



Advanced Loading Tower

KIVI lezing

15 April 2021

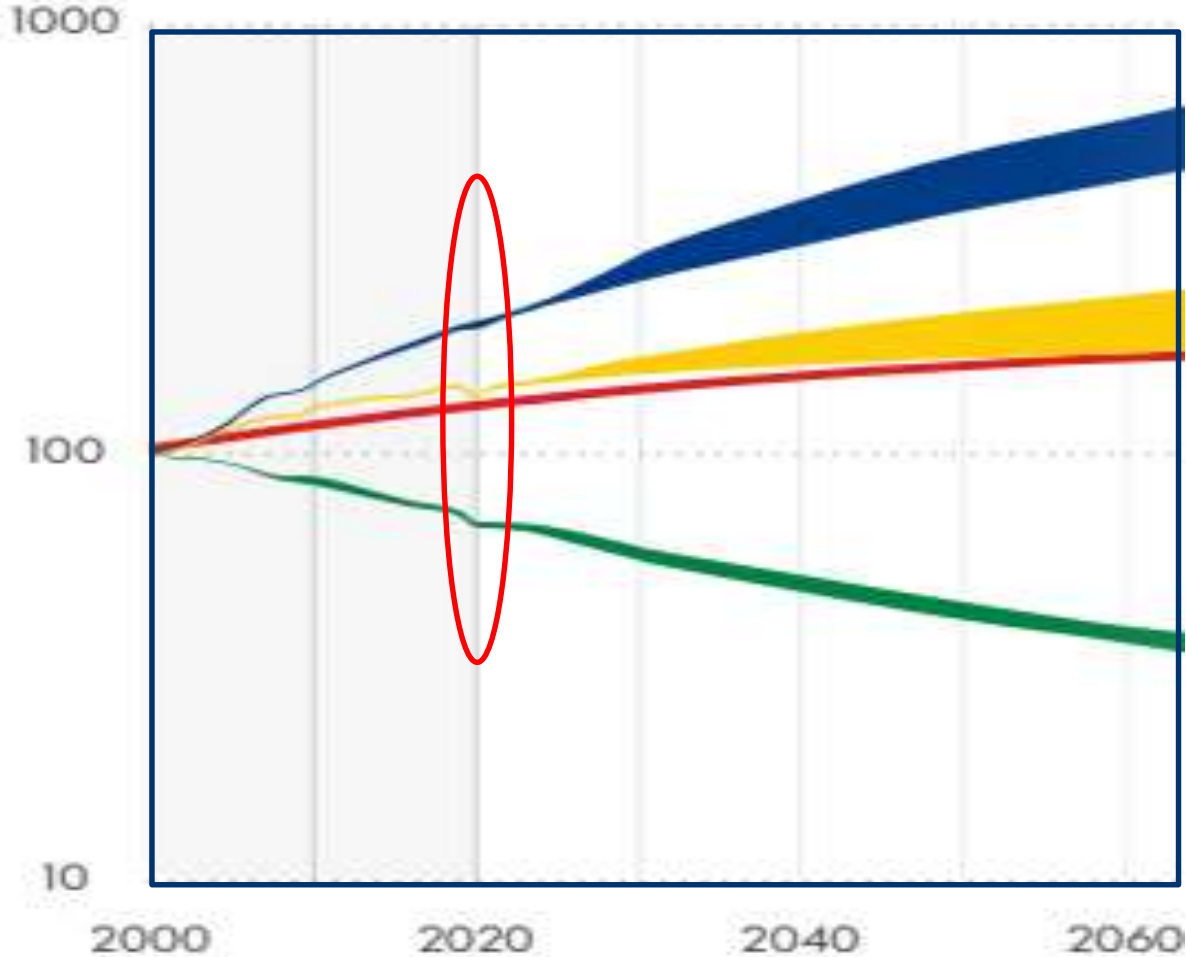




Founded in 1978
Privately owned
1000 employees



Energy trend



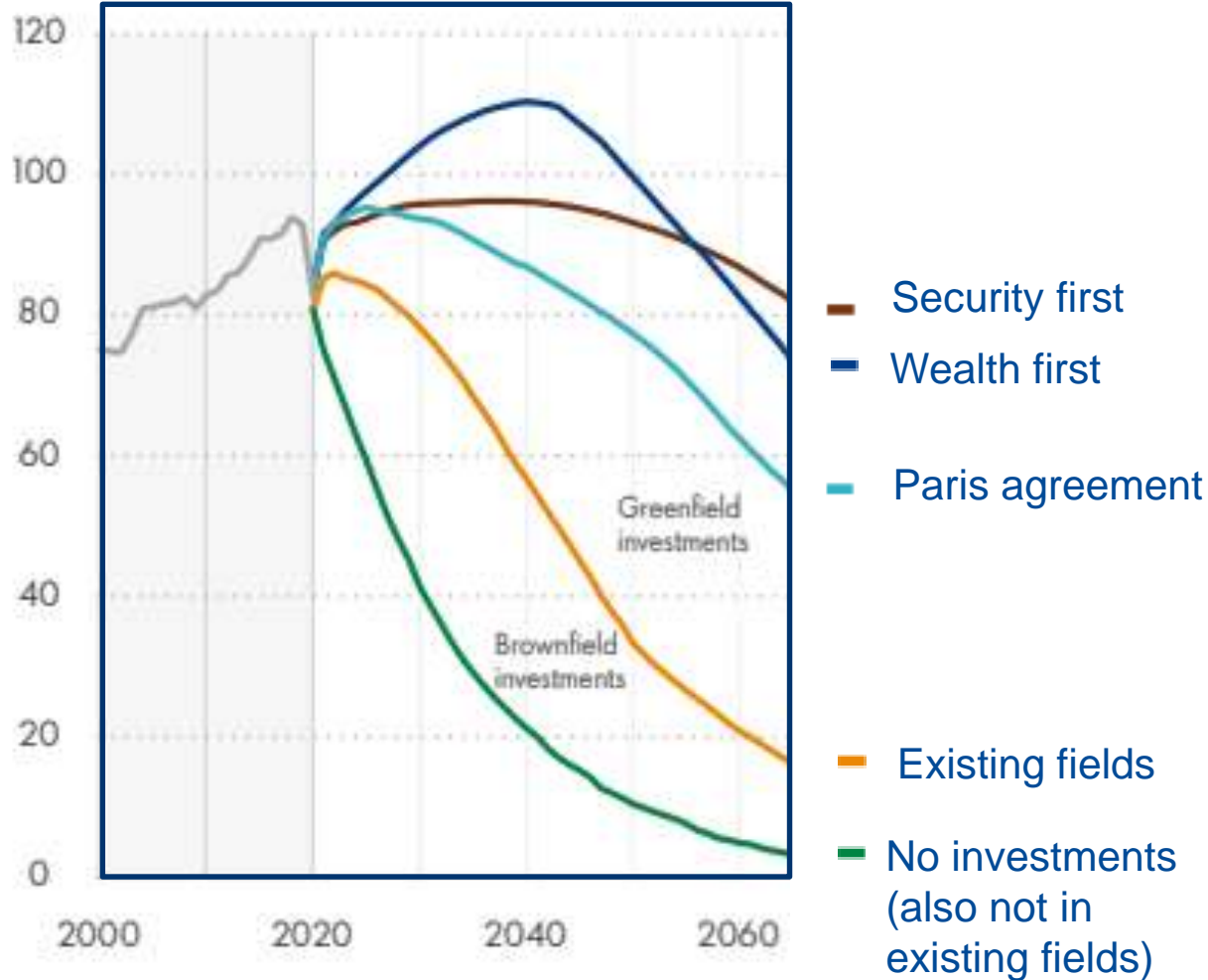
- GDP
- Energy demand
- Population
- Energy / GDP

Source: Shell Energy Transition Scenarios

Future of oil and gas

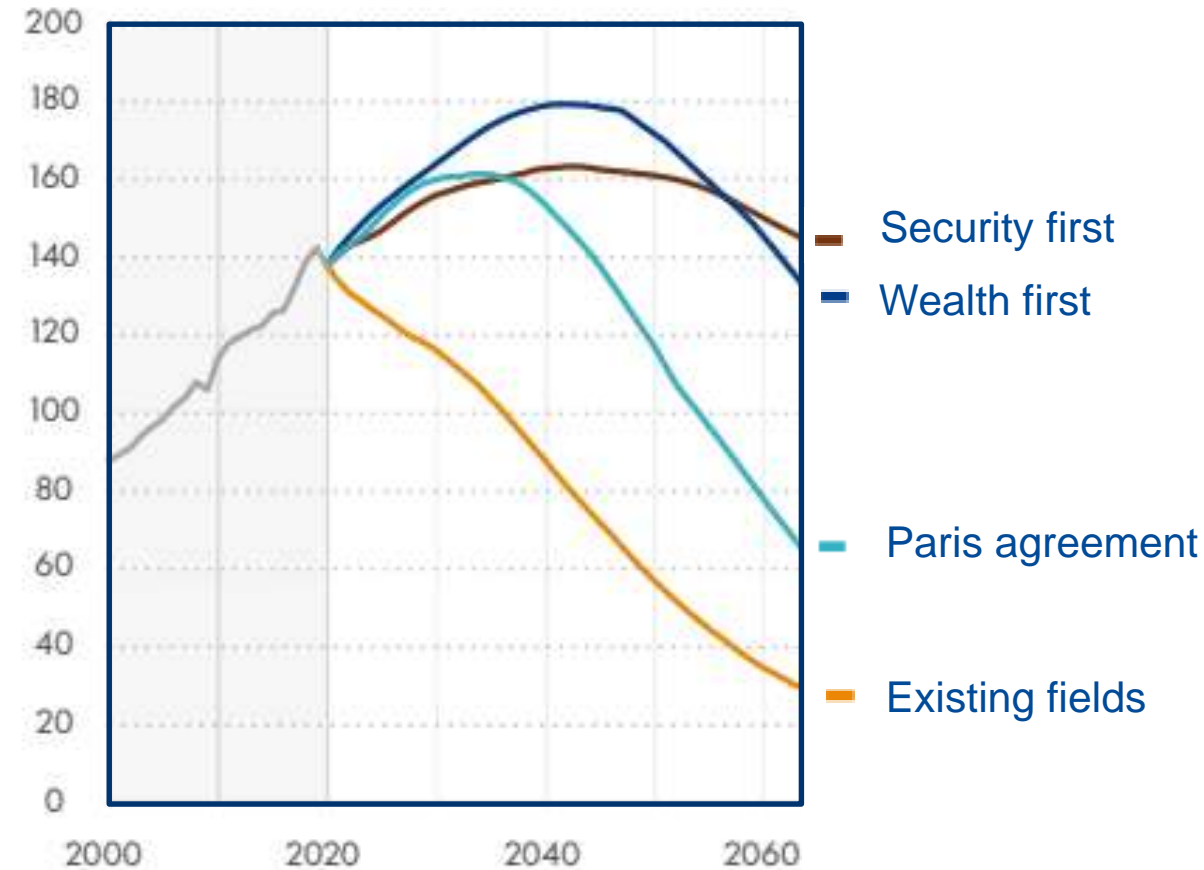
Total oil* production

Million barrels/day

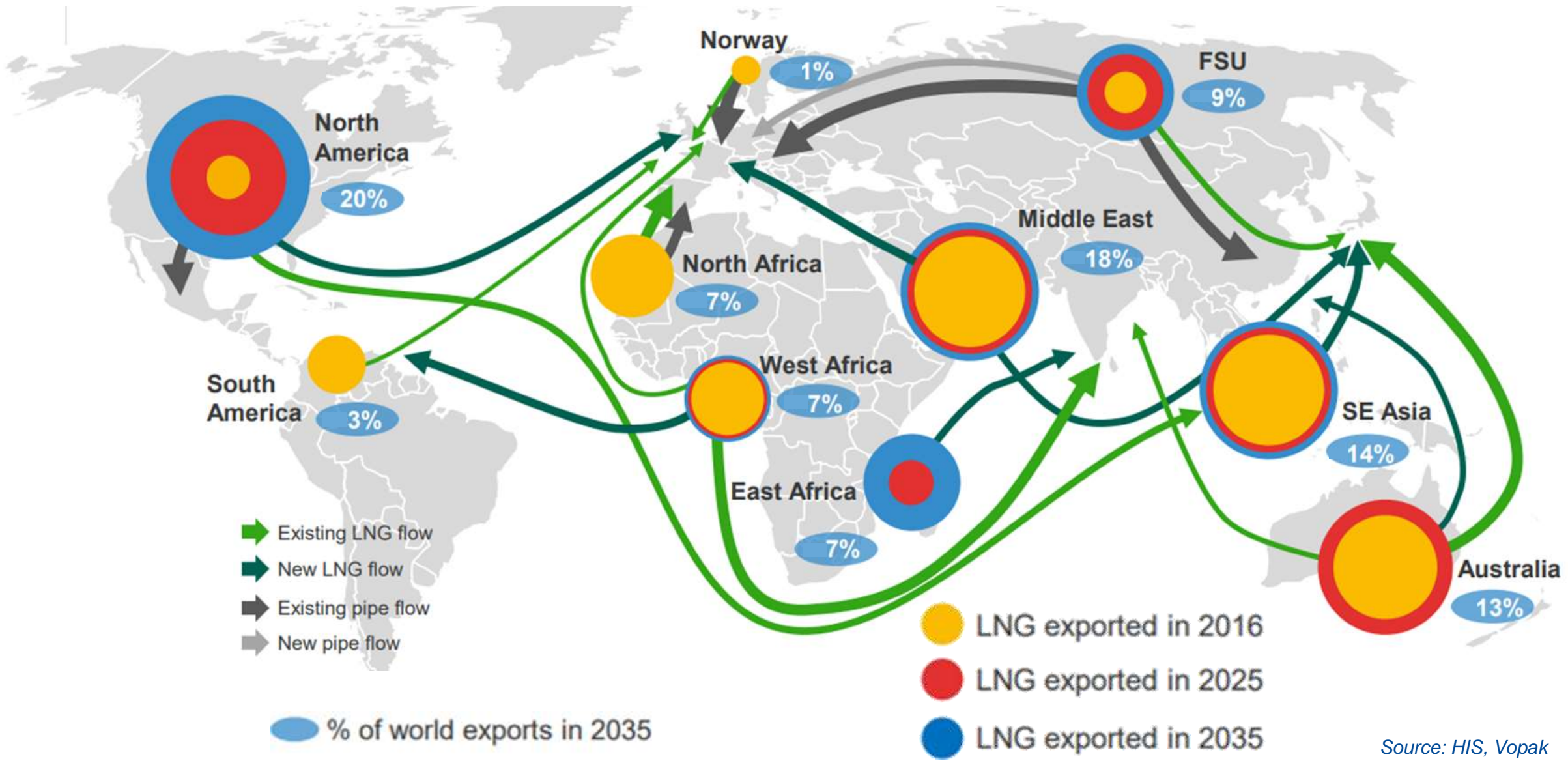


Natural gas* production

Trillion cubic feet/year

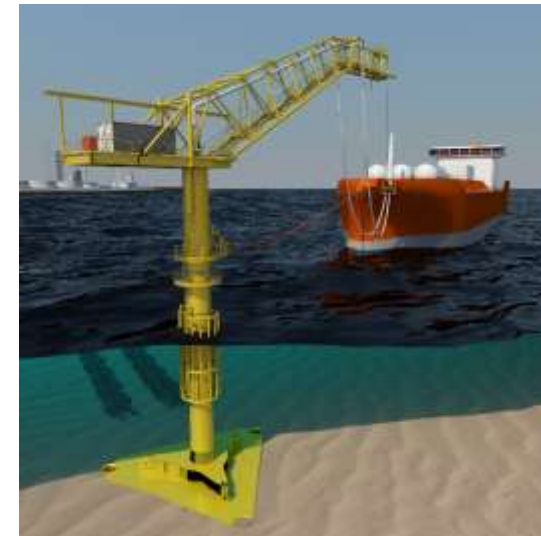


LNG market developments

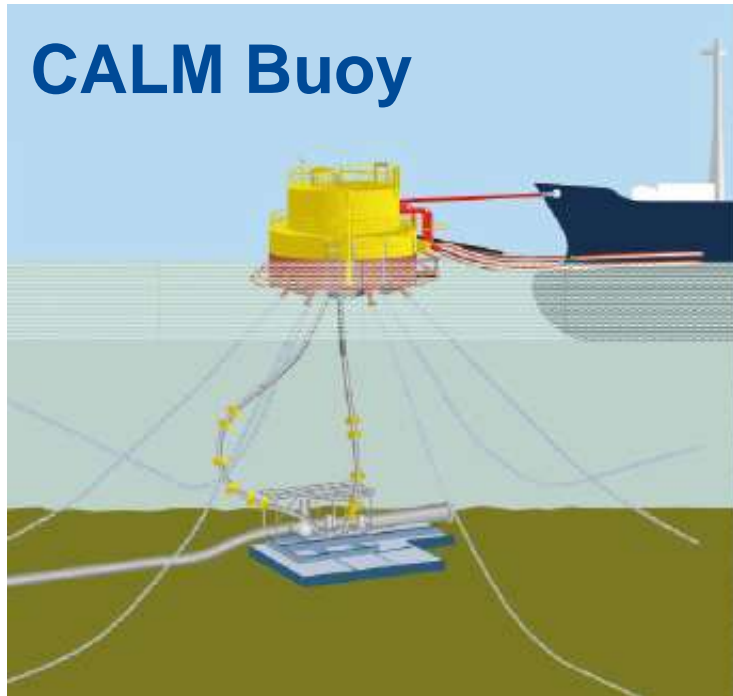


Bluewater's Advanced Loading Tower

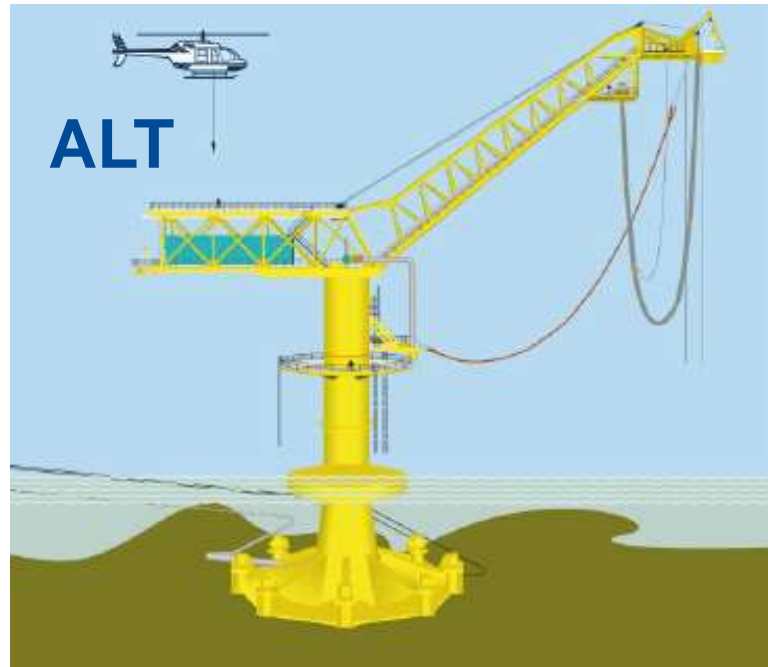
- Advanced loading tower (ALT) technology
- Where are ALTs used
- How can the ALT support energy transition?
- What is the future of ALTs



Single Point Mooring: Jetty-less loading

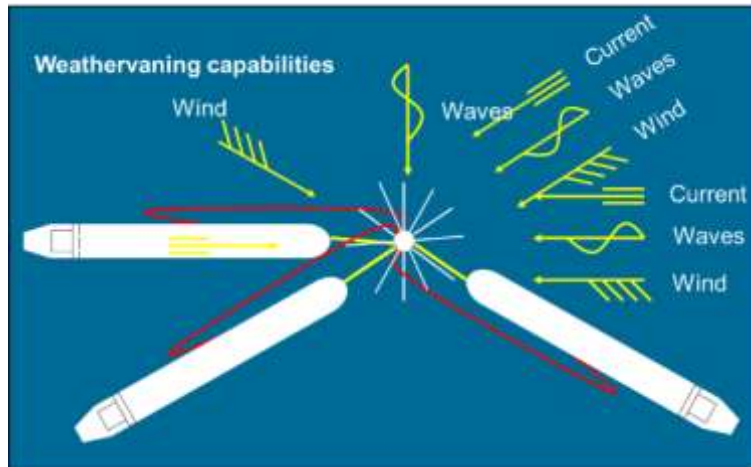
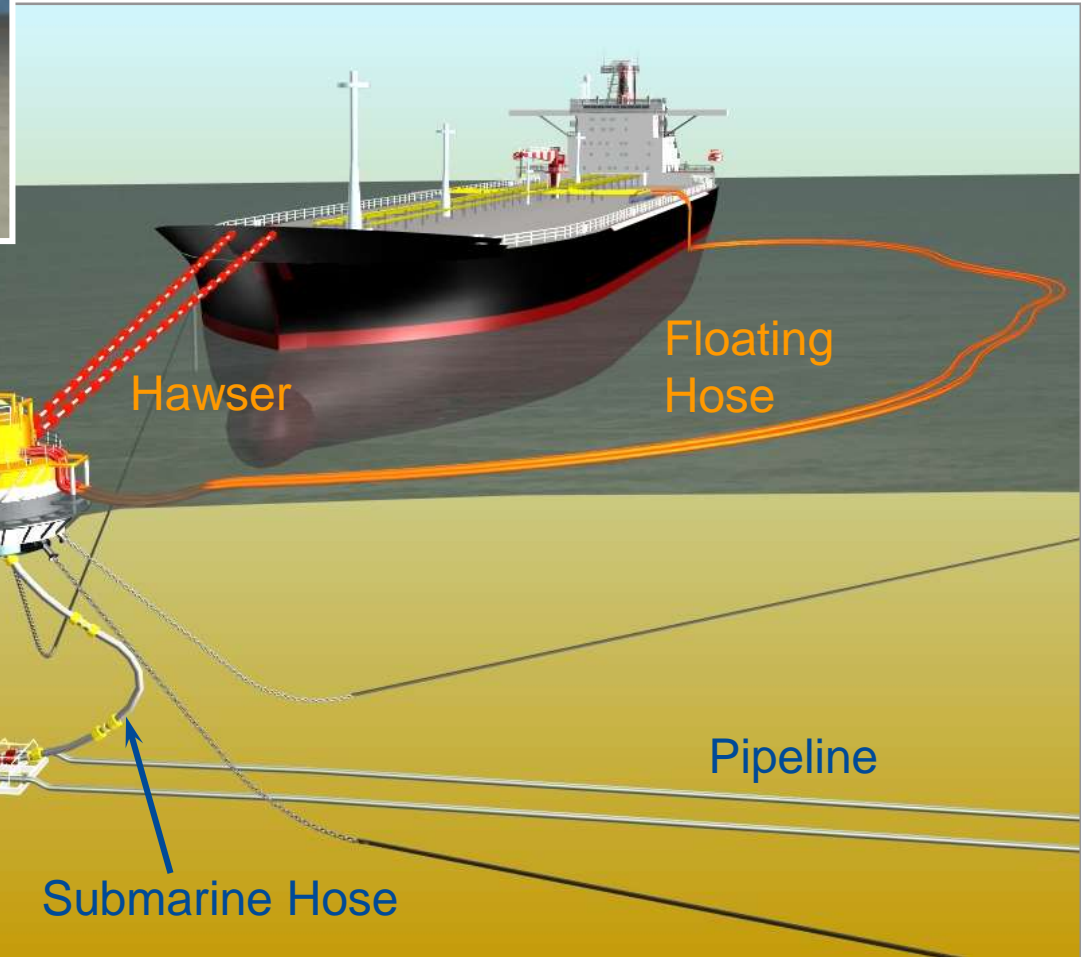
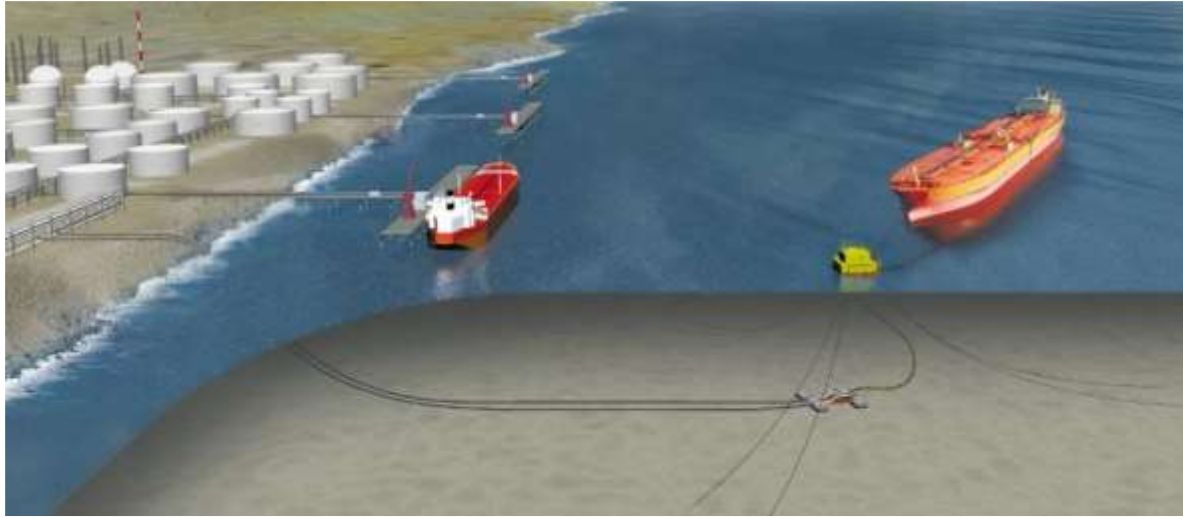


Catenary Anchor Leg Mooring



Advanced Loading Tower

CALM Buoy



CALM Buoy not feasible:

- Ice invested waters
- Aerial hoses
- Water depth too shallow



Arctic loading tower



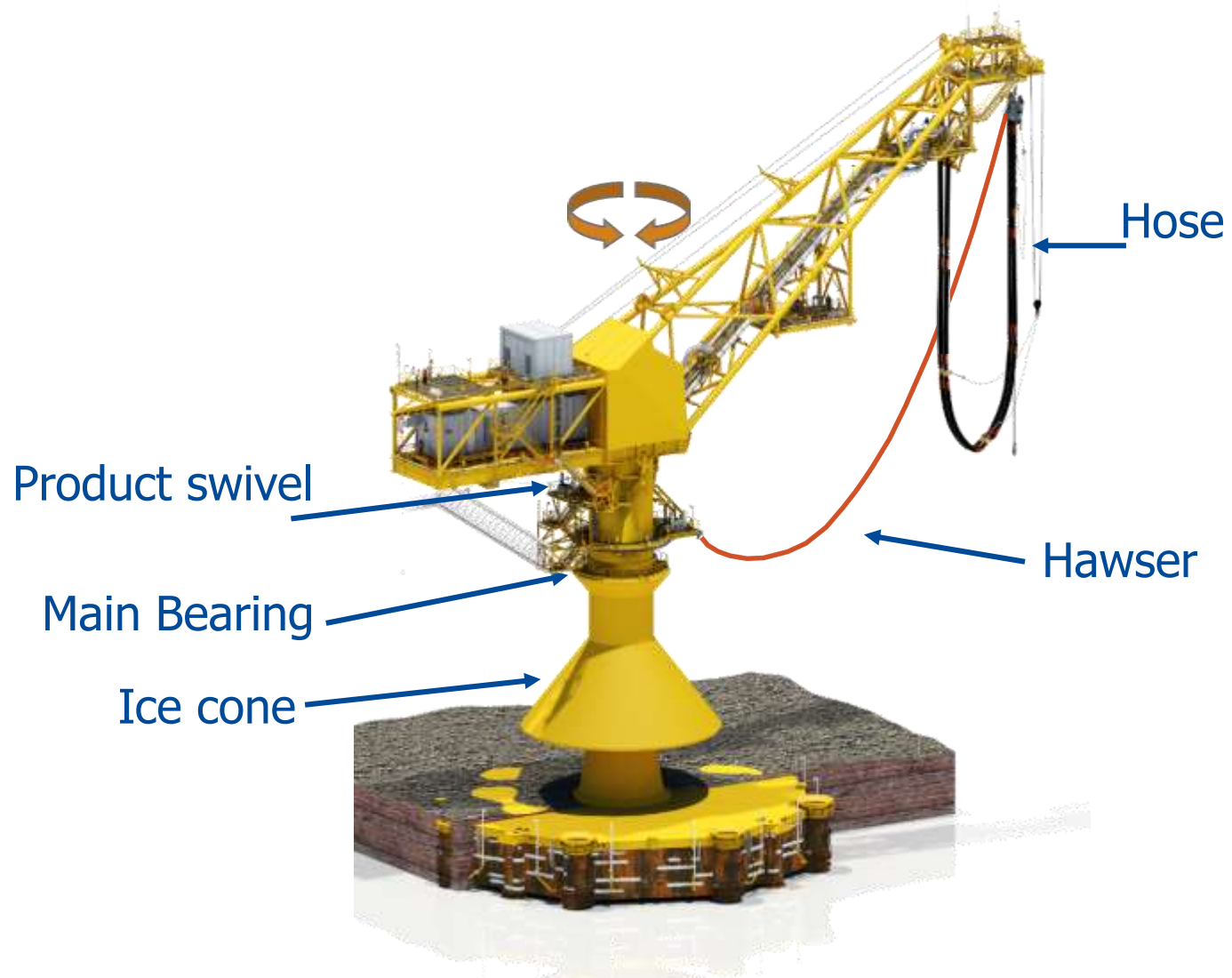
Cryogenic loading tower

Arctic Loading Tower application

- All year around tanker loading
- Shallow water (10m – 40m water depth)
- Ice management for access channel



Arctic Loading Tower



Bluewater's track record

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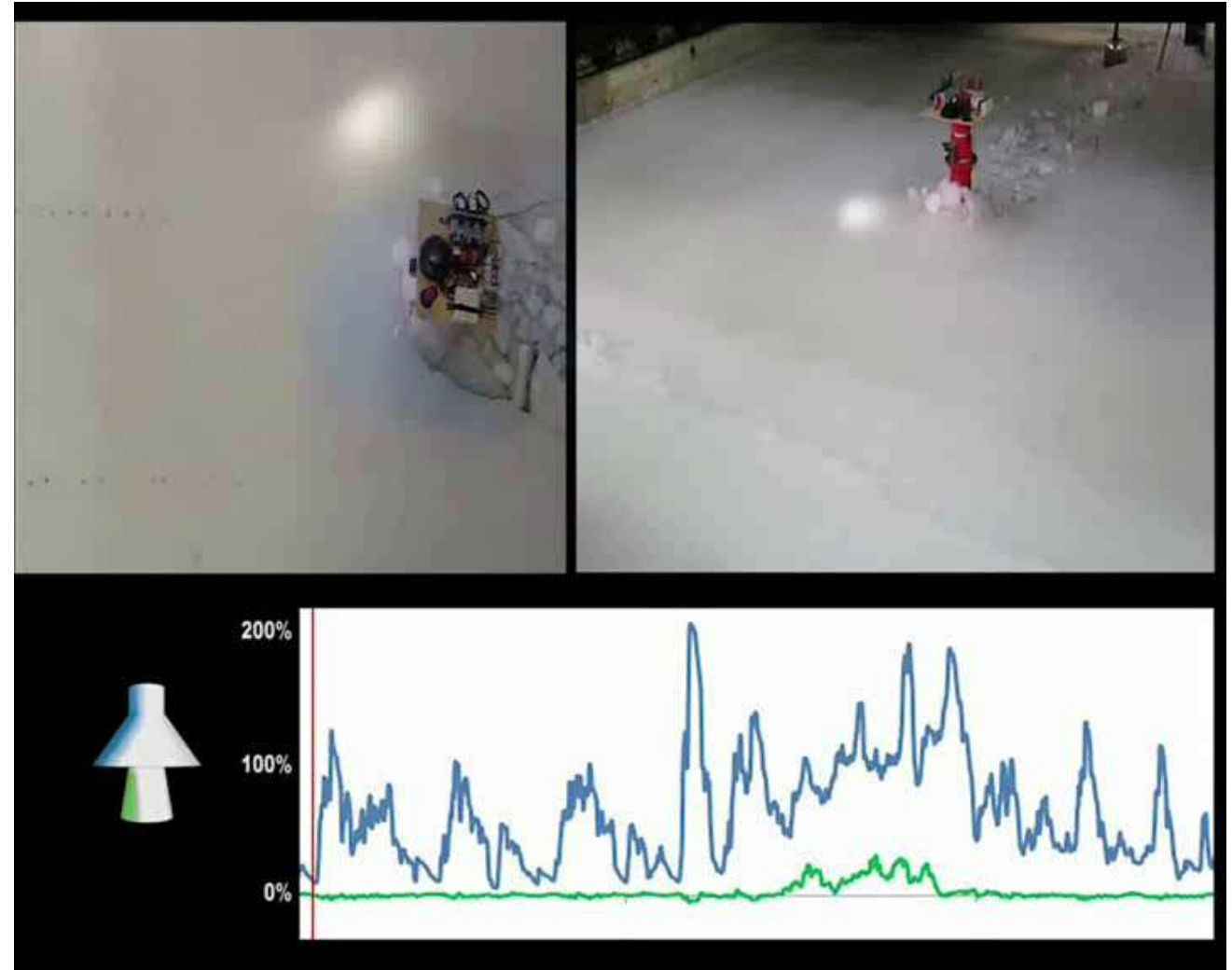
Sakhalin



Bay of Ob (Yamal - Siberia)

Ice load determination

- Model testing at HSVA in Hamburg
- Survival en Operational Ice loads



Operations in arctic

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Fully remotely controlled

Tanker loading in practise

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*Starboard
(green/blue)*

*Port side
(red)*

LPG Starboard (green)

LPG vapour return Starboard (blue)

Gas-condensate Port side (red)

From Artic to Cryogenic

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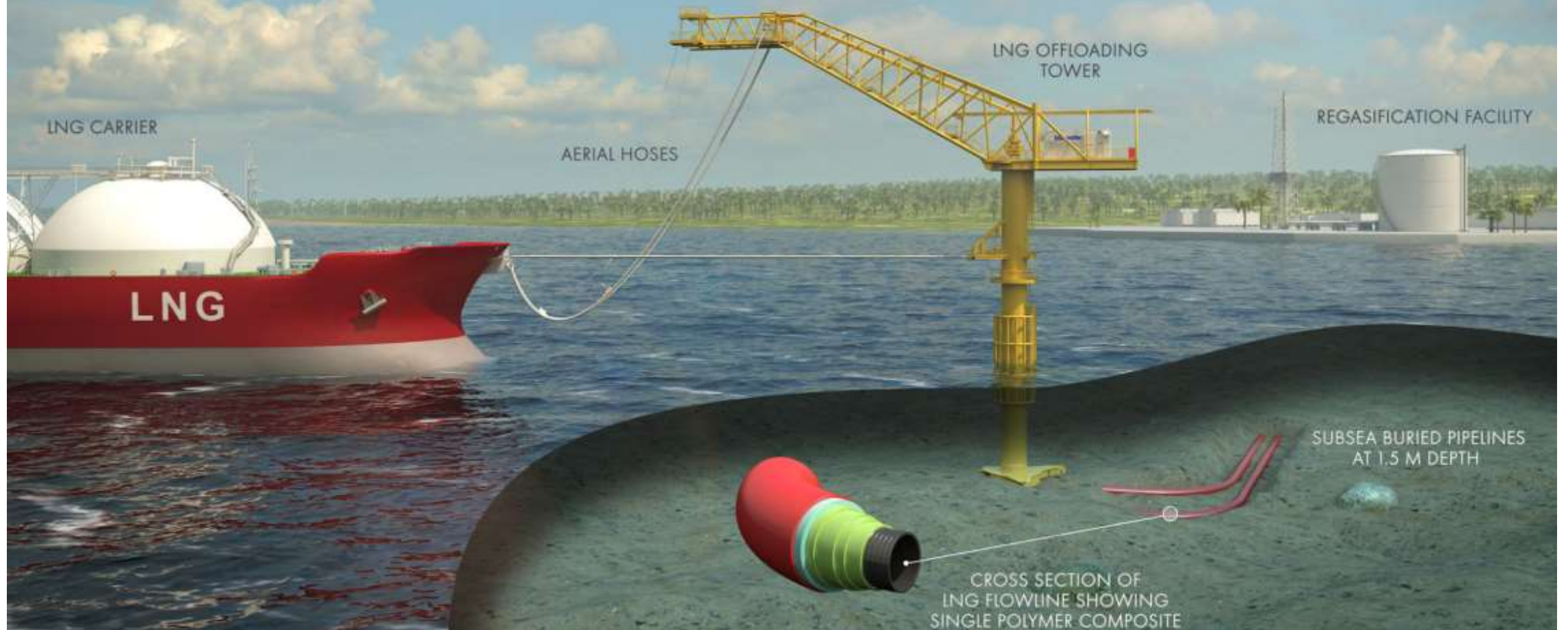


Cryogenic offloading Tower for LNG

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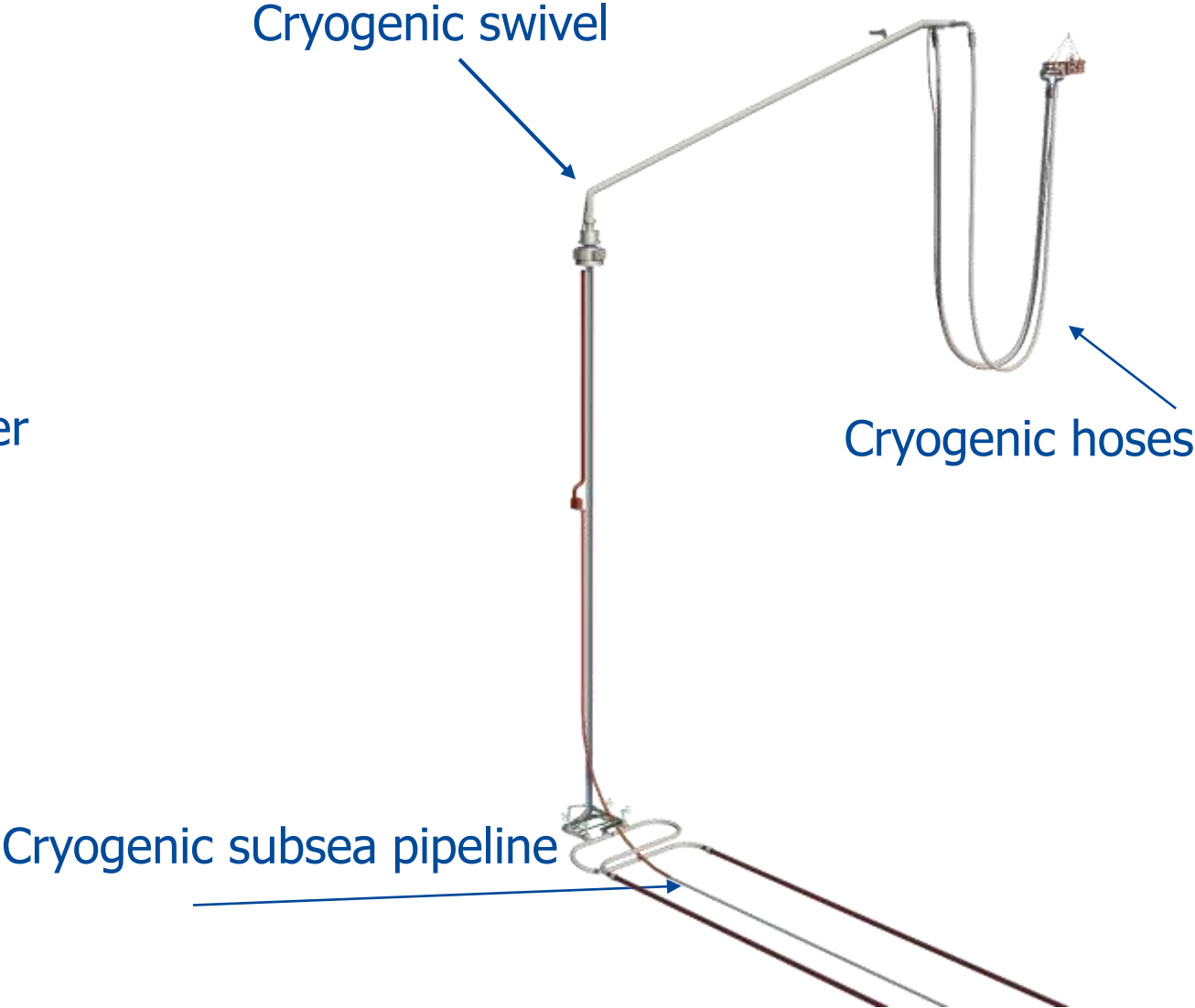
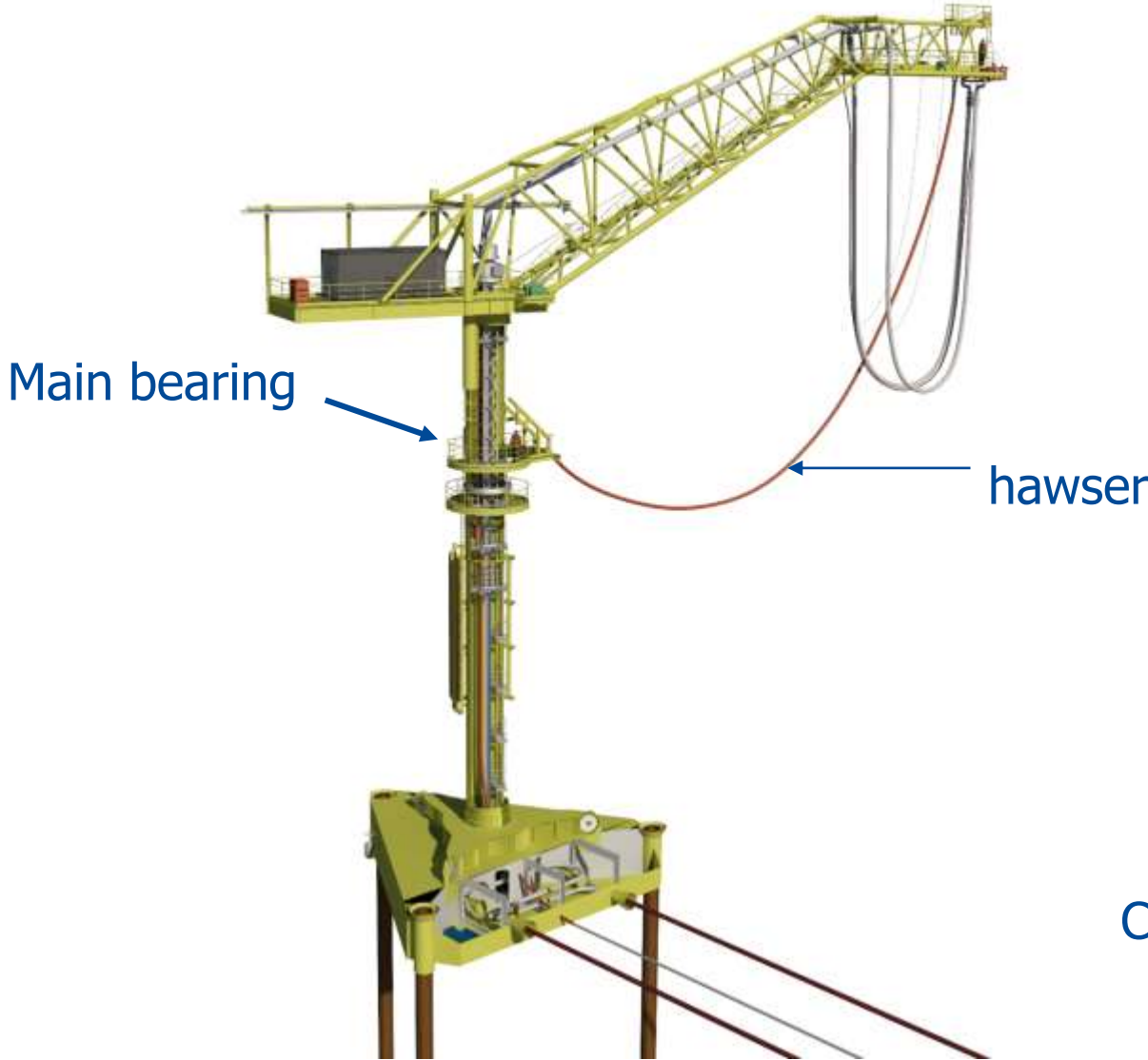


Jettyless for small-scale LNG import

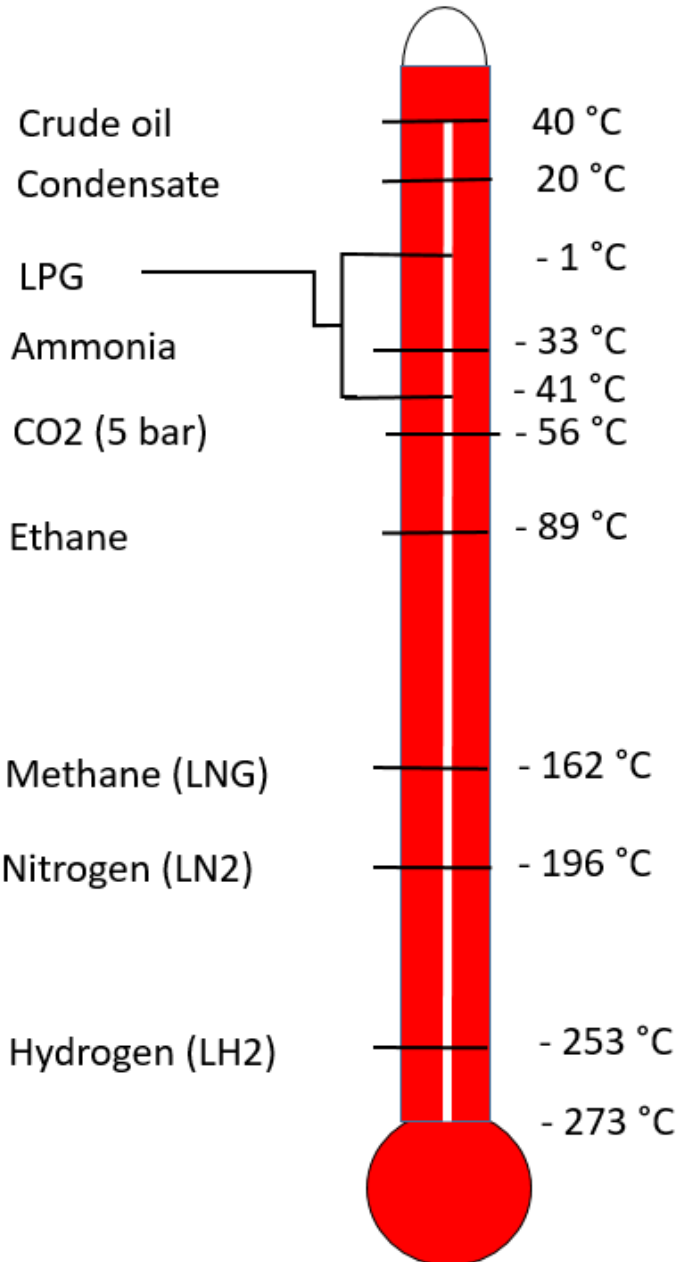


Cryogenic Loading Tower

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What is cryogenic?

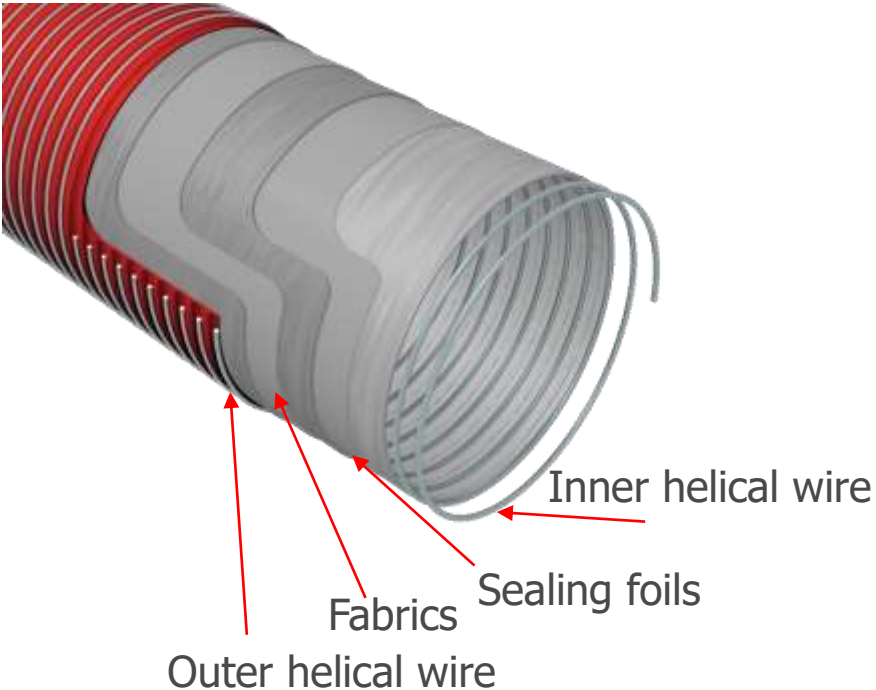


Rubber single or double carcass hose

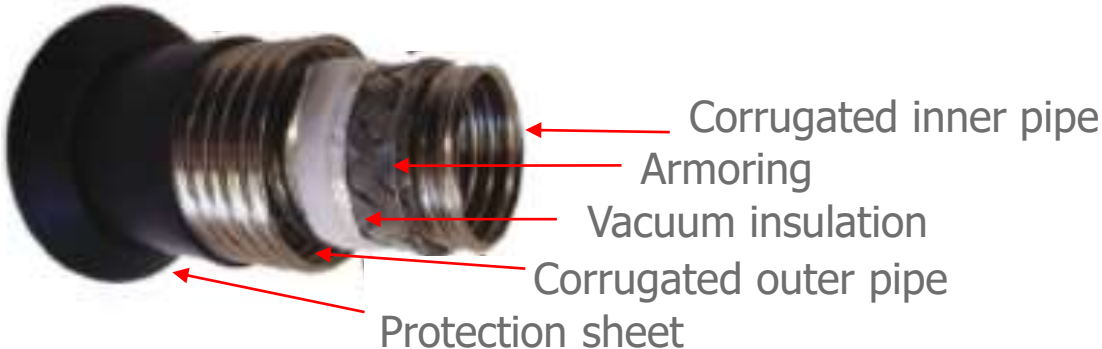


Cryogenic hoses

Composite hose



Bellow hose



Multi-LNG White



LNG hose



Cryoflex



Cryoline



Hose fatigue tests

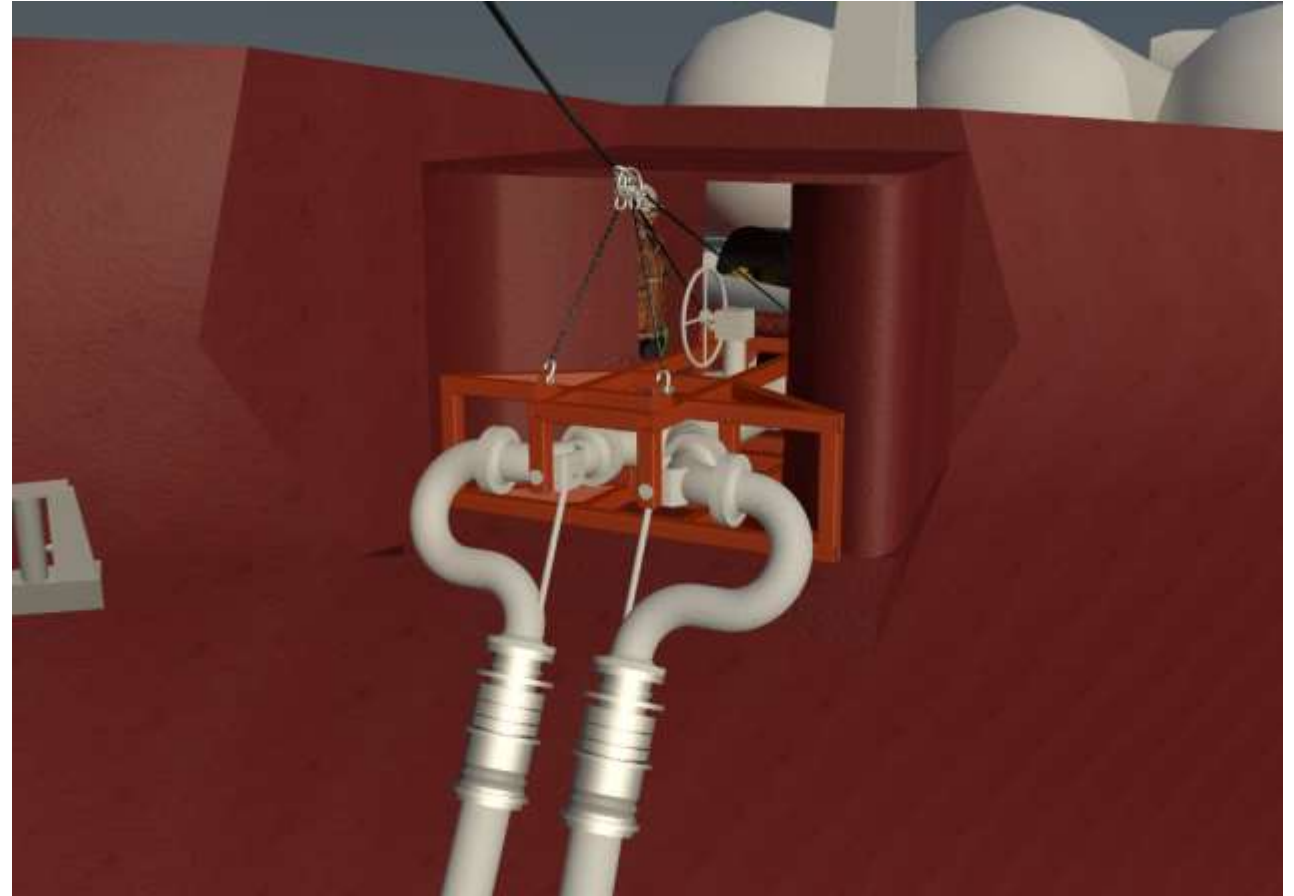
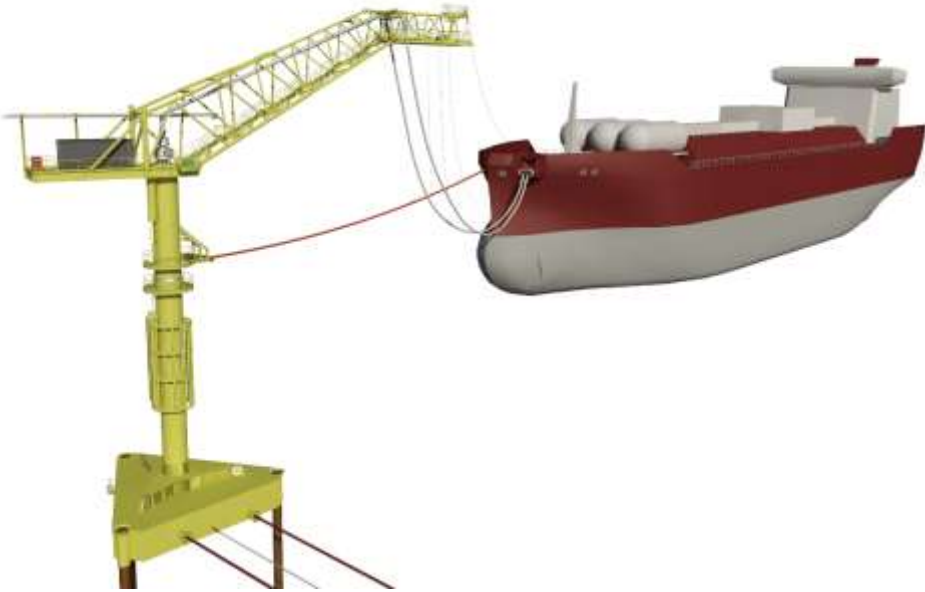


Further hose tests

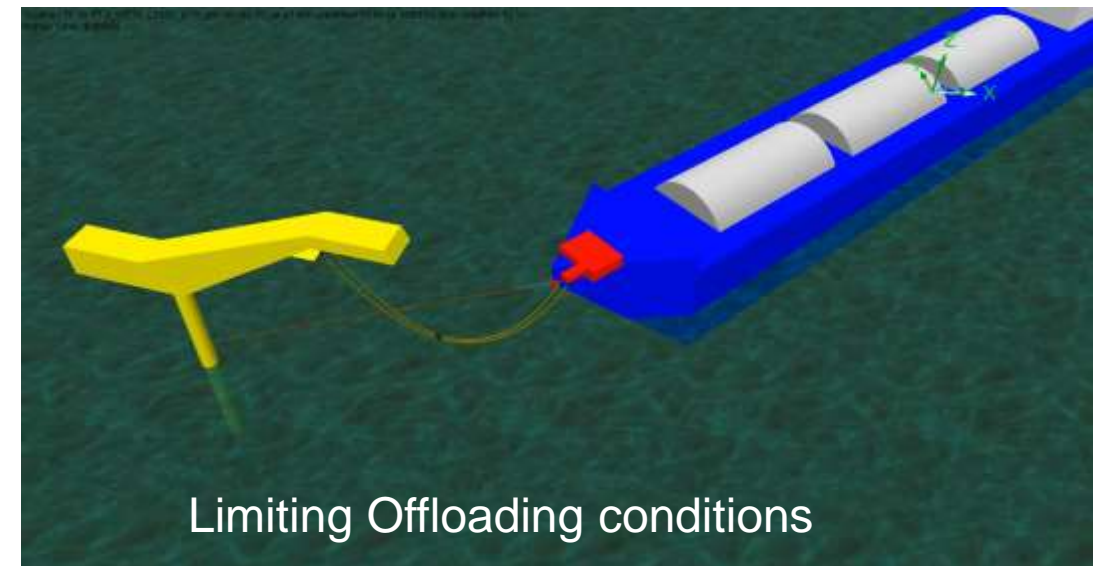
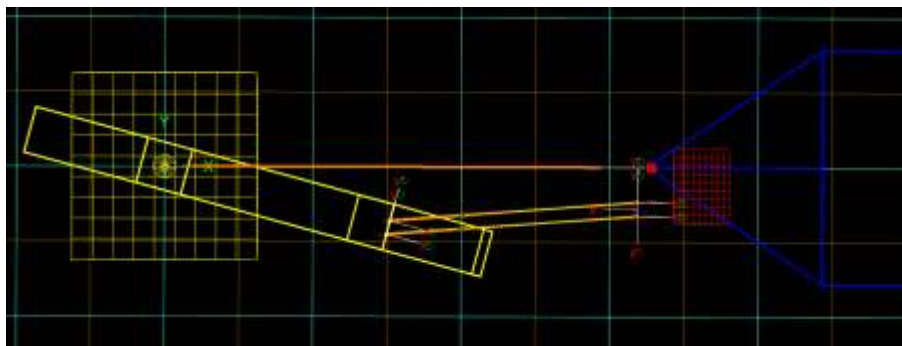
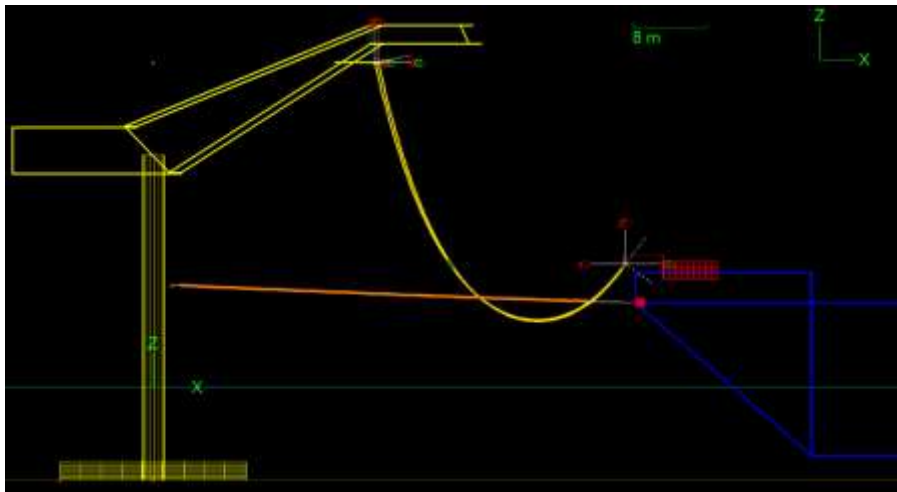
- Maximum & failure pressure
- Minimum bend
- Pressure & temperature cycling
- Fatigue
- Flow rate



- Wide catenary hose arrangement
- Hose end with swivels



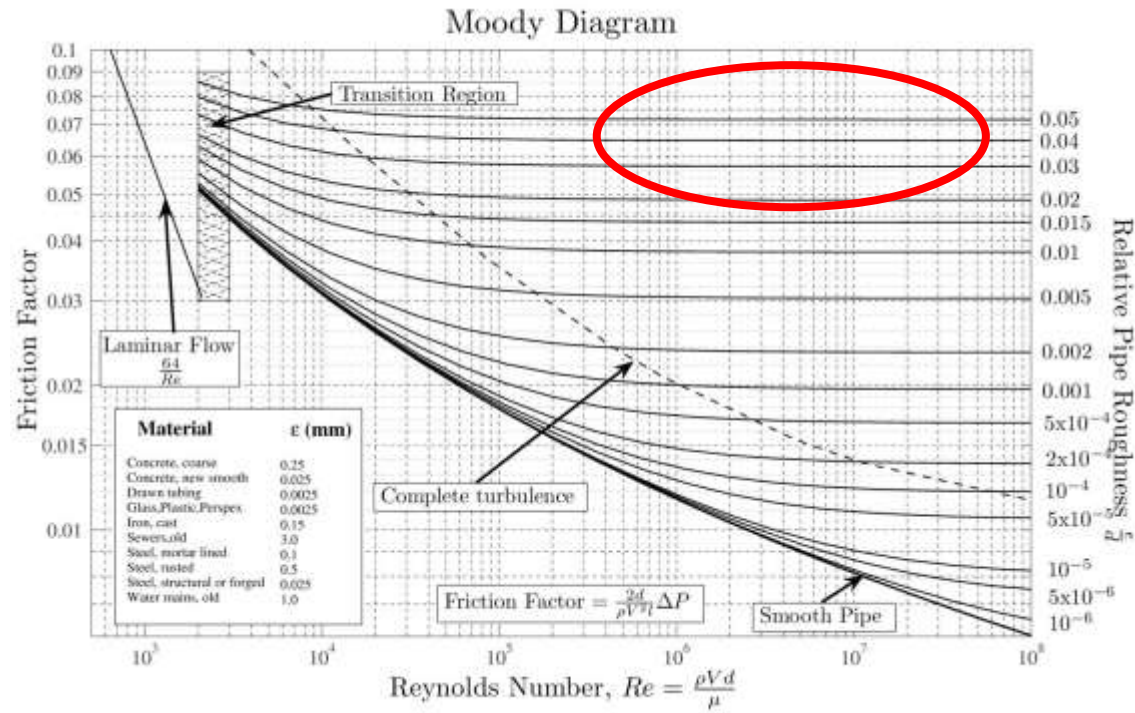
Orcaflex model verifications



Pressure drop test

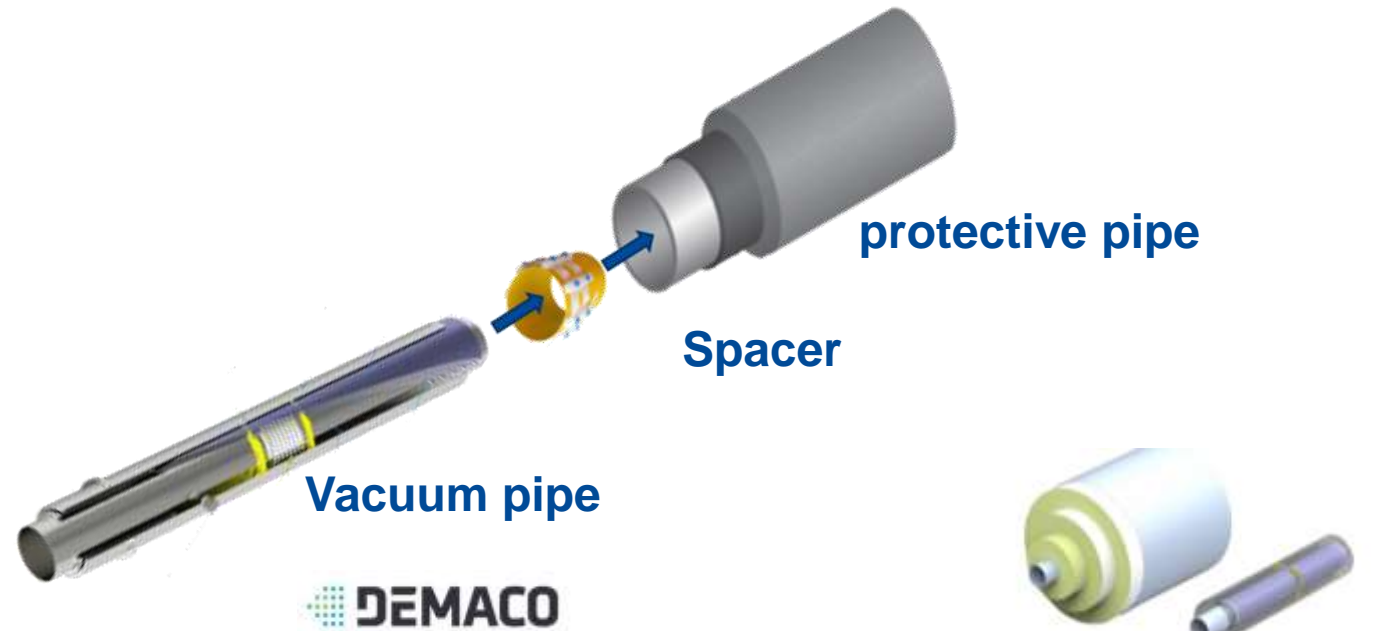
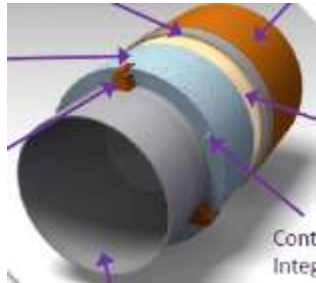
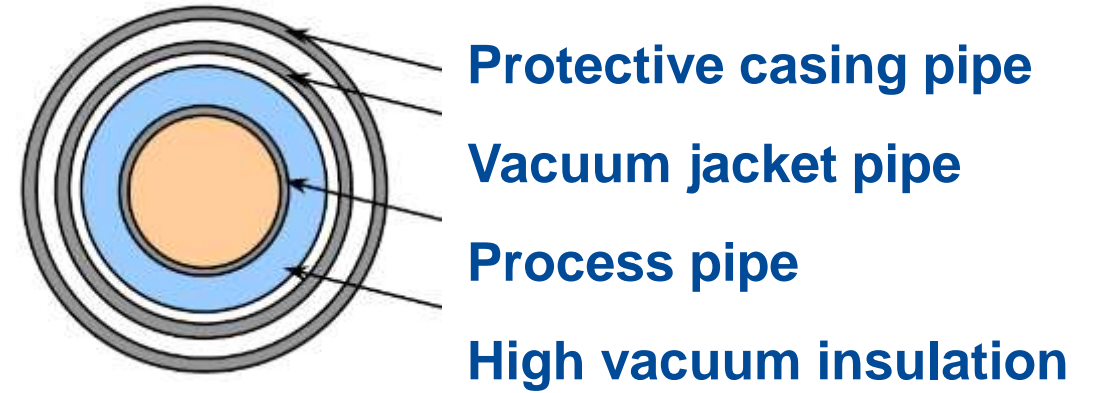
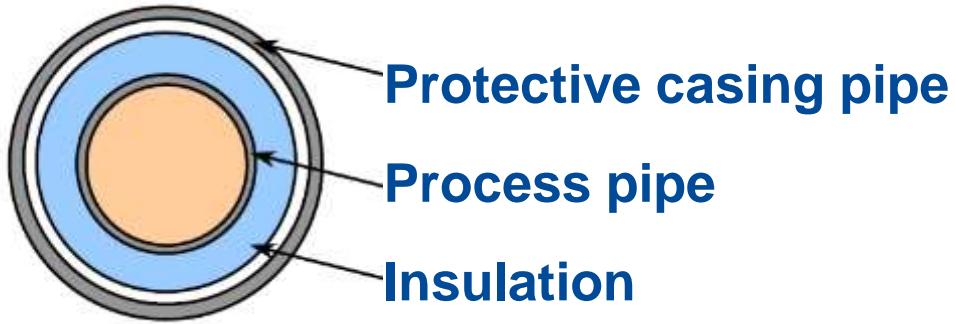


Composite and bellow hoses

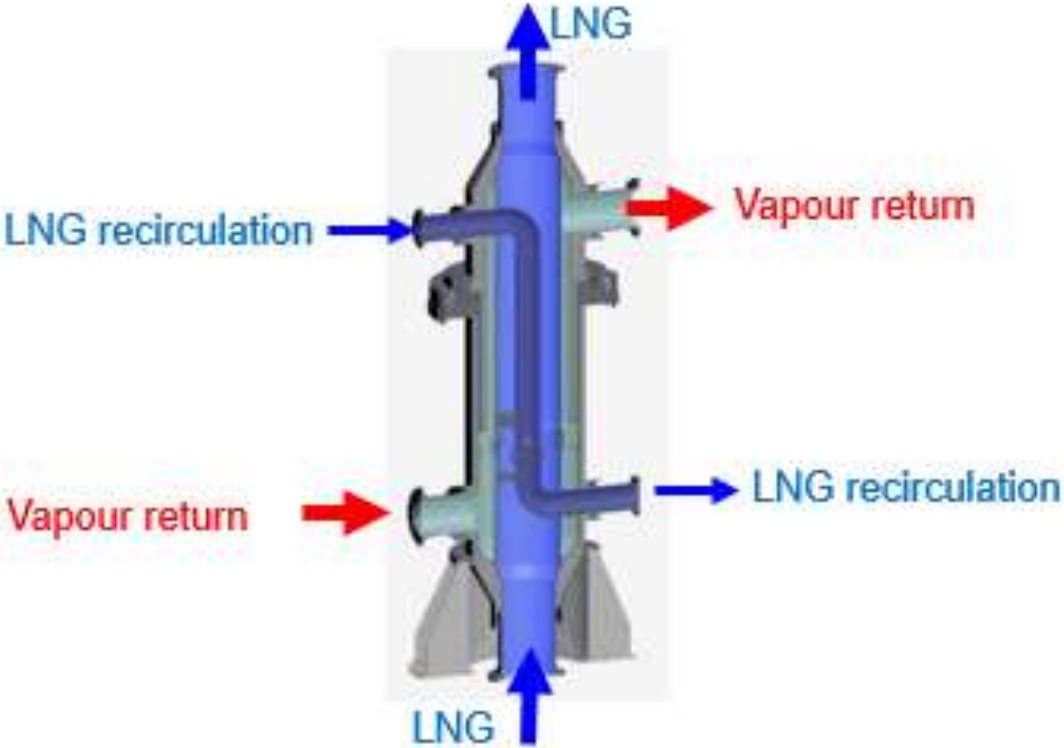


Subsea cryogenic pipeline: PIP

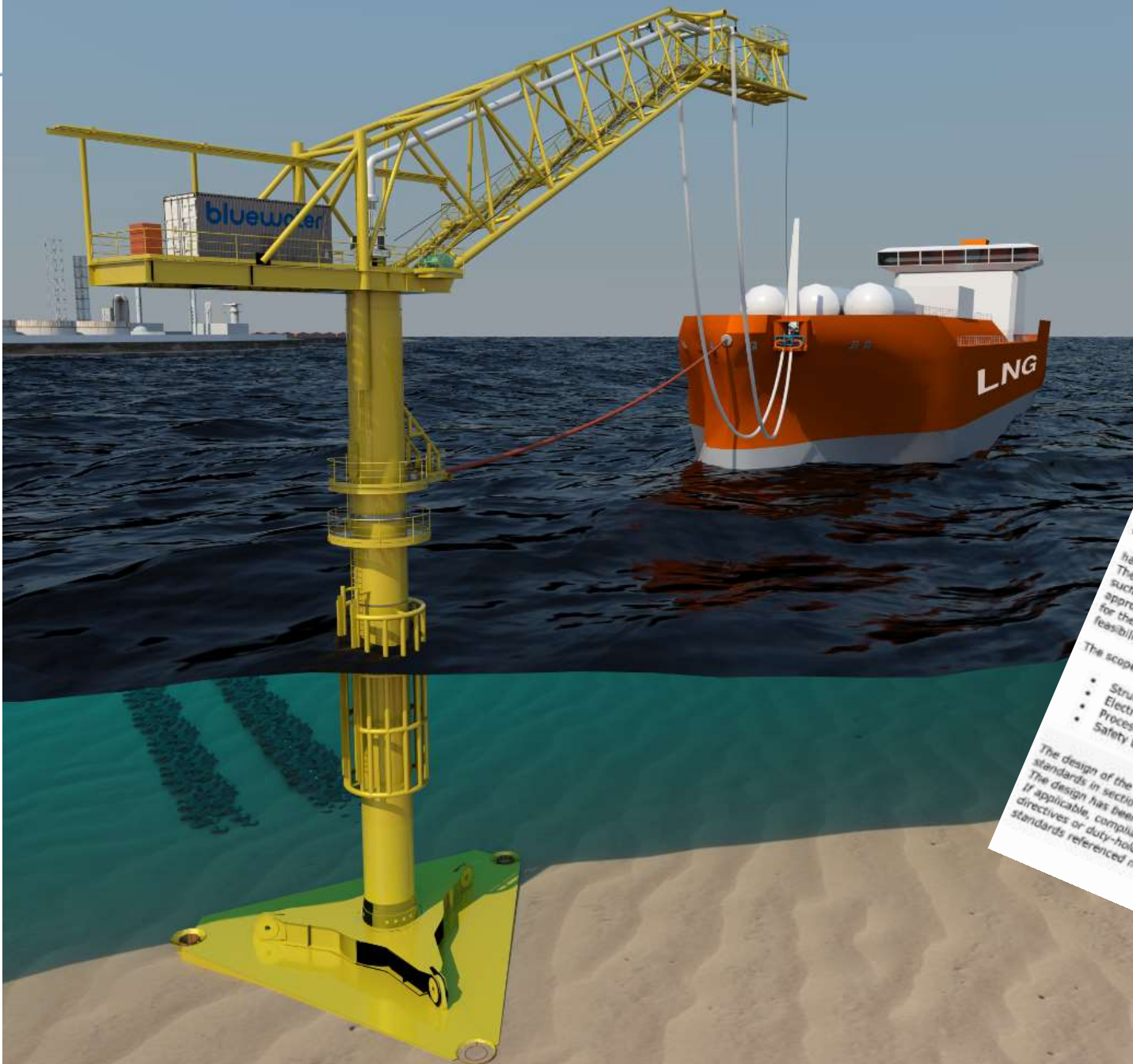
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Multipath cryogenic swivel



Bluewater Test Facility, Netherlands



DNV-GL

APPROVAL IN PRINCIPLE PRE-DESIGN VERIFICATION REPORT

DVR: **10178405-A0794635-AIP-001** Rev.: **00** Date of Issue.: **2020-07-22**

Particulars of Design

Customer / Manufacturer: **Bluewater Energy Services B.V.**

Contact Person: **Harry Brouwer**

Customer reference: **0-1750-1**

Location of work: **Hamburg**

Purchase order / project no.: **0-1750-1 | 10178405- A0794635**

Asset / Item: **Cryogenic Loading Tower Concept (CLT)**

This is to verify that the preliminary design of **Cryogenic Loading Tower (CLT)** has been reviewed and approved in principle. The process and scope of an approval in principle is not defined in any standard applicable to such a construction. So DNVGL used good engineering practice in offshore industry to approach this project. The scope and extent of the review is based on minimum requirements for the safety of a CLT which DNVGL assumes as relevant in a very early design stage and feasibility study for such a CLT.

The scope of review consists of the following disciplines:

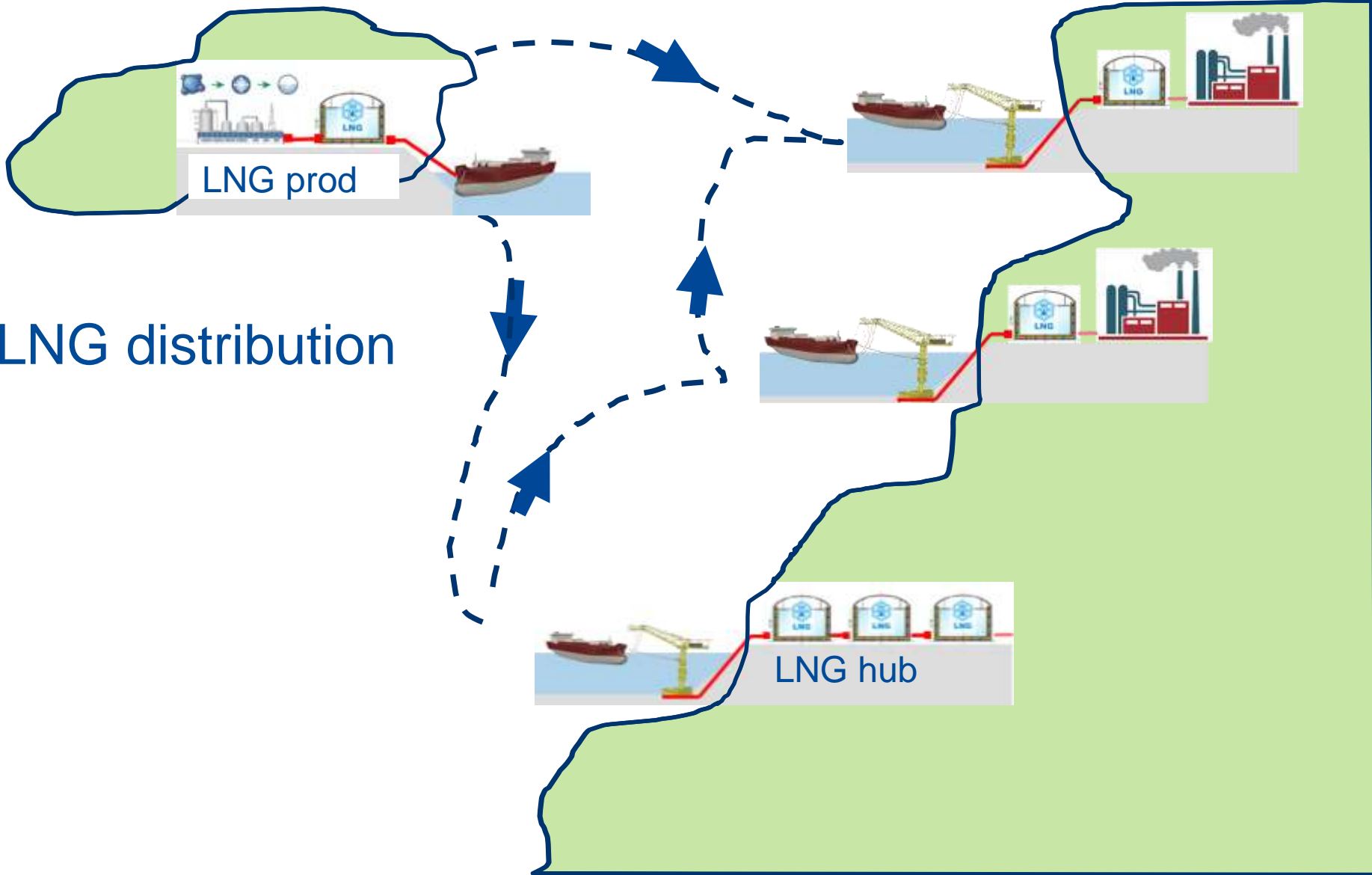
- Structural Design
- Electrical Design
- Process/Piping Design
- Safety Design

The design of the above equipment has been found to be in accordance with the referenced standards in section A.

The design has been reviewed, using documents see section B of this report, with regards to the relevant EU directives or duty-holder performance standards have not been considered however the standards referenced may assist in demonstration of compliance with these requirements.

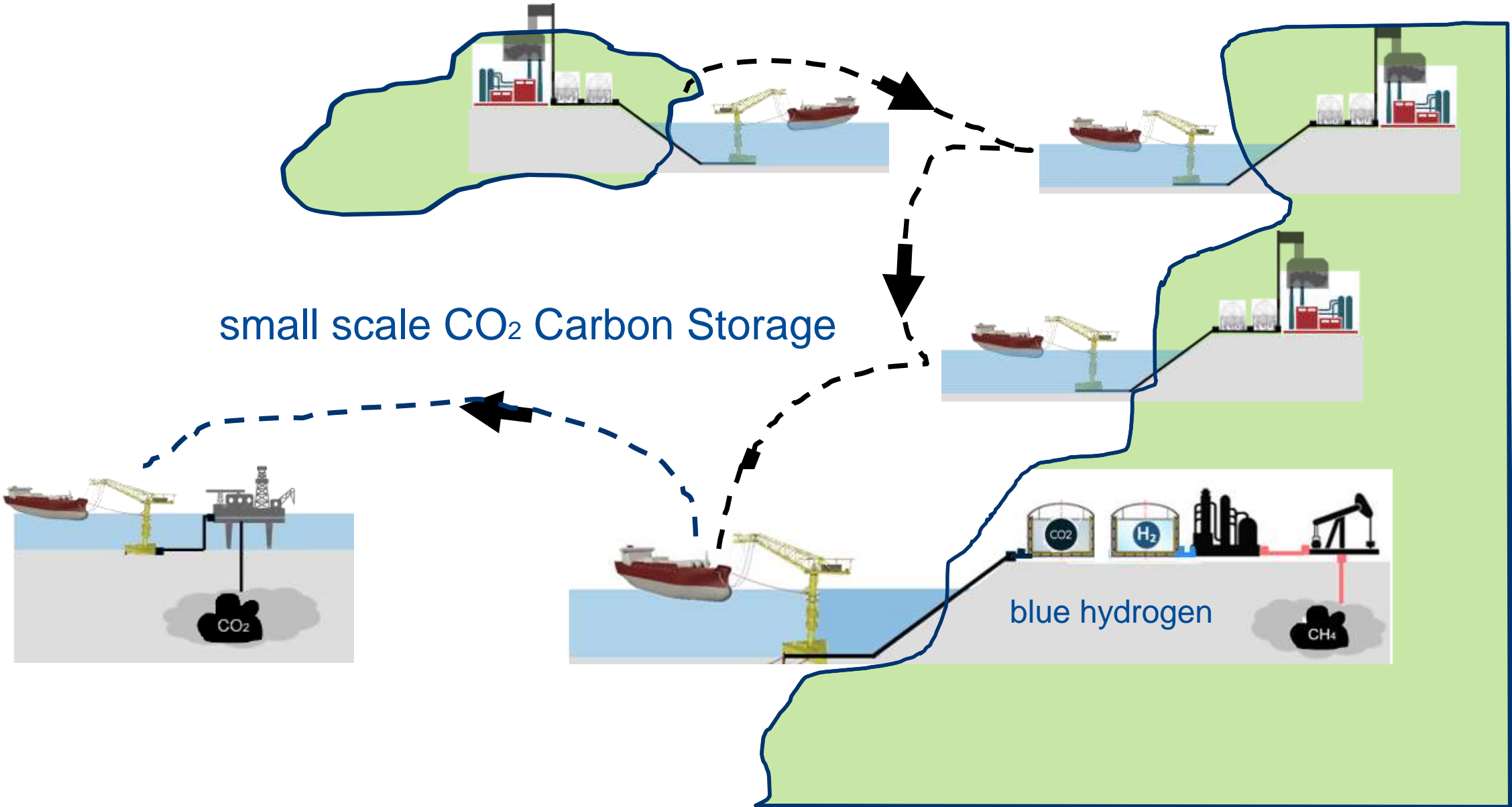
CLT in LNG distribution

small scale LNG distribution



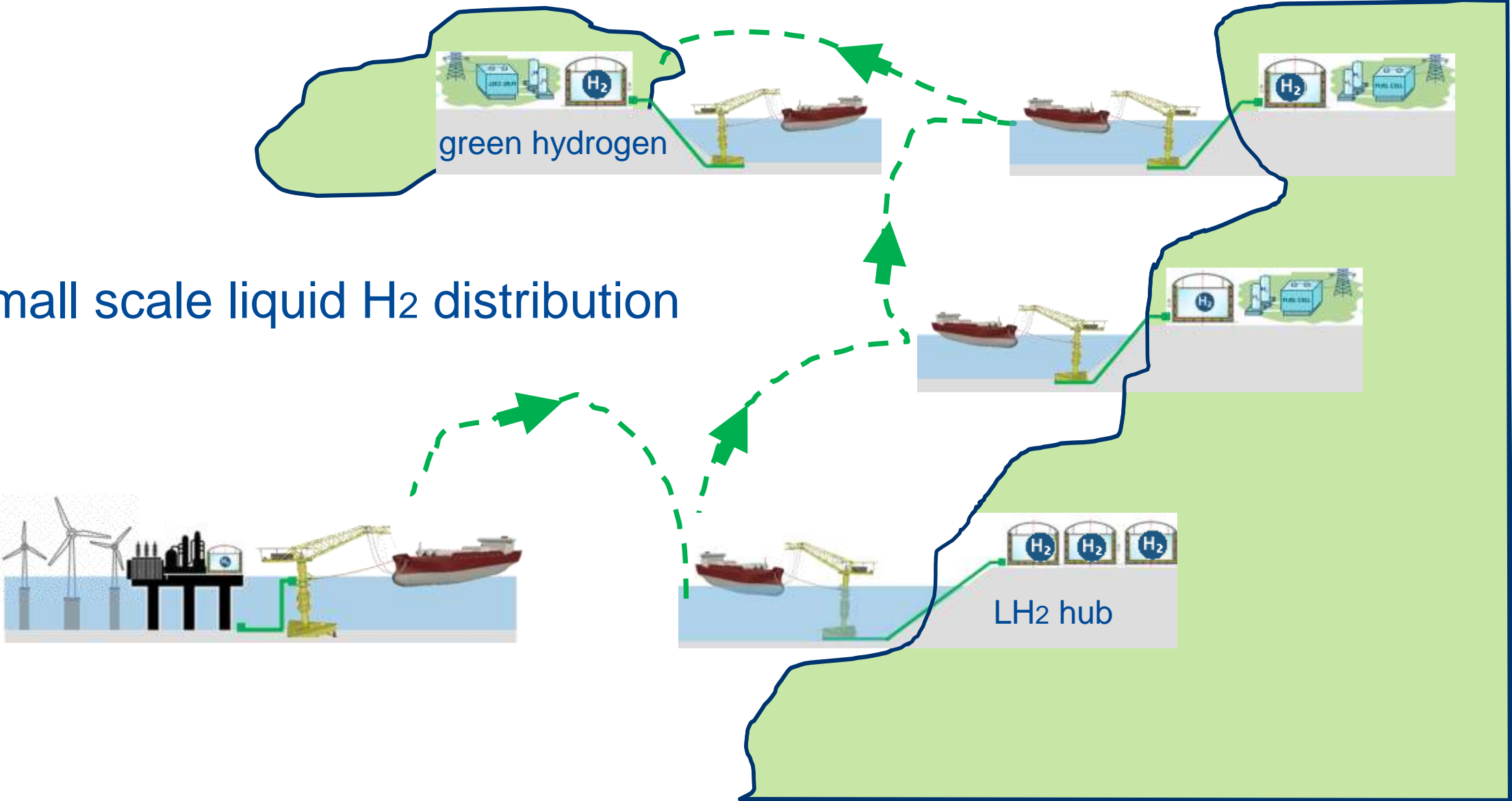
CLT in Carbon Capture and Storage network

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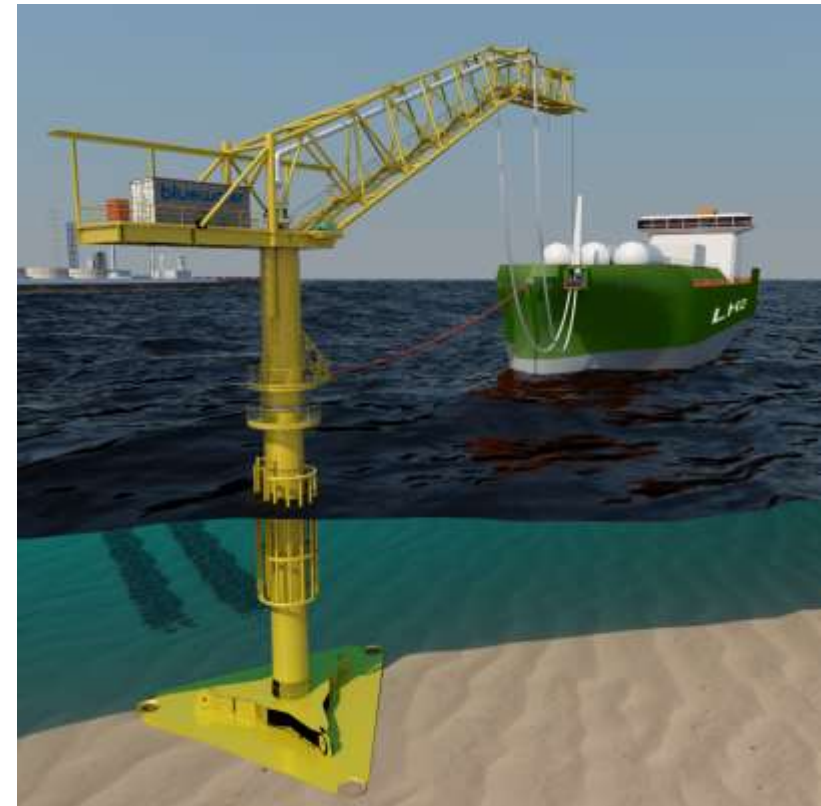


CLT in Hydrogen distribution

small scale liquid H₂ distribution



- Proven concept using existing components
- Suitable for tankers, LNG carriers, CO₂ carriers and future LH₂ carriers
- Enabling technology for net-zero future





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