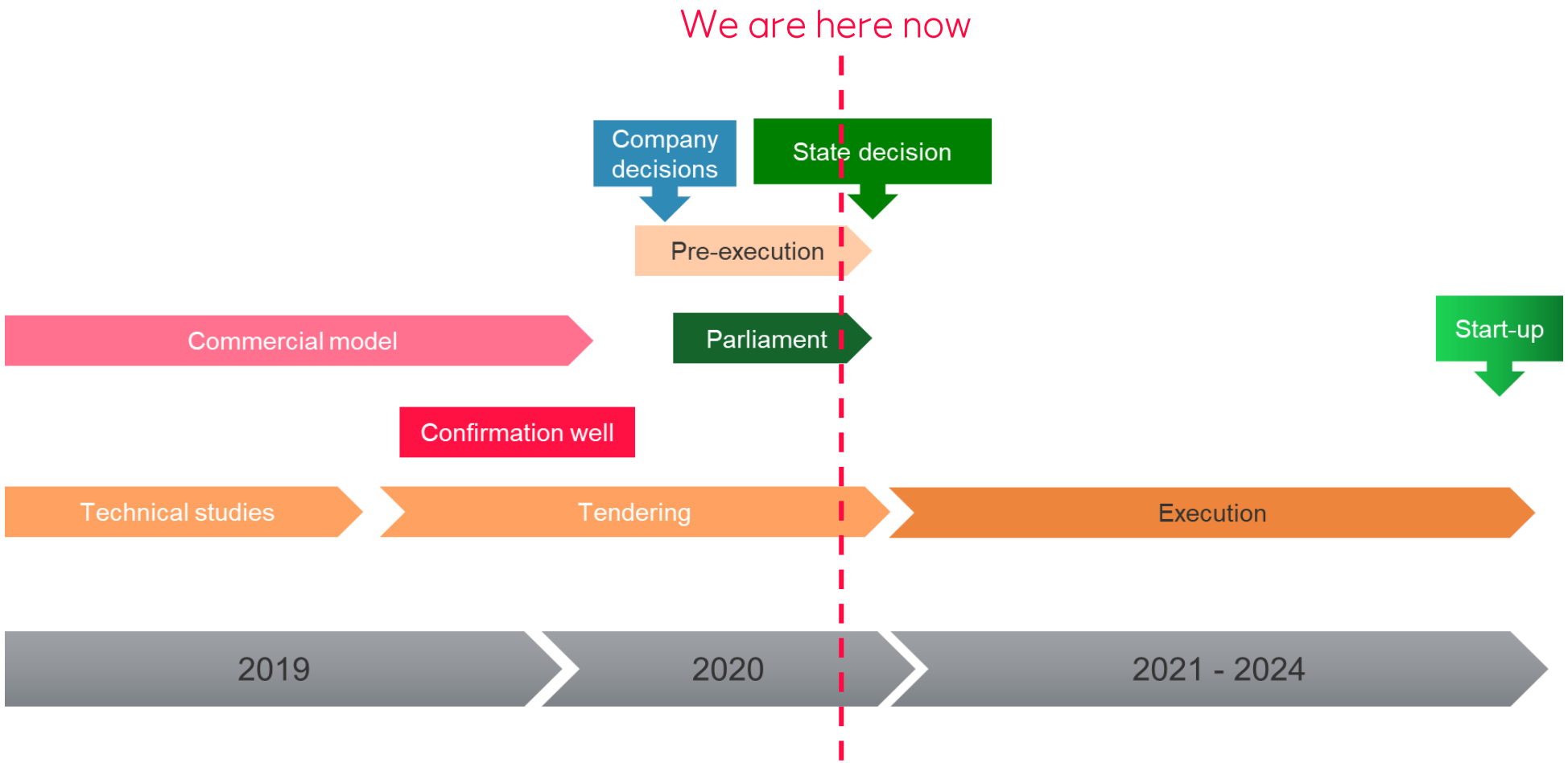
CO_2 transport by ship

- Cargo Systems for CO_2
  - 7,500 m^3 capacity
  - Tank operating condition: 15 barg, ca.-26°C
  - Offloading @ 800 m^3/hr
- 'LPG standard' design
  - Proven concept based on food industry model
- Initially two ships
  - Transport capacity scalable with number of ships



Adapted version of map from the report "Industry in a changing climate" (Bellona Europa, 2018).

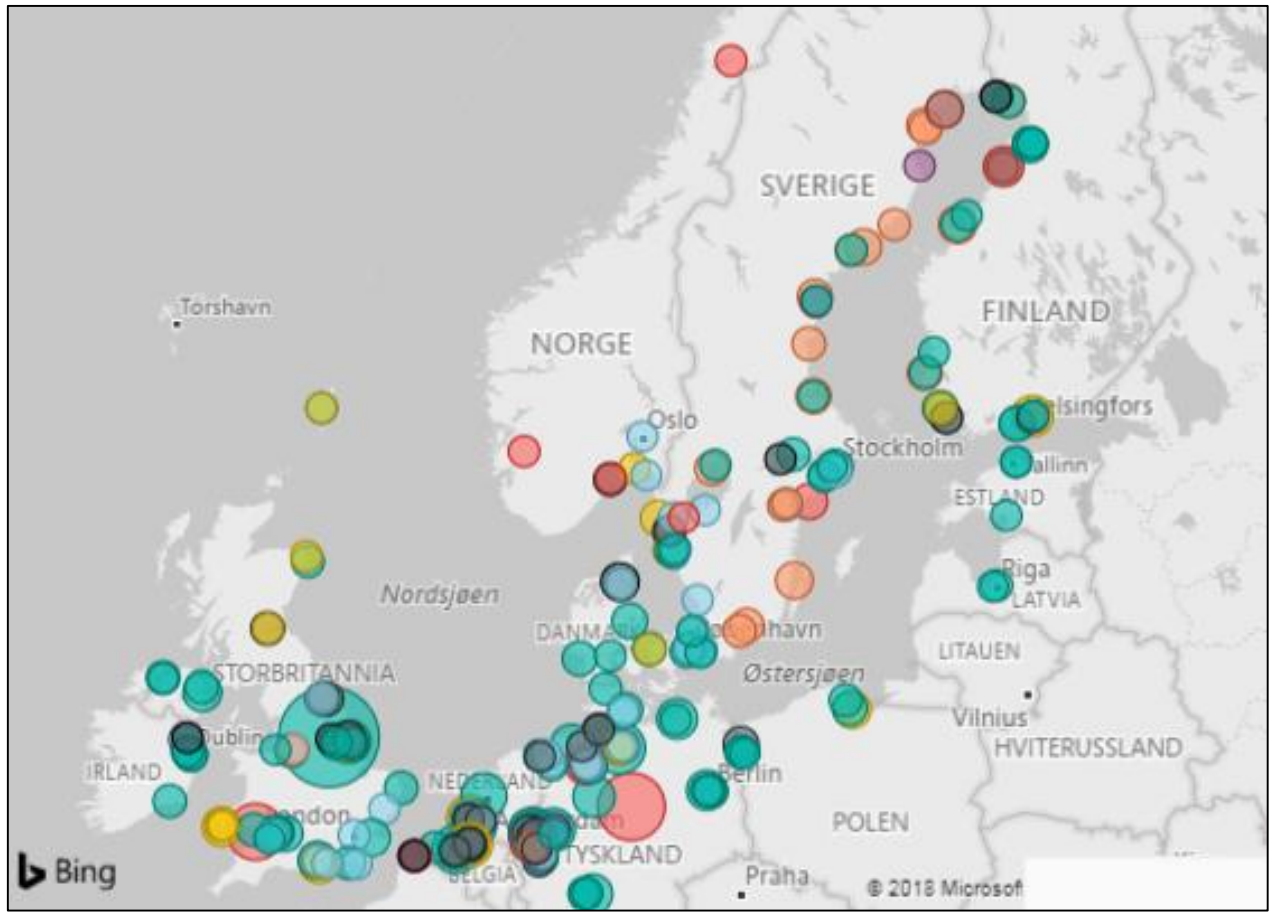
Northern Lights phase 1 schedule



Commercial / Volume Staircase

'Tag Line'		Revenue Model
CCS is a normal business	xyz mtpa capacity **Phase 3: Further expansion of NL's facilities as CCS takes off at a bigger scale** - Further 3rd party volumes	Fees from 3rd parties
Build-up	5 mtpa capacity **Phase 2: 3rd Party Volumes to expand** - "Anchor Customer" to enable FID? - Other 3rd party volumes, subj. to facilities capacity	Fees from 3rd parties
Base Project	1,5 mtpa capacity **Phase 1: State Subsidies needed to get the project going** - One or two capture plants (Norcem and/or Klemetsrud) - 3rd party volumes to utilize spare capacity	SSA (NPV neg. as stand-alone) + Fees from 3rd parties

Enables "open source" offer for CO_2 emitters to establish capture



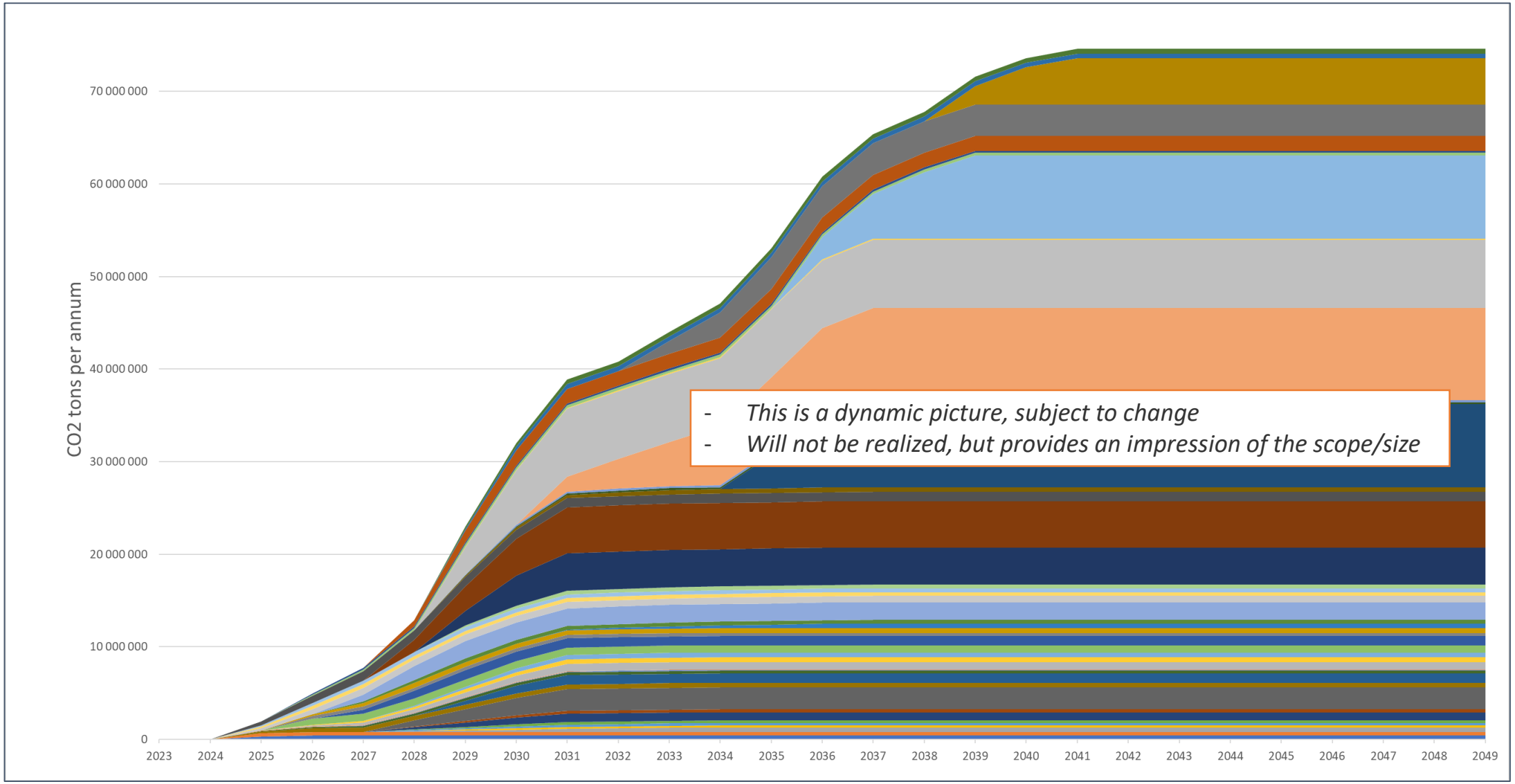
Source Endrava & Carbon Limits

Large potential with long-life sectors:

- Hydrogen and power from natural gas
- Waste incineration
- Cement
- Biomass and biofuel
- Steel
- Refinery

- *Northern Lights is relevant and within reach for about 350 facilities and 300 MTPA of these "most attractive candidates"*

Indicative profile based on companies in dialogue with Northern Lights



Northern Lights

Sverre Overå, project director