



Ørsted Infrastructure Assets

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Re-purposing Offshore Pipelines for CO₂ transport

DTU Offshore CCS Conference June 2023

June 2023



Offshore wind



- Global leader in offshore wind
- Develop, construct, operate and own offshore wind farms
- Ambition to reach ~30 GW installed capacity by 2030



Onshore renewables



- Strong presence in the United States and Europe
- Develop, operate and own onshore wind, solar PV and storage projects
- Ambition to reach ~17.5 GW installed capacity by 2030



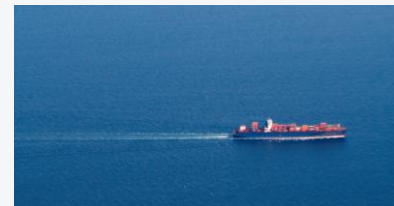
Bioenergy & other



- Presence in Europe, including bioenergy plants, legacy gas activities and patented waste-to-energy technology
- Own and operate bioenergy and waste-to-energy plants, and optimise gas portfolio



Renewable hydrogen and green fuels



- Emerging platform with 10 pipeline projects (+3 GW) mainly in Europe
- Develop, construct, own and operate hydrogen facilities
- Ambition to become a global leader in renewable hydrogen and green fuels by 2030

Infrastructure Assets


- Own and operate Ørsted Oil and Gas infrastructure

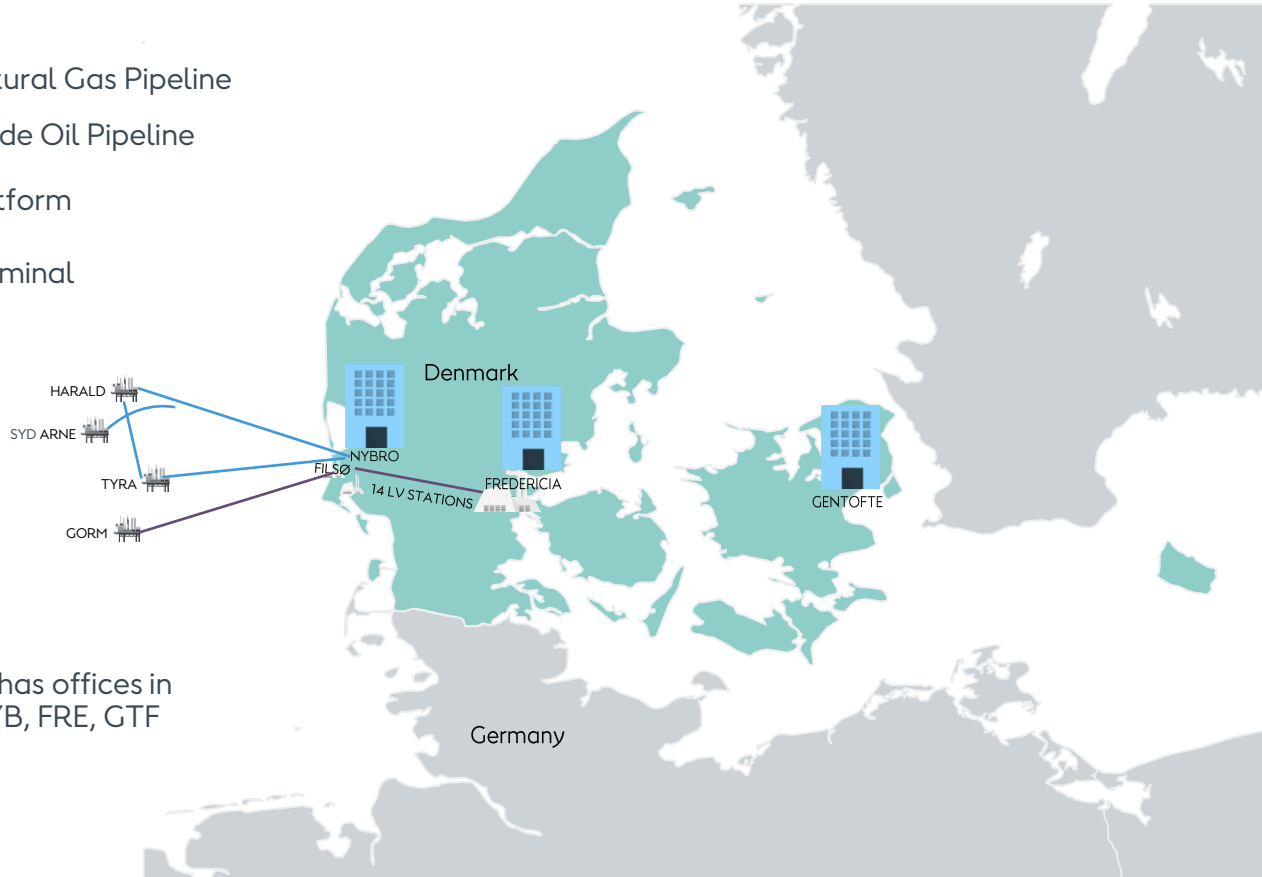
The footprint of Ørsted Infrastructure Assets

— Natural Gas Pipeline

— Crude Oil Pipeline



 IA has offices in NYB, FRE, GTF



Historical look back at the natural gas infrastructure

- 1973-74 oil crisis: 2 countries were 99% dependent of imported energy: Japan + Denmark
- Oil crisis caused a severe economic crisis, unemployment - and no driving on Sundays...



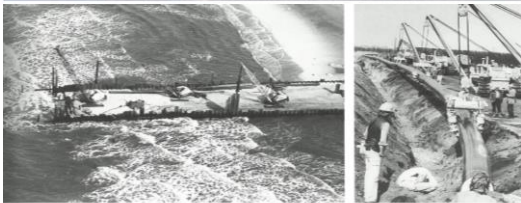
Car free Sundays in Denmark as a result of the oil crisis in 1973

DANISH
ENERGY
AGENCY



History

Establishment of the danish Natural gas infrastructure 1980 - 1984



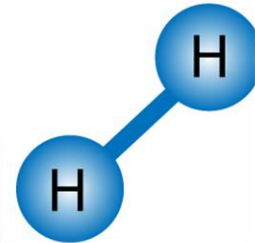
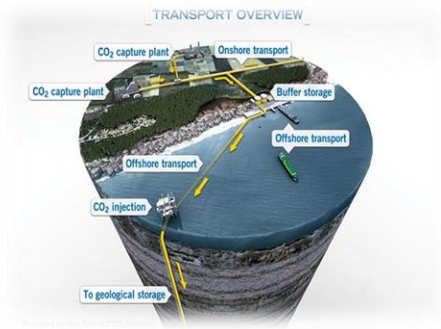
Initiation of Nybro Gas Treatment Facility
October 1st. 1984



Now and The future



e-methanol
 CH_3OH

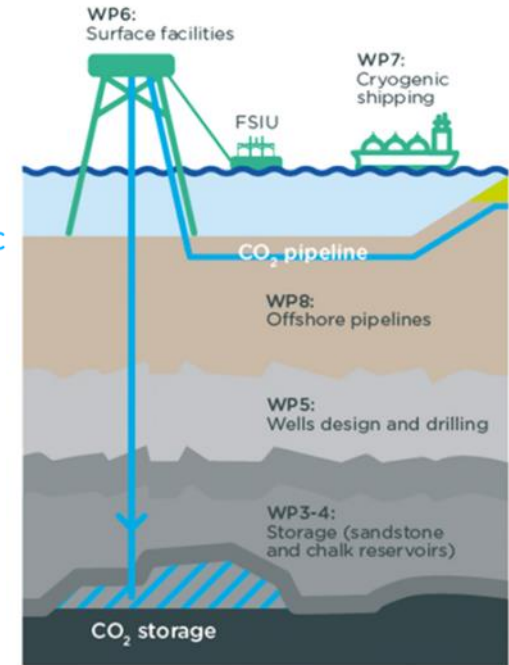


Infrastructure Assets joining the green transition

- Initiatives to reduce O&M CO₂ footprint
- Re-purposing offshore pipelines for H₂ transport
- Re-purposing offshore pipelines for CO₂ transport

→ **Bifrost, CO₂ transportation and storage project leveraging on existing O&G assets**

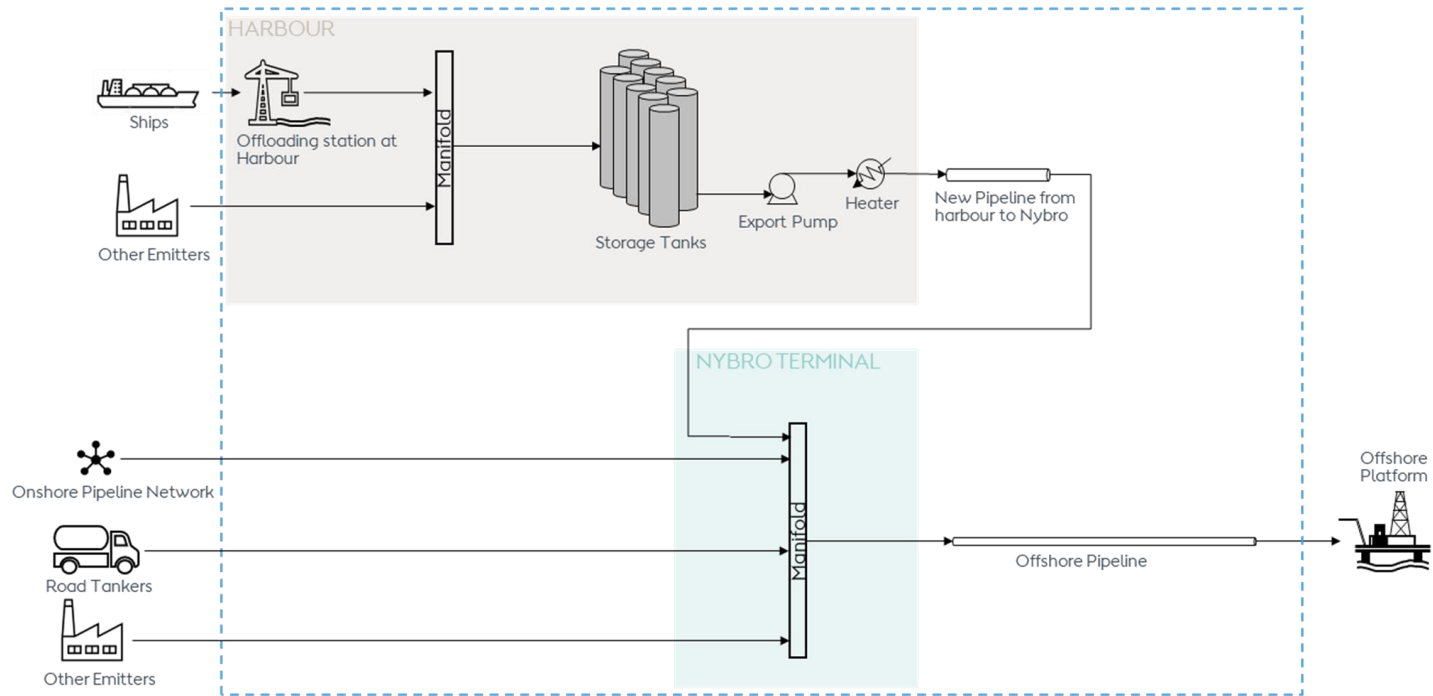
- 2-year study funded by EUDP
- 3 study partners DUC (TotalEnergies, Noreco, Nordsøfonden), DTU & Ørsted



Bifrost – liquid CO₂ pipeline scenario

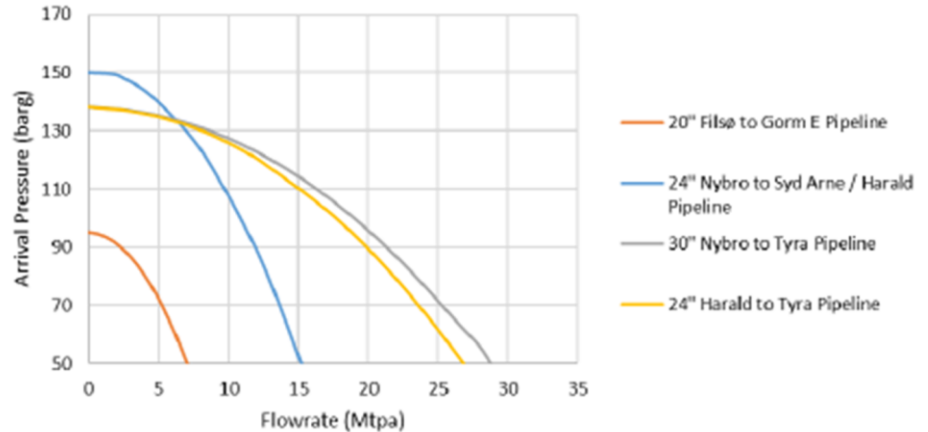
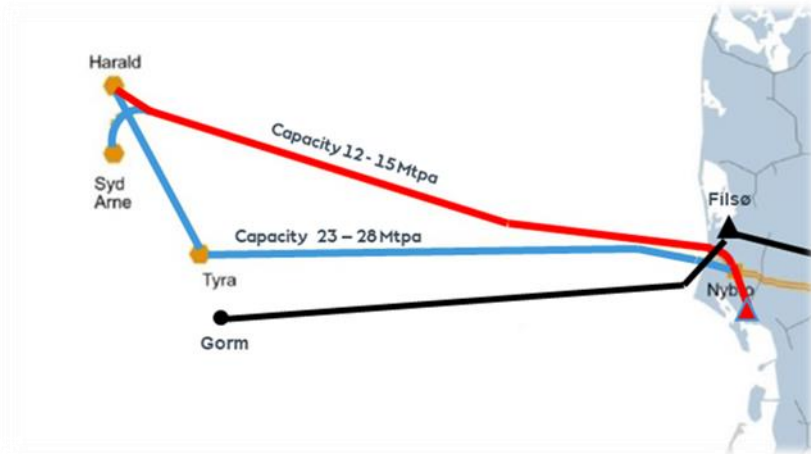


Bifrost – liquid CO₂ pipeline transport scenario



Offshore Pipelines – conclusions.....so far

- Pipelines are fit for service and transportation of liquid CO₂
- High capacity
- An early opportunity re-purpose “Harald to Nybro” pipeline
- Significantly smaller CO₂ footprint and environmental impact compared to building new pipelines
- Significant cost savings compared to new off-shore pipelines
- Further maturation with the goal of achieving 3. party verification



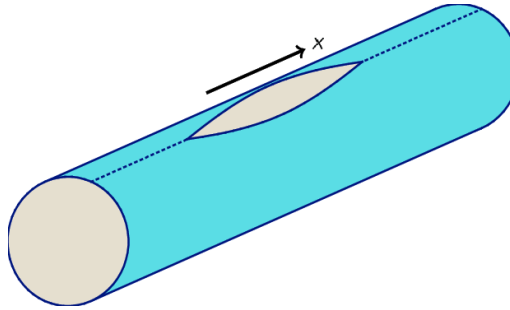
Offshore pipelines – Main risks identified

Running Ductile Fracture

- Small initial fracture, can start the running in the pipeline, if CO₂ saturation pressure is above 60bar – 65bar.

Mitigation

- Dry CO₂ purity >99.5 mol%



Internal Material Coating

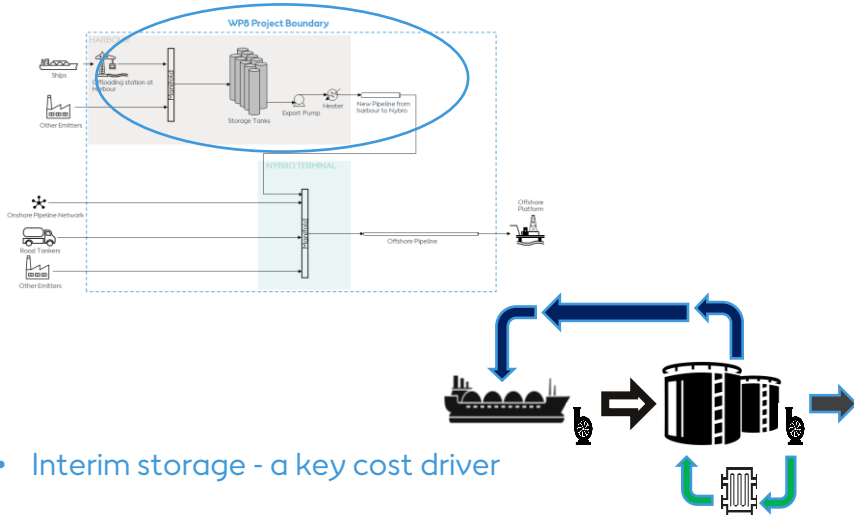
- The 24" pipeline has Internal Epoxy flow coating
- Risk of detachment of the coating in case of rapid depressurization

Mitigation

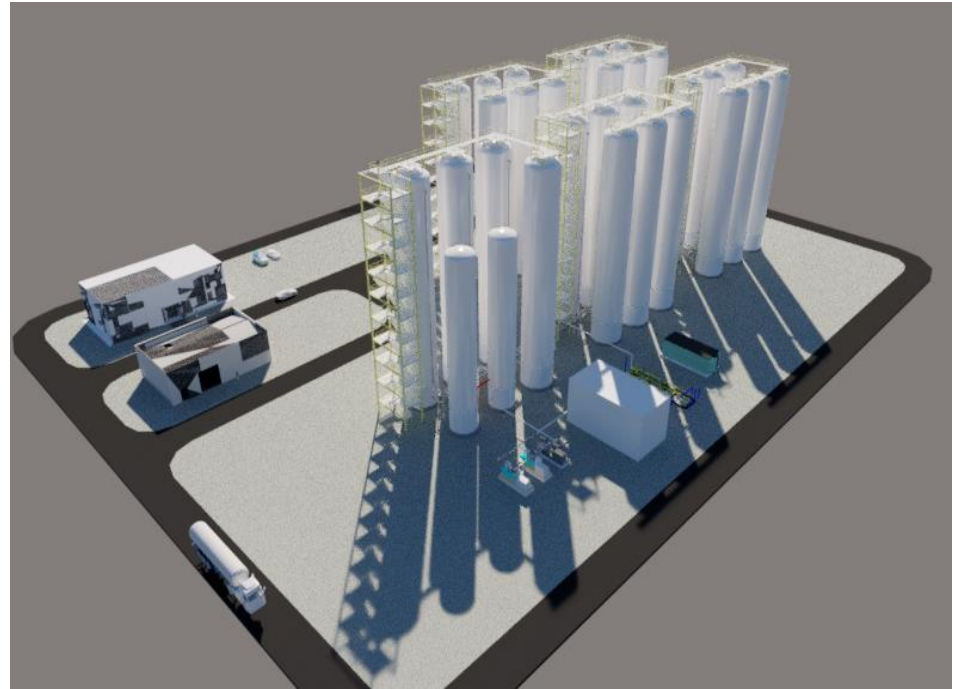
- Qualification testing (in progress)
- Potential filter at platform



Generic onshore CO₂ transport scenario - highlights



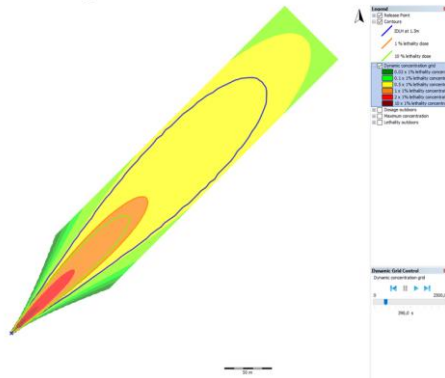
- Interim storage - a key cost driver
- Shipping interface – key factor for storage requirements
- Operational challenges
 - secure at stable flow
 - what happens at a standstill?
- Space requirements
- Onshore pipeline also a key cost driver – but otherwise almost “business as usual”



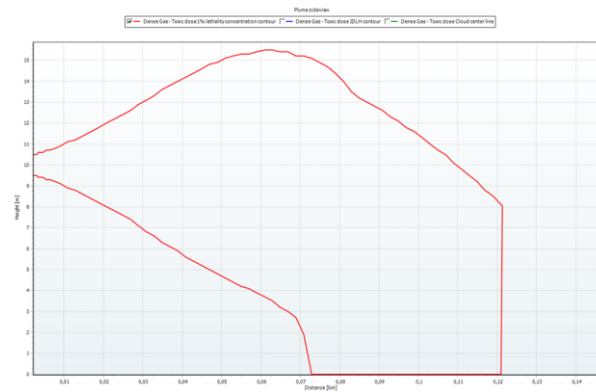
Process safety & permitting

- CO₂ is not considered a dangerous substance.....the same goes for water, but you would almost certainly try to avoid a tsunami!
- Current permitting and process safety requirements for CO₂ predominantly applies to smaller quantities of CO₂
- We apply our Oil & Gas process safety competences to CO₂ where relevant:

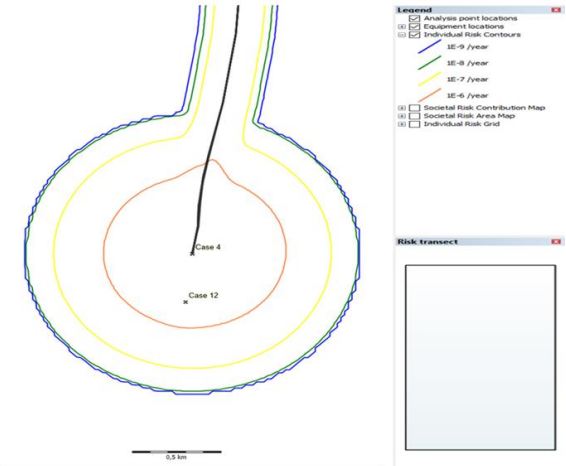
Consequence Modelling



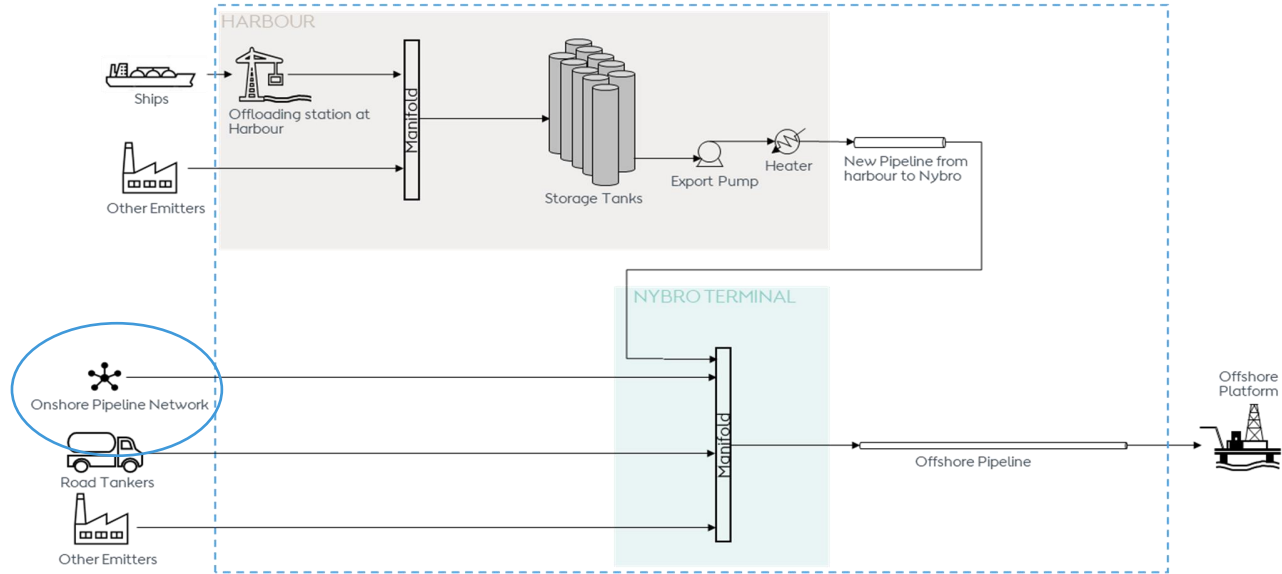
Plume side view



Risk Modelling



Perspective – pipeline infrastructure



A Danish infrastructure perspective



Source: Evida, May 2023

- Cost-efficient transport (pipelines and ports)
- Cost-efficient storage - primarily driven by import of European CO₂
- Enabler for biogenic CO₂ utilization and PtX
- Ideally positioned for both NW European CO₂ as well as Baltic CO₂, enabling Denmark to become a European CO₂ hub.

