CO_2 Hubb in the Port of Gothenburg

Opportunities, Challenges and Lessons learned from a Project- & Port Perspective

Tina Mårlind

Webinar Gassnova 2023-11-22

GÖTEBORGS HAMN

Port of Gothenburg

- Scandinavia largest port and the Nordic Energy Hub
- Guaranteed access for business to the entire world
- World-leading rail connections with climate-smart and resource-efficient freight transport
- 50/50 import/export
- Ice-free all year round, no tide
- Approach time from open sea to quayside is 90 min






PORT OF GOTHENBURG

Emissions calculations when comparing CO_2-transportation* between railway and ships (12,500 m^3 capacity vessel)

Stockholm – Gothenburg – Kollsnes:

14 kg CO_2 eqv./m^3

Yearly capacity m^3 CO_2: 1,650,000
Days between vessel departures: 3

Stockholm – Kollsnes:

33 kg CO_2 eqv./m^3

Yearly capacity m^3 CO_2: 728,000
Days between vessel departures: 6,3

Gävle – Kollsnes:

39 kg CO_2 eqv./m^3

Yearly capacity m^3 CO_2: 615,000
Days between vessel departures: 7,4

**Source: IVL – Swedish Environmental Research Institute, dated 2022-09-30*

Project CinfraCap in brief

- Initiated 2020 as a cross sectorial collaboration between 6 private and public companies to develop a cost-, climate- and environmentally efficient infrastructure for transport and intermediate storage of CO2
- Potential to handle up to **4 Mton CO_2 / year**
- The project received support from the Swedish Energy Agency´s Innovation Program ”*Industriklivet*”

Energimyndigheten

Göteborg Energi · GÖTEBORGS HAMN · NORDION ENERGI · preem · Renova · st1

PORT OF GOTHENBURG

Scope – Benefits with Shared Infrastructure

GÖTEBORGS HAMN

2020

2021

PHASE 1
FEASABILITY

2022

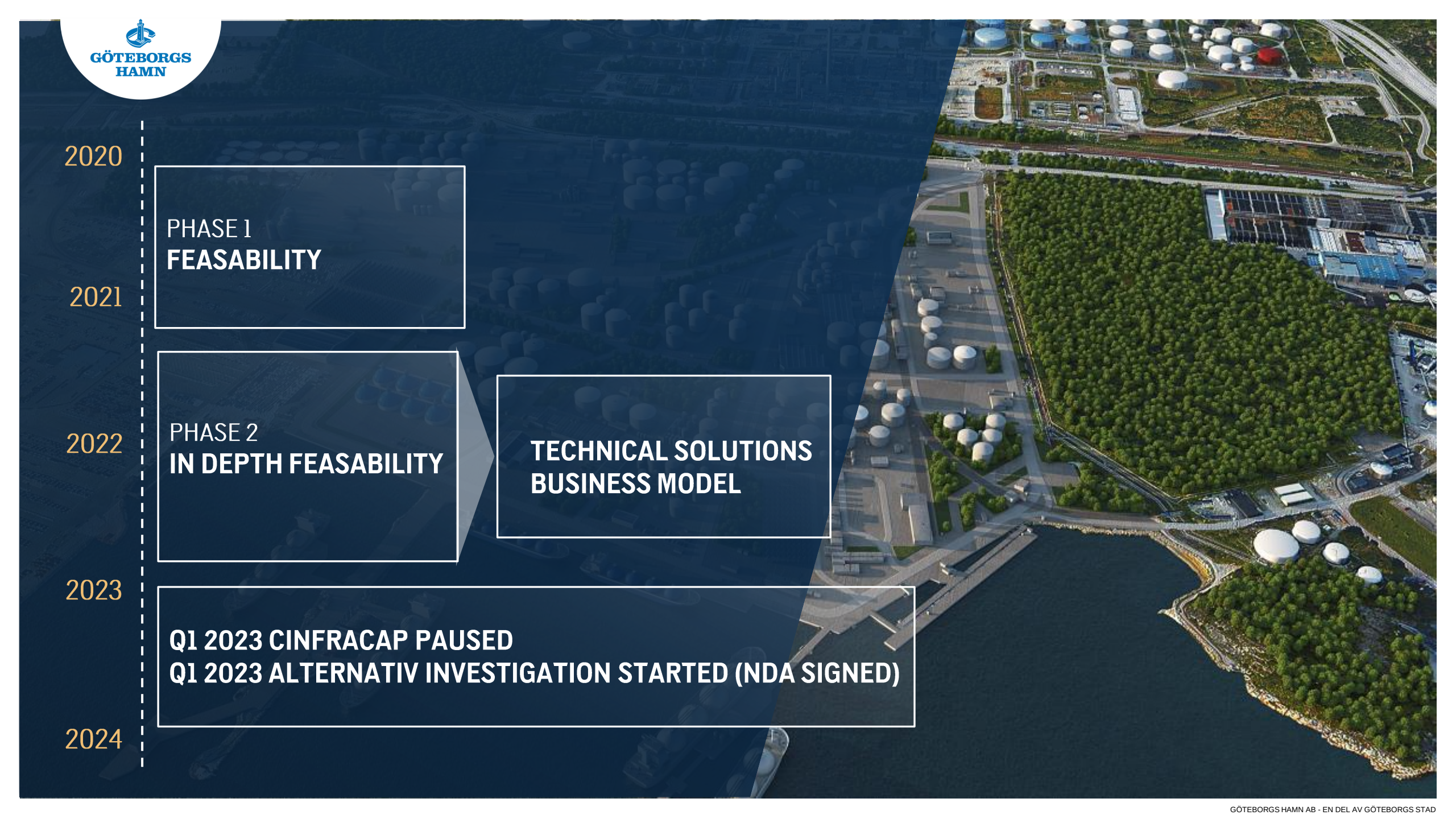
PHASE 2
IN DEPTH FEASABILITY

TECHNICAL SOLUTIONS
BUSINESS MODEL

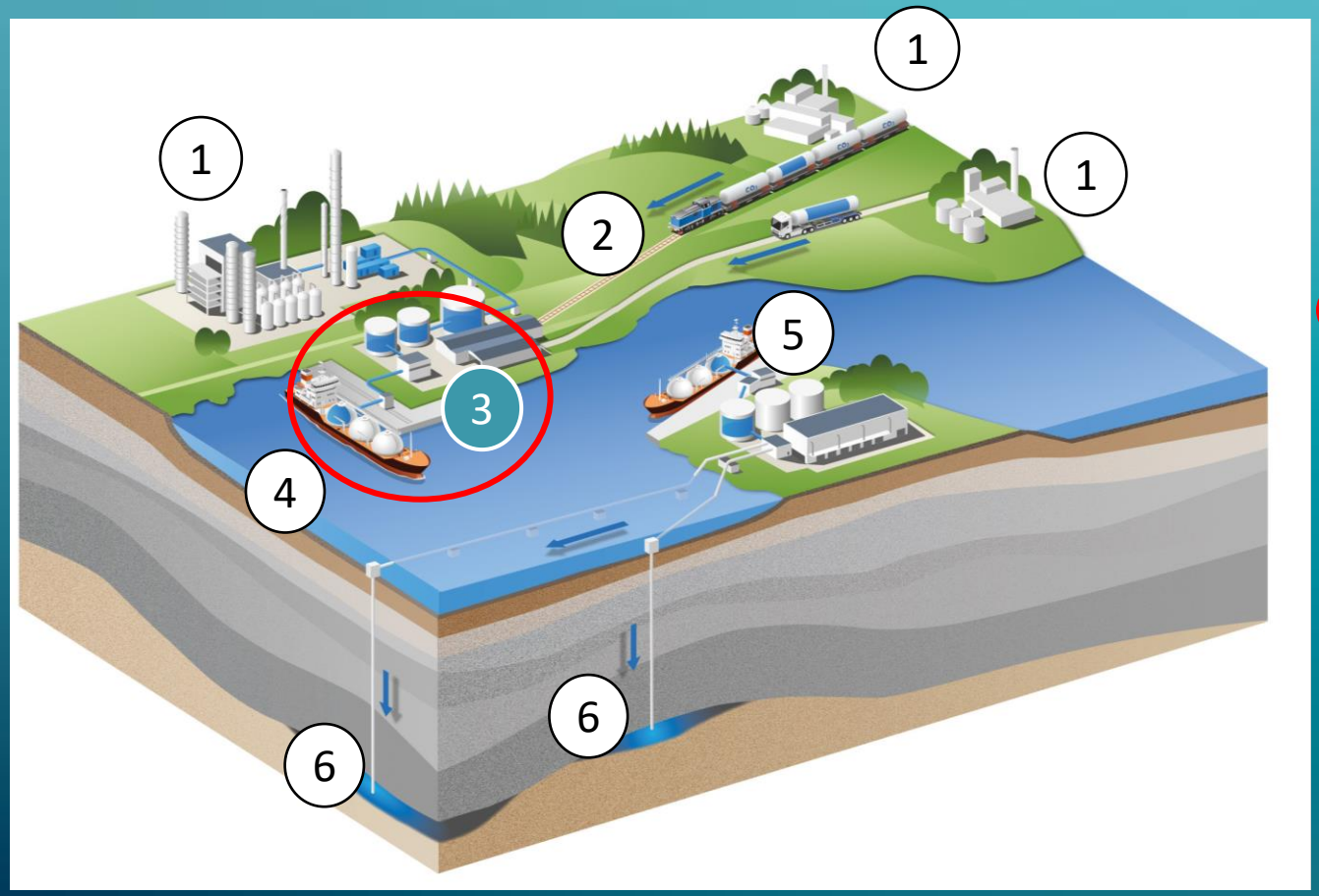
2023

Q1 2023 CINFRACAP PAUSED
Q1 2023 ALTERNATIV INVESTIGATION STARTED (NDA SIGNED)

2024



CinfraCap in the CCS Value chain



1. CO_2 is captured at industrial site
2. Transported by pipeline, train or truck
3. CO_2 terminal with interim storage.
4. Sea transportation
5. Storage provider
6. Permanent storage in an underground geological formation.

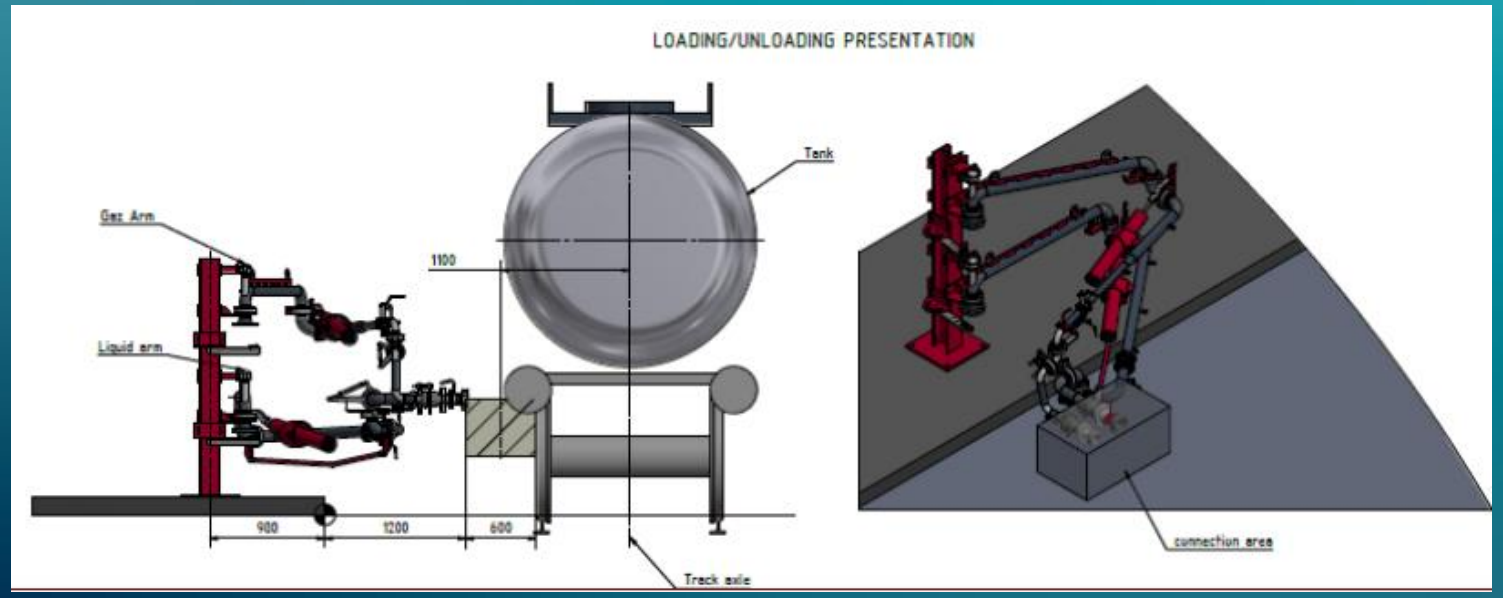
CinfraCaps interfaces

CinfraCap Phase 2 Results

- Technical solution: **4 Mton CO2/year**
- Business model – principles of tariff model
  - **Open access**, low risks, transparency (inspired from NG and LNG business)
  - **Volume-based & cost reflective**: EUR/ton throughput based on actual costs
  - **Take or Pay**: client pays for annual maximum throughput independent of actual throughput
  - *(Tariffs 5-15 % of total costs of CCS Value Chain)*
- CAPEX 150 MEUR (+/- 30%, when joint liquification)
- Preparations for Phase 3 – suggested contracts categories
  - Category 1: Joint Venture infrastructure owners
  - Category 2: Stakeholders early customers
  - Category 3: Stakeholders future customers
  - Category 4: Joint Venture - Landowner agreement

Examples of interfaces & design conditions

Purity
Pressure
Temperature
Flowrate
Measuring technology
Risk assessment



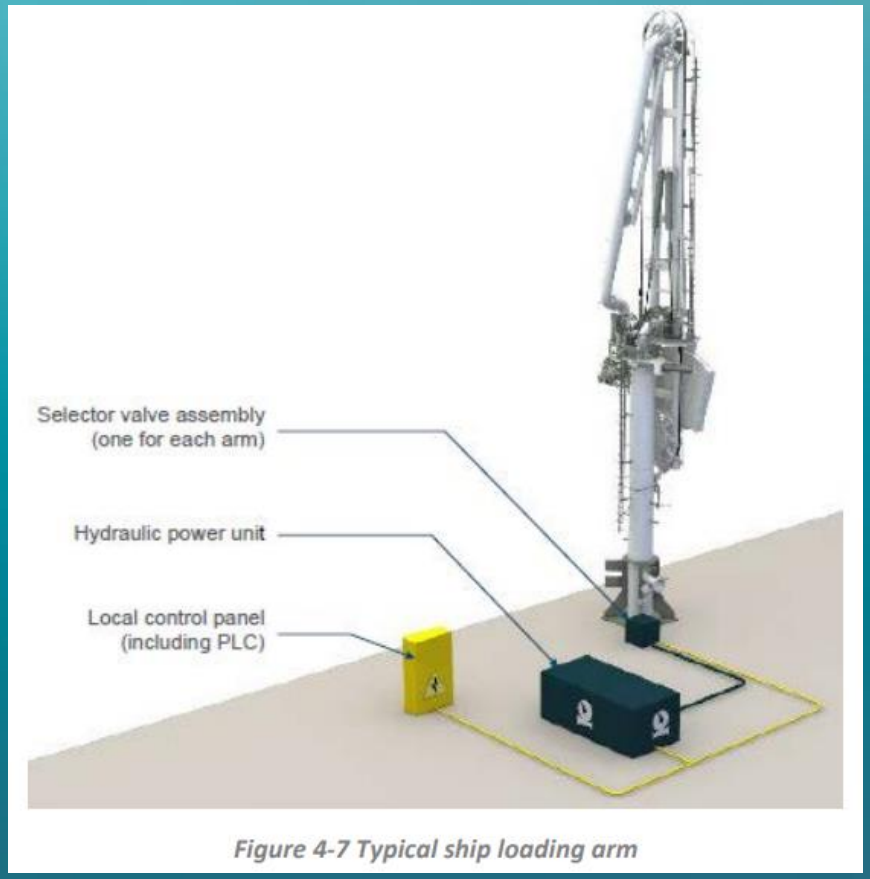
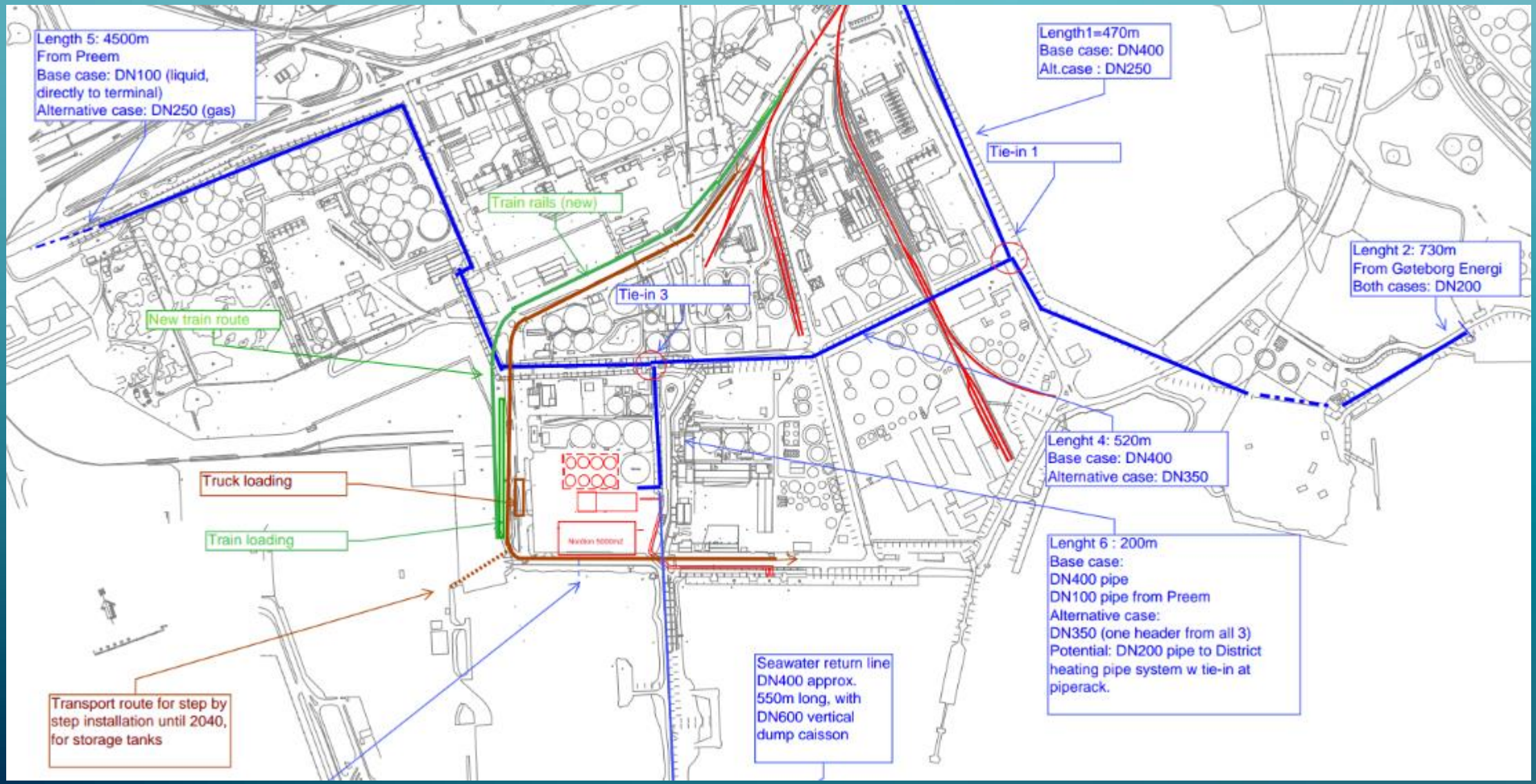


Figure 4-7 Typical ship loading arm

PORT OF GOTHENBURG

Pipe Tie-ins



Tariff estimates for different infrastructure elements and CO2 throughputs – examples

- **Pipeline** approx. 5 km for 0,3 Mt CO2 /yr ~ 2 EUR/ton CO2
- **Truck** off-loading for 1 Mt CO2 /yr ~ 0,9 EUR/ ton CO2
- **Train** off-loading for 2 Mt CO2 /yr ~ 0,8 EUR/ ton CO2
- **Interim storage and loading** for 4 Mt CO2 /yr ~ 5 EUR/ton CO2

The tariffs are highly dependent on the total CO2 throughput

The longer the contract time, the lower the risk and tariff

Main Challenges during CinfraCap Phase 2

1. Many uncertain conditions along the whole value chain (technical, commercial, legal) which increased the uncertainty in making decisions
2. Differences between the parties' internal decision-making processes/timetables and thus different opportunities for making FID
3. The technical and business WP were carried out too separately from each other
4. Discussions concerning the business model and setups

- Q1 2023 the project CinfraCap was put on hold
- An alternative investigation with other collaboration partner started immediately (NDA was signed and thus no external communication have been made)

Reflections – we need to reduce uncertainties

Technical value chain

- Accurate volume estimates are crucial – sets which volume to build for and when. Unfortunately Catch 22 - Carbon capture companies need T&S for FID, and T&S companies need CC volumes for their FID
- Setting the correct redundancy on intermediate storage is tricky – depends on volumes estimates, logistics inflows/outflows, seasonal variations, permitting timeline for storage facilities ship-sizes,, and frequency to permanent storage sites (on-shore/off-shore)
- Flexibility is important - Sufficient TRL but no off-the-shell products, no int. standards yet set and no solutions for large scale implementation exists and never have been put together in full commercial chain before
- Dialog with licensing authorities critical

Business and funding

- We need large scale to bring down costs – should we build in stages that follow the market development or build large-scale right away?
- Allocation of risks and rewards is challenging when new contractual set-ups depends on other parties in the value chain
- Both biogenic and fossil CO_2 are needed now – different value chains have different degrees of maturity and thus different need for replacement products (e.g. Power-to-X + hard-to-abate em.)
- Scandinavia have large potential of biogenic CO_2 (CHP, Waste-to-energy, Pulp & Paper…), well developed energy systems and stable governments

Standards and Accounting

- Lack of methodology – governance/regulation/legislation in Sweden would help the market
- Possibility for private capital to contribute to the financing of projects via VCM
- We need to speak the same language and clarify the term T&S, i.e. distinguish between land vs. sea-based infrastructures nationally
- Should there be a discussion in Sweden concerning e.g.
  - Support of establishment of transport networks and clusters
  - National pipeline infrastructure

Key takeaways

Overall

- Right mindset - we are all colleagues because there is no time for any alternative
- We need to reduce risks and uncertainties along the whole value chain – clear regulations and financial support mechanisms are critical
- We need to solve the Catch 22 problem – could the solution be to focus on establishing CO_2 transport networks and export hubs to serve clusters of emitters instead of a few CC projects?

Project specific for a CO_2 hub

- Set the right mindset and clear Roles & Responsibilities early between project partners and focus on how to reach FID
- Develop the technical scope in close connection with the business scope
- Secure volumes
- Conduct dispersion calculations early in the project to find optimal location for the hub

Thank you

Tina Mårlind

tina.marlind@portgot.se