



CCUS and Low Carbon Fuels

11 – 12 March 2025 | Tokyo, Japan

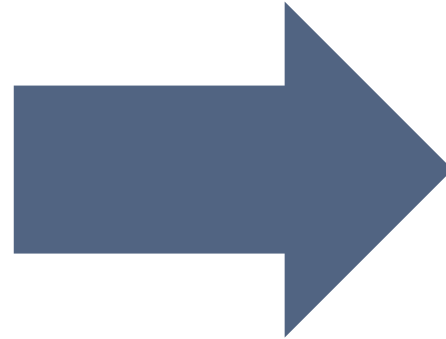
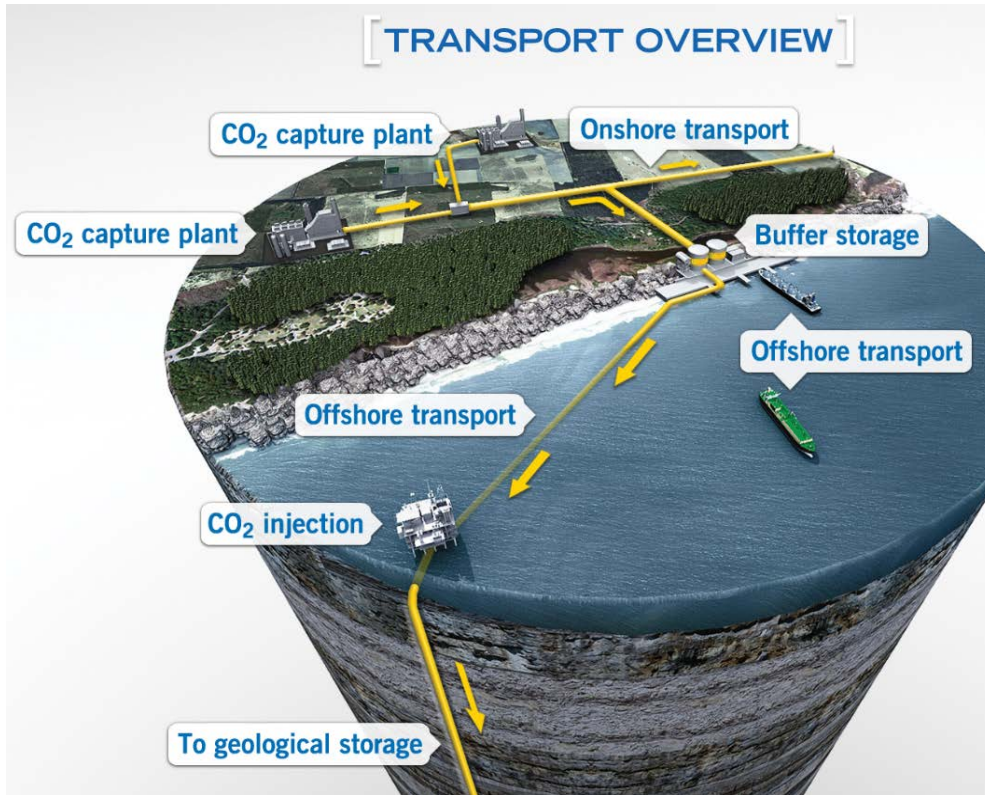
KNCC's view on marine transportation of Liquified CO₂

Tomoki Inoue

Knutsen NYK Carbon Carriers AS seconded from NYK Line



Key features of the CCS value chain

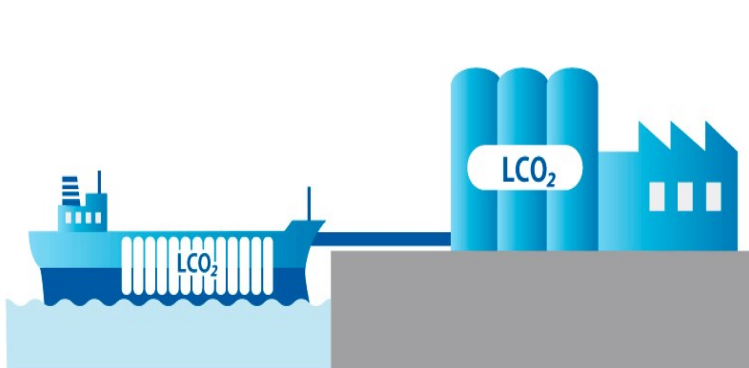


- Waste management
- Scale game
- Capital intensive
- Long term commitments

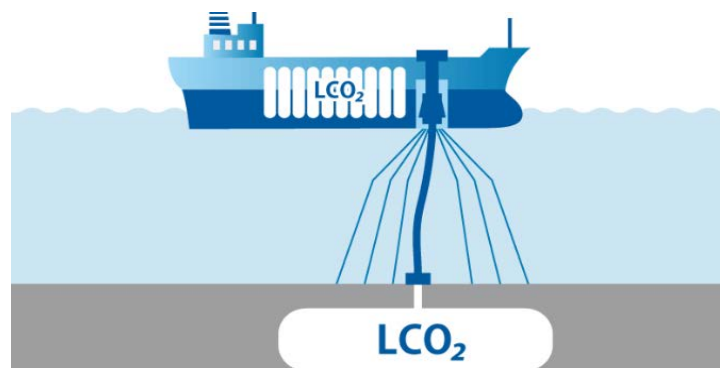
Unique approach

✓ All three modes regardless offshore/terminal

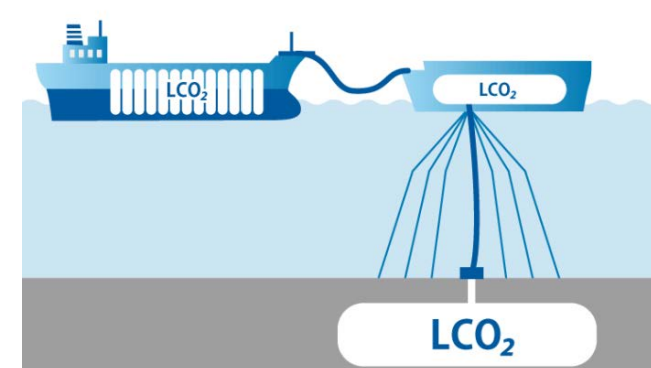
Mode	Temperature	Pressure	Scope	Vessel capacity	Tank
EP	0 to 10 degC	34 to 45 bar	TtT, DIO, FSIU	7,500-80,000cbm	LCO2-EP Cargo Tank
MP	-30 to -25 degC	15 to 18 bar	TtT	7,500-20,000cbm	Type-C tank
LP	-50 to -45 degC	6 to 10 bar	TtT	20,000-80,000cbm	Type-C tank



TtT: Terminal to Terminal

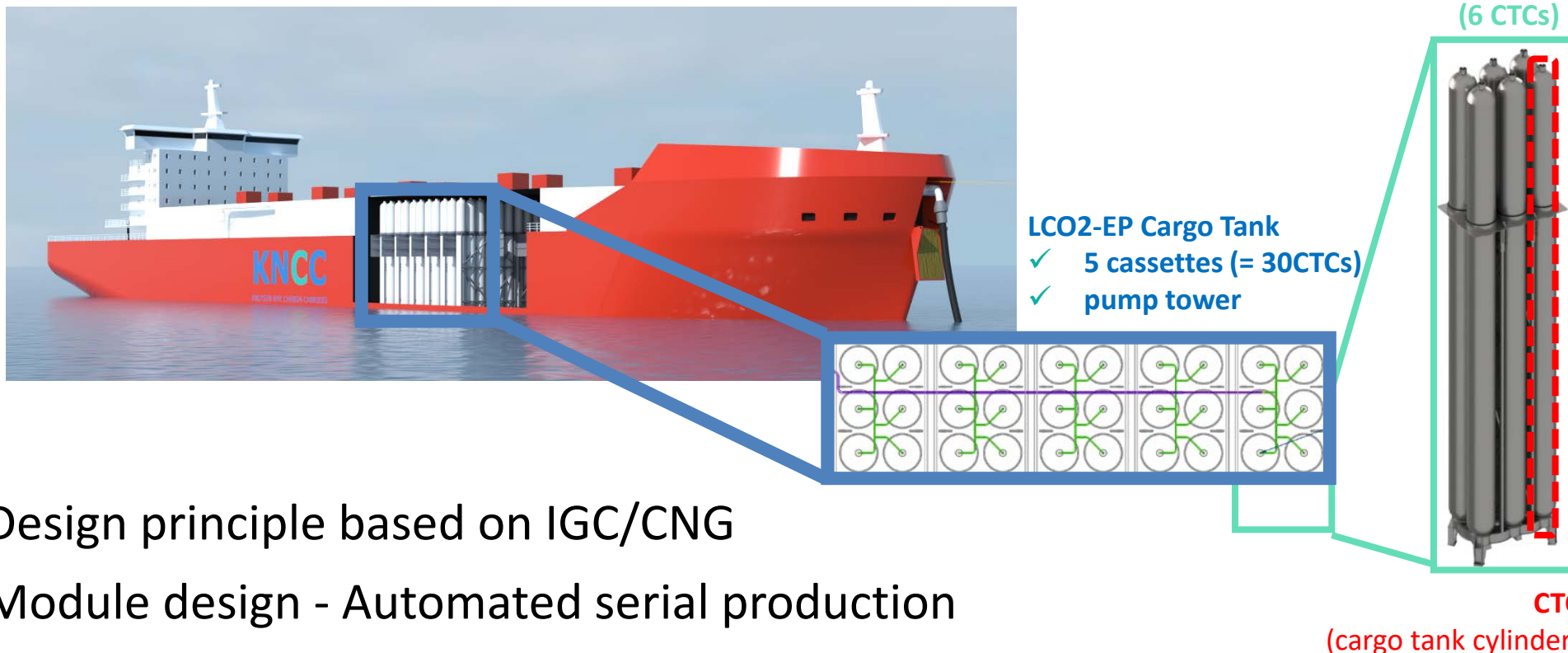


DiO: Direct injection Offshore



FSIU: Floating Storage Injection Unit

LCO2-EP Vessel Design



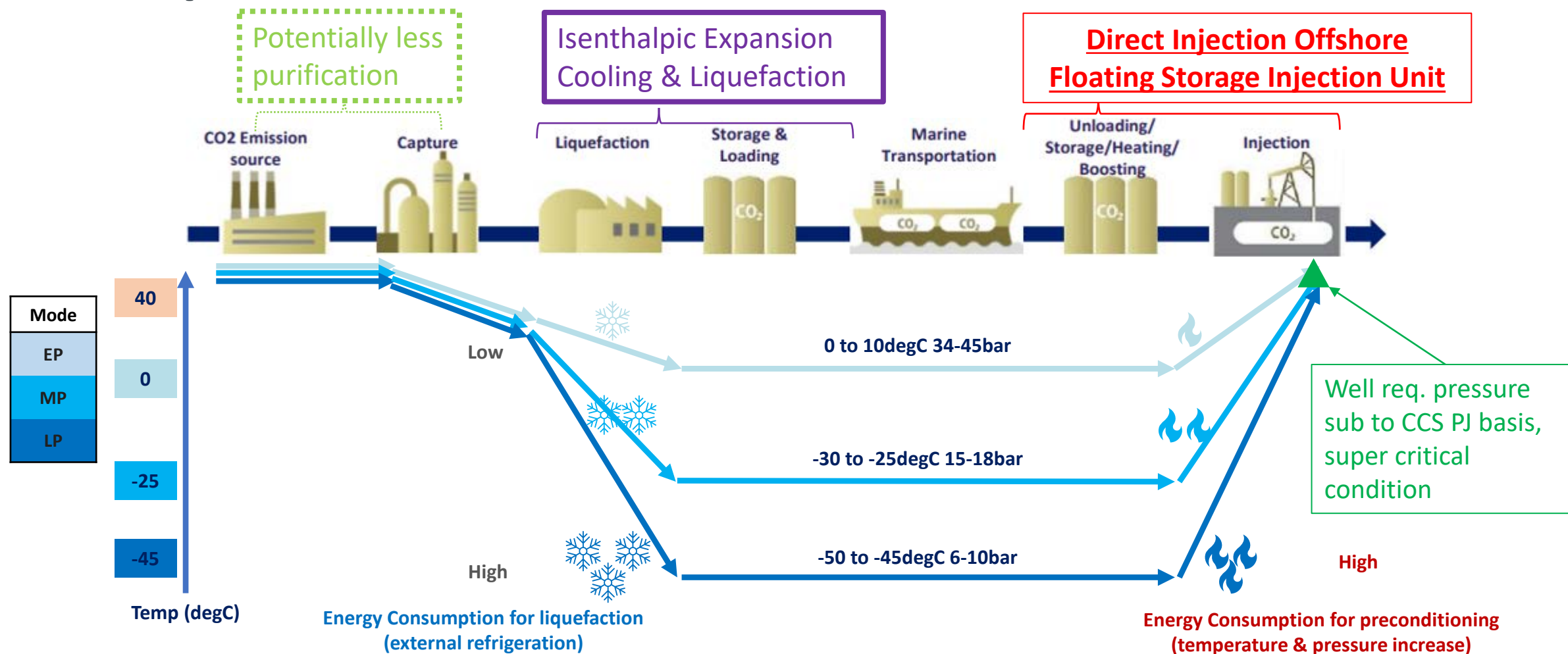
- ✓ Design principle based on IGC/CNG
- ✓ Module design - Automated serial production
- ✓ Uniform loading/discharging as a system
- ✓ Probability approach for inspection/maintenance
- ✓ No sloshing concerns during offshore operation

Demonstration approach to materialize this concept...

- ✓ Accumulating LCO₂-EP handling experience
 - ✓ Scaled real operation
 - ✓ Effects of impurities (future)
 - ✓ Crew training (future)
- ✓ Constructability study with shipyards and suppliers



Proposal for economical value chain based on EP

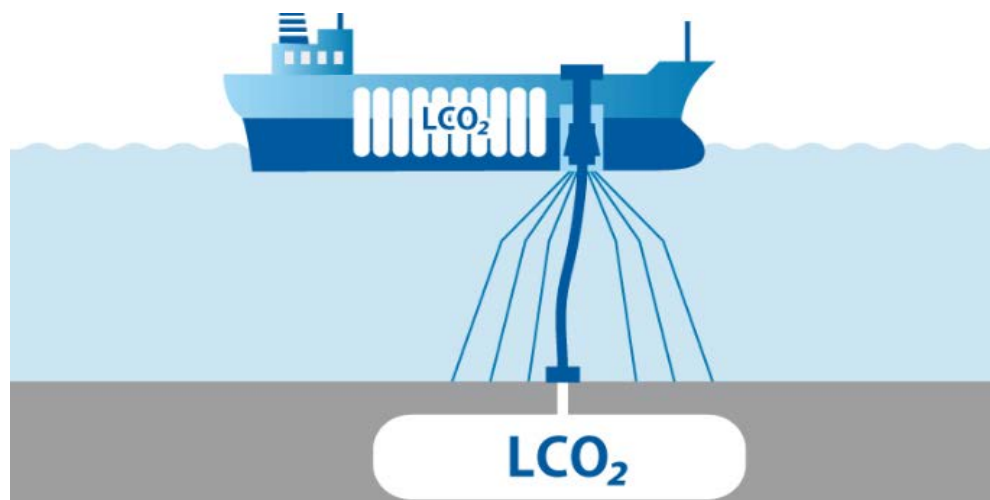


✓ Proposals standing at CO2 properties

Regulatory approach – battery limit at North Sea

Norwegian Maritime Authority (NMA)

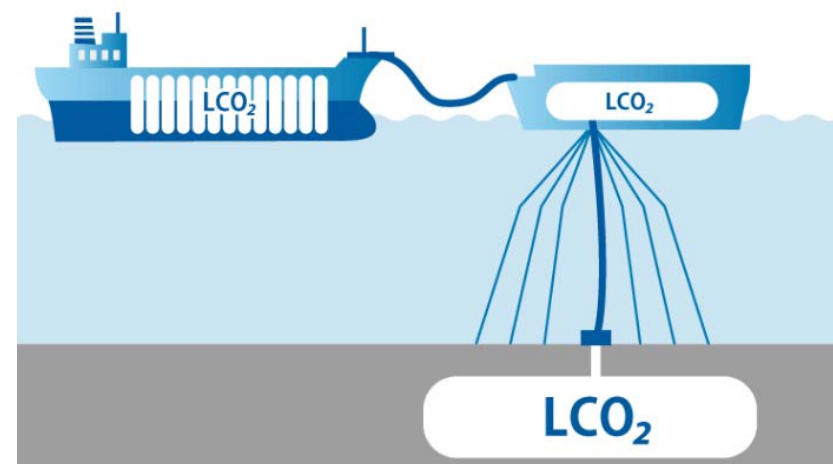
- ✓ DIO Vessel under scope of IMO
- ✓ FSIU depend on HAVTIL stance



DIO: Direct injection Offshore

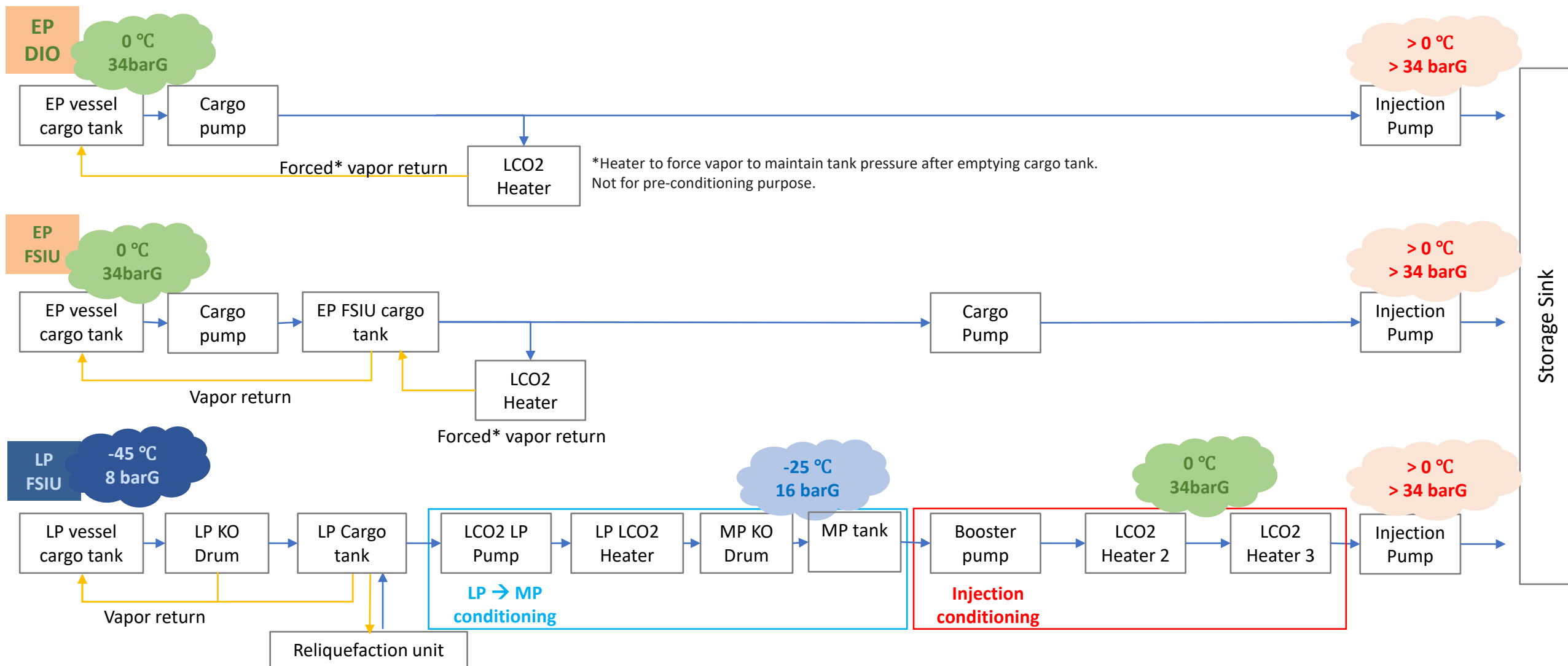
Norwegian Ocean Industry Authority (HAVTIL)

- ✓ Impact the well safety and integrity under scope of HAVTIL
 - ✓ Flange to Injection pump
 - ✓ Well control

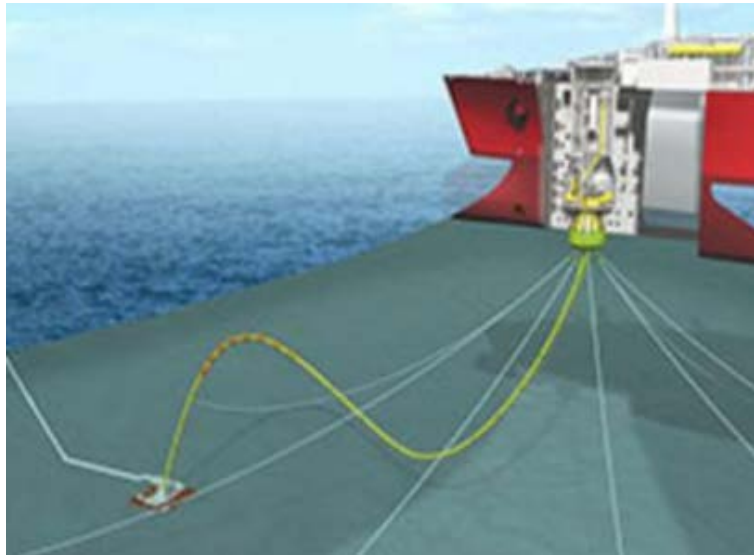


FSIU: Floating Storage Injection Unit

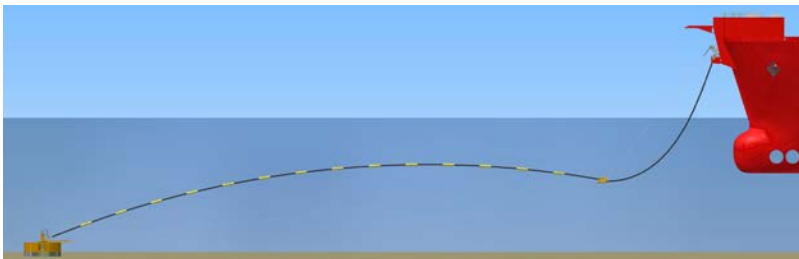
Block Flow Diagram when injection offshore



Mooring - STL and SAL



STL: Submerged Turret Loading



SAL: Single Anchor Loading

STL		SAL
70 - 350m	Water depths	12 – 120m
Hs 4.5	Operational limits (connection)	Hs 4.5 m
Hs 7 m	Operational limits (dis-connection)	Hs 5.5 m
Higher than SAL	Uptime	Lower than STLs
Yes during approach/connection	DPS requirement (fuel consumption)	Always
Buoy & Anchor system	Reuse of equipment	Yes
High	Subsea CAPEX	Low
High	Vessel CAPEX	Low
Proven in O&G	Readiness	Proven in O&G
Yes	KNOT experience	Yes

Summary for DIO concept with LCO2-EP

- ✓ KNCC to cater LP/MP/EP to CCUS market
- ✓ LCO2-EP :
 - ✓ has been developing from design/demonstration
 - ✓ constructability study with shipyards
- ✓ DIO proposal for an optimization
 - ✓ Defined battery limits at North sea
 - ✓ To utilise offshore EOR experience
 - ✓ To combine known technology at Oil&Gas industry