Northern Lights & Research on CCS Facilities

CATO, Rotterdam, 26.06.2019

Michael Drescher

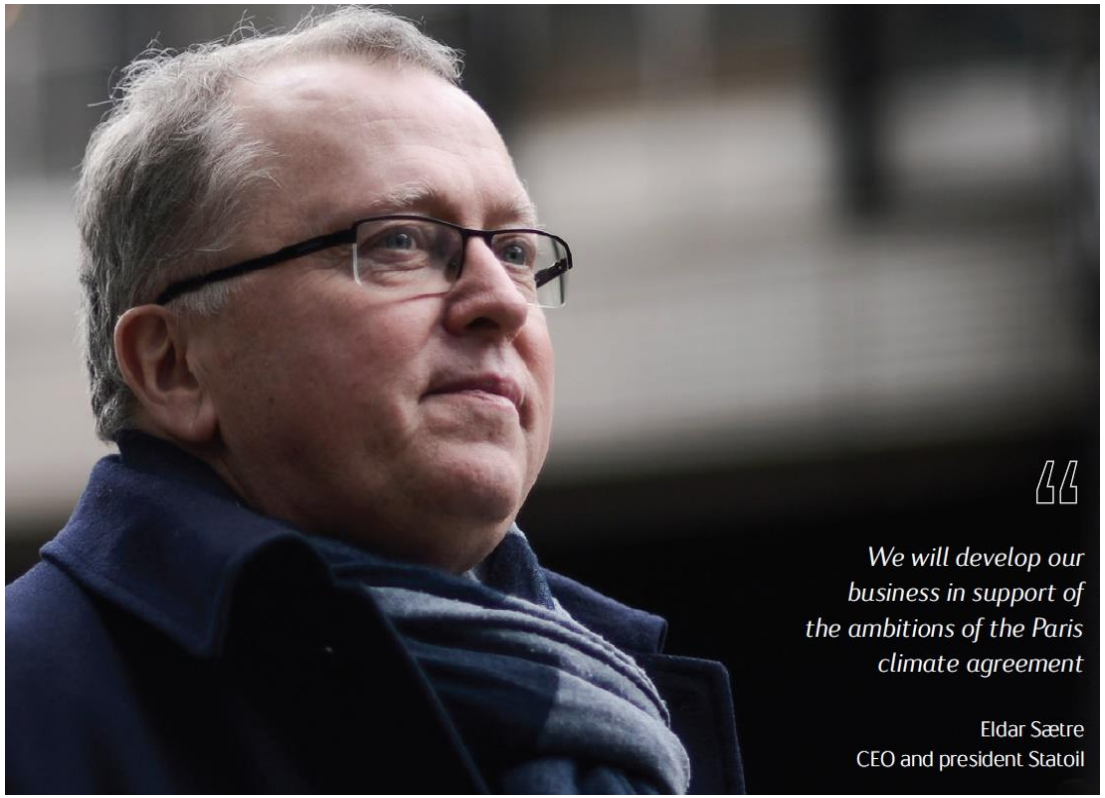
Equinor vision: Shaping the future of energy

A ***low CO_2 footprint*** is a competitive advantage and a top strategic priority

Evaluating ***CCS and clean hydrogen*** in the transition to a low carbon society

Exploring ***several business opportunities*** by reforming natural gas to clean hydrogen, while capturing and storing the CO_2

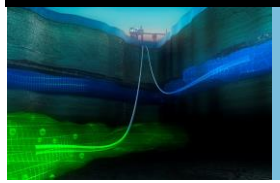
Meet future climate targets in ***power, industry, transportation and heating***



Our Technology Roadmap towards CCS – Building future competitiveness & European CCS network

1996-2020

Experience (2 Mt/yr)



Sleipner
Snøhvit
Technology Centre Mongstad (TCM)

- Safe CO_2 storage demonstrated
- 1st generation transport solutions
- Post-combustion capture from gas based power production qualified

In Operation

Norther Lights is an essential step

2020-2025

Open storage hub (<5 Mt/yr)

Northern Lights (NL)
Third party CO_2 storage

- Multi-sourcing of CO_2 & future CO_2 logistic chains
- Reduce cost for expanding Northern Lights
- Scale-up CO_2 storage NCS and/or international: Qualify capacity, integrity & monitoring methods

Value Chain Demonstration

2025-2030

Expand network (>20 Mt/yr)

Connect NO, UK,and NL
Magnum, OGCI Clean gas project

- Offshore receiving and offloading concepts
- Qualify several storage hubs in North Sea to serve de-carbonization of first CCS industry and hydrogen projects

Market build

2030-2040

Further expand (>100 Mt/yr)

H21NoE
Clean H_2 business
Third party CO_2 storage

- Multi-source, multi-store logistics concepts
- CCS cost significantly reduced: learning by doing and sharing of infrastructure

Large Scale Implementation

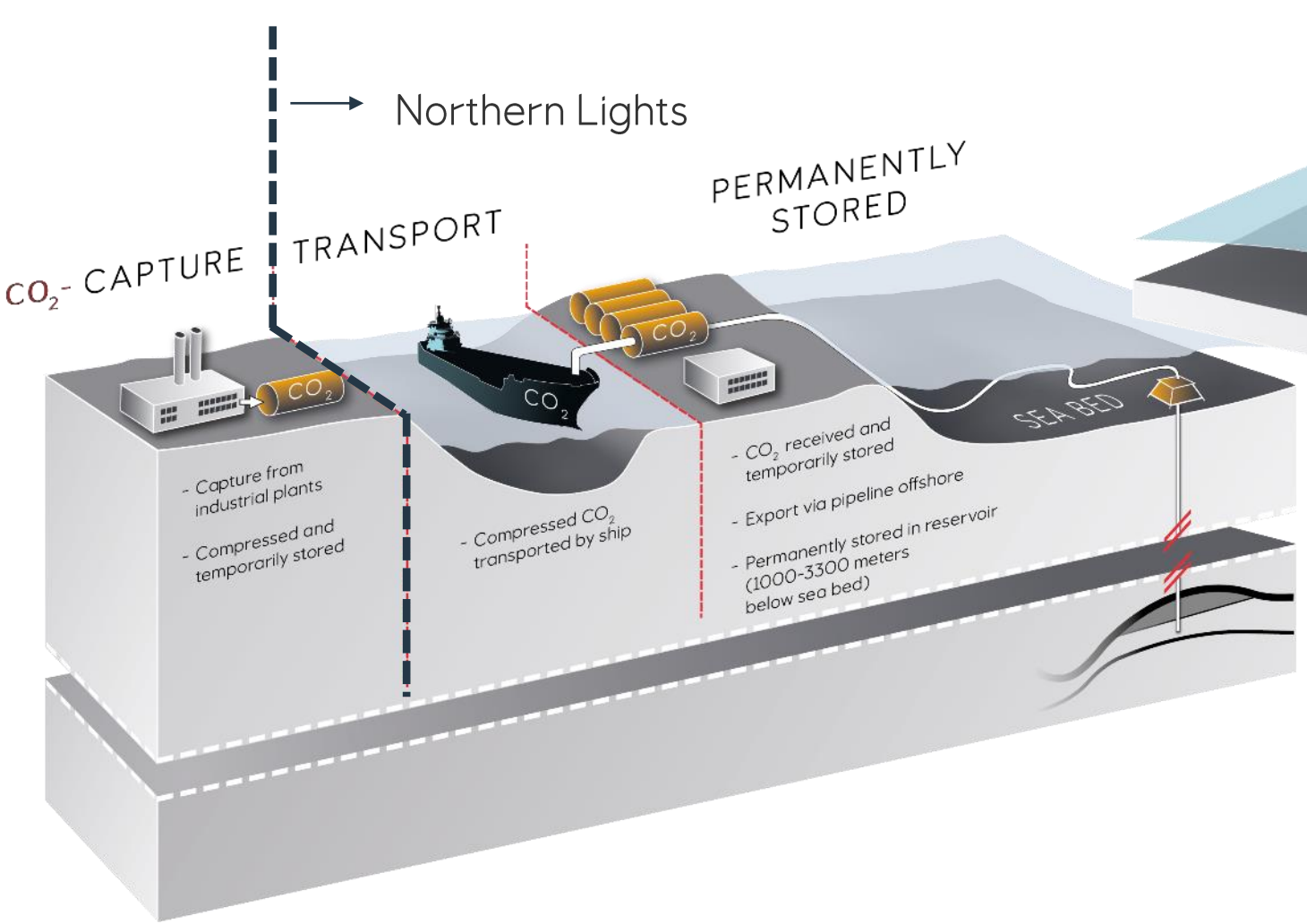
2040-2050

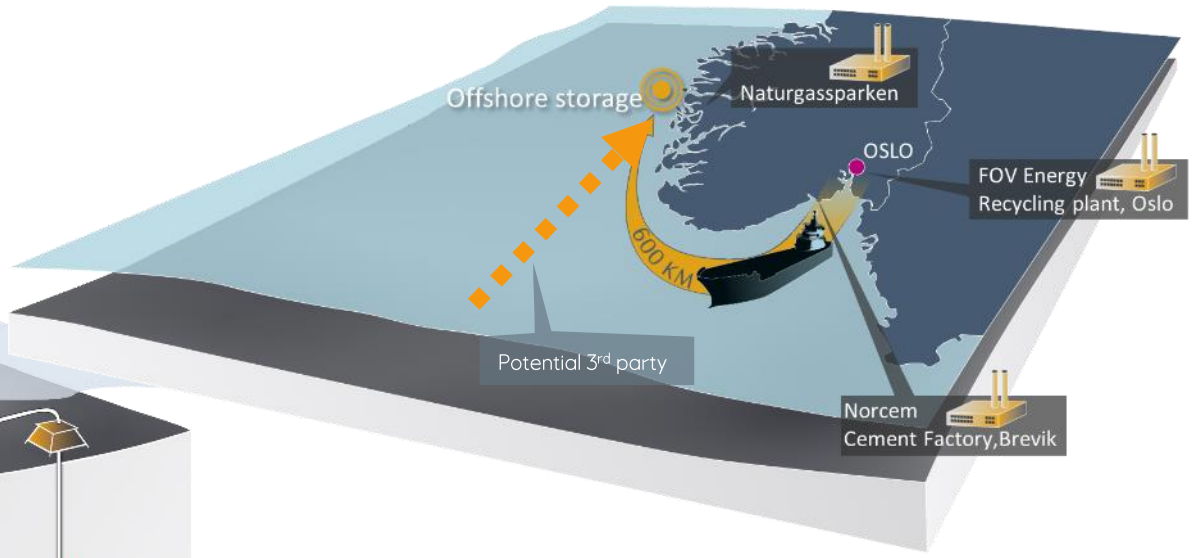
Low carbon competitiveness

Clean H_2 business
Storage business third party CO_2
CCS own emissions

- CO_2-negative CCS chains
- Technologies for efficient global CO_2 storage exploration and field development

Norwegian full scale CCS demonstration project





GASSNOVA

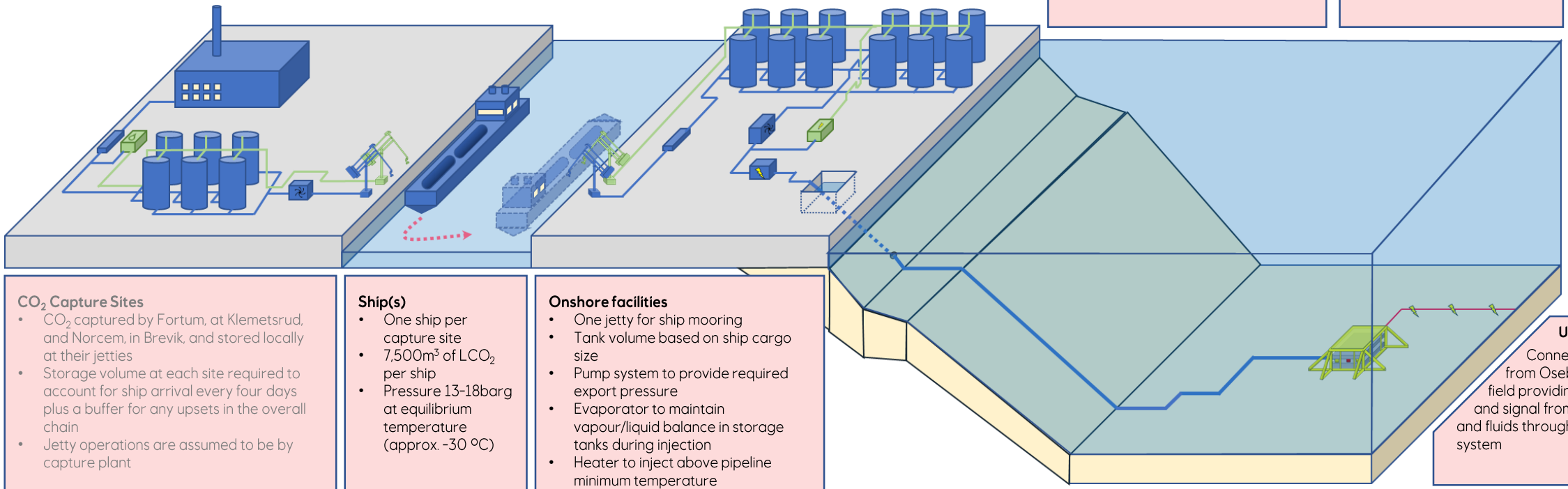
equinor

TOTAL

Northern Lights: Concept Overview

Pipeline
- 110km un-insulated pipeline
- 12 ¼ 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 ~2-3000m depth
- Pressure in reservoir ~2-300bar
- Temperature in reservoir ~100 ºC

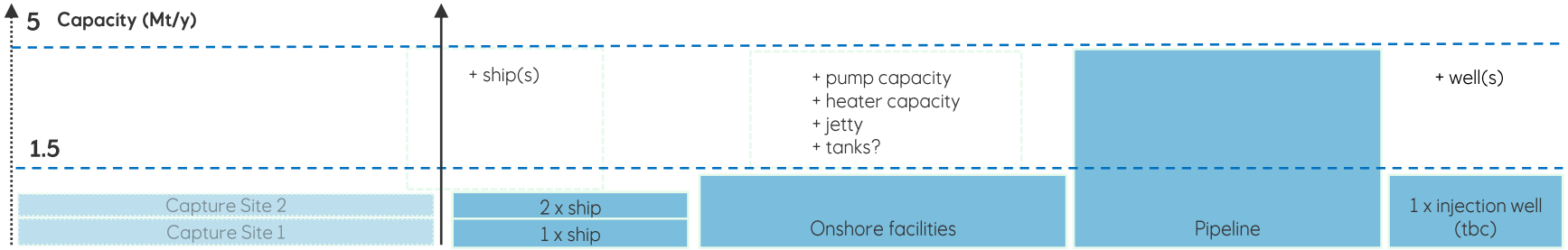
CO_2 Capture Sites
- CO_2 captured by Fortum, at Klemetsrud, and Norcem, in Brevik, and stored locally at their jetties
- Storage volume at each site required to account for ship arrival every four days plus a buffer for any upsets in the overall chain
- Jetty operations are assumed to be by capture plant

Ship(s)
- One ship per capture site
- 7,500m³ of LCO_2 per ship
- Pressure 13-18barg 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

Umbilical

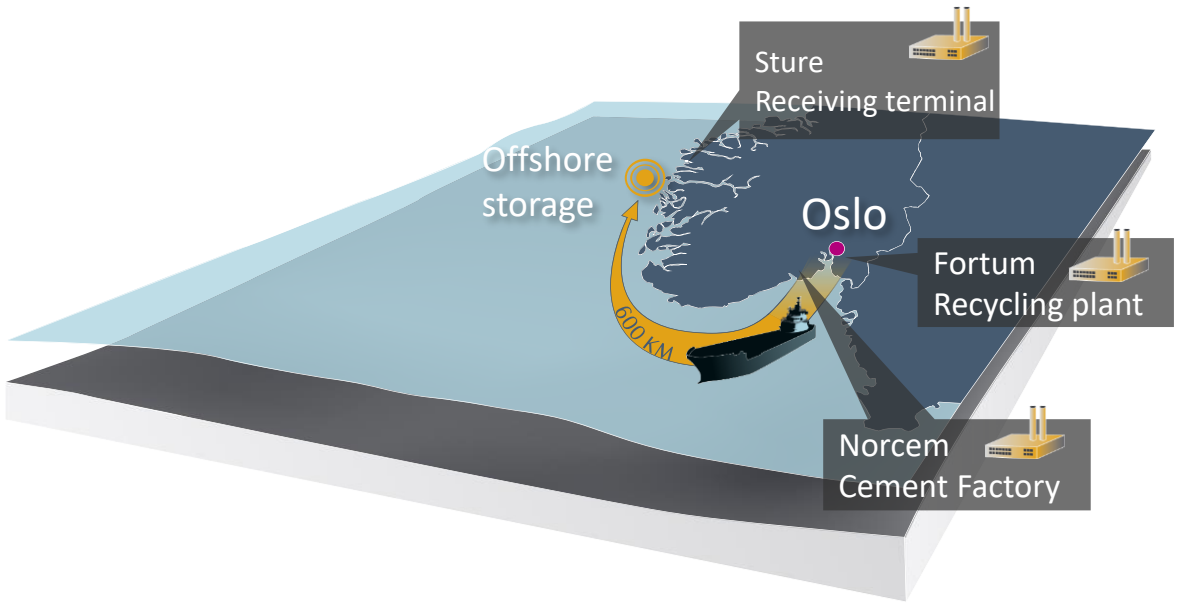
Connection from Oseberg-field providing power and signal from DC/FO and fluids through umbilical system



Storage complex
- Planned in the Johansen formation south of Troll ("Aurora") with an expected capacity of at least 100 Mt of CO_2
- Contingency storage in Heimdal (depleted field)

Northern Lights: Status and plan

- Drilling confirmation well including well test – Q1-2020
- Partner FID and PDO/PIO submission – Q2-2020
- State FID – Q4-2020
- Execution up to Q4-2023 - Demonstration period starts



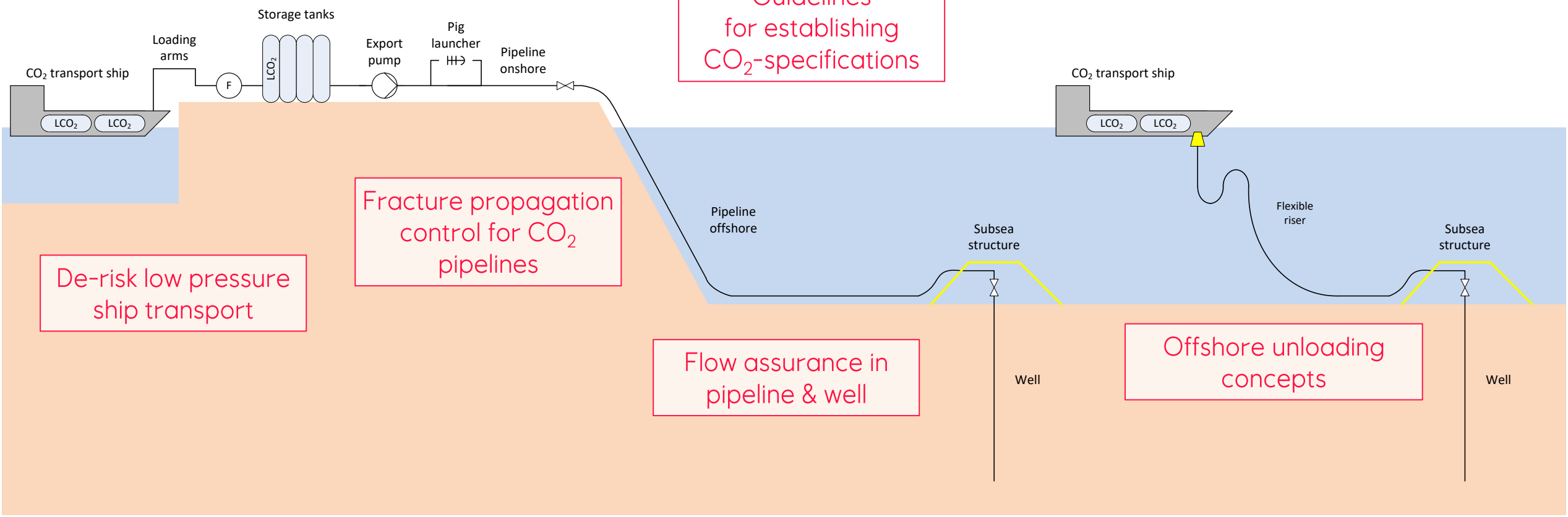
R&D Activities on CO_2 Facilities

Close R&D dialogue

equinor

TOTAL

Guidelines for establishing CO_2-specifications



Fracture propagation control for CO_2 pipelines

De-risk low pressure ship transport

Flow assurance in pipeline & well

Offshore unloading concepts

Flow assurance in pipeline & well

What safety margins do we need for flow assurance?

- Pure CO_2 & CO_2 with impurities
- Steady-state, transient, 1-phase & 2-phase flow
- Understand different flow geometries, valve models & scalability

CO2 FACT JIP

DEFACTO JIP

Validated software for CO_2 flow assurance

Understand the validity domain & uncertainties

Guidelines for establishing CO_2-specifications

"What is the CO_2-spec?" (Design basis)

Different scenarios need different solutions!

- Challenge Northern Lights CO_2-spec
- Ship based chains vs. pipeline networks
- Different sources & storage reservoirs
- New vs. reuse of facilities

- Capture & purification technologies
- Safety
- Material
- Thermodynamics & chemical reactions
- Operational risks
- Stream analyzing
- Economics

Guidelines/ methodology for establishing cost-effective CO_2 specifications

Key messages

- Learning from Northern Lights
  - Guiding Equinor´s R&D activities
  - Close dialogue with partners Shell and Total
- Equinor´s objective of its R&D portfolio on CCS is to contribute to the deployment of a European CO_2 transport and storage network
- Using R&D collaboration to mature industry, vendors & research institutes across nations

Northern Lights & Research on CCS Facilities

Michael Drescher, Principal Researcher CO_2 Transport