

#1 CO₂ TRANSPORT TECHNOLOGIES, CONTRACTUAL FRAMEWORKS AND SYSTEMS



MODERATOR

Stijn Santen

BUSINESS DEVELOPMENT AND ADVOCACY
LEADER

EBN

Stijn Santen studied chemical engineering and has worked for 18 years in Shell. He was the founder of the first successful CCU projects; Shell-Omya (1998) and Shell-OCAP (2005).

In 2019 he joined EBN to develop the CCS project Aramis. Since 2023 he is also the chairman of the CCS projects network of ZEP and organizes capacity building for governments and business development with industrial partners.

GASSNOVA 

KNOWLEDGE 20
SHARING 26
CCS & CDR Summit



SPEAKER

15 April

Workshop #1 CO₂ transport technologies, contractual frameworks and systems

12:00-12:20

After receiving my degree in Applied Physics in 2004 I have worked in a range of roles related to flow and heat transfer modelling. For the last 15 years I have worked in various roles related to flow assurance and integrated production/injection system modelling. I have focused exclusively on CCS since 2020, working on the Porthos and Aramis projects.

Wouter Schiferli

FLOW ASSURANCE DISCIPLINE LEAD

EBN

GASSNOVA 



Responsible **CO₂ storage**

ebn

Need for integrated modelling in CCS project development

Gassnova Knowledge Sharing Summit 2026
Workshop 1, 15 April 2026

Wouter Schiferli (EBN)
Flow assurance discipline lead

Presentation overview



- Intro to EBN
- Netherlands: CCS in depleted gas fields
- Differences with aquifer storage
- Effect of reservoir on injection strategy
- Integrated modelling: Calysto tool

Natural gas projects
(Investor, trader, managing gas storage)



State-owned company
(shareholder Min of Econ Affairs)

Geothermal projects
(developer and investor)



EBN (staff ca. 300) operates always in
JV's

Strategic pillars of EBN

CO₂-transport and storage
(developer, investor and sometimes operator)



EBN engages/participates in >10
storage ventures



Energy System analysis
(advisor, communicator)

CCS Portfolio EBN

Transport & Storage in depleted gas fields



TotalEnergies	
Shell	
Eni	
Harbour Energy	
ONE-Dyas	
Porthos Stores	
Porthos Trunkline	
Aramis Trunkline	
Spurline	

Portfolio Summary

- Offshore transport & storage portfolio
- Developing transport capacity for >25 Mtpa
- Developing >10 stores with 5 operating partners
- Exploring aquifer potential
- Porthos project start injection in 2026
- Aramis project unlocking large scale transport
- Direct injection projects for stranded assets



CCS in depleted gas fields vs aquifers



Storage in depleted gas fields in NL

- Long history of offshore gas production
 - Many depleted fields close to end of life
 - Situated close to major emitters:
Rotterdam, Antwerp (Be), North-Rhine Westphalia (Ge)
- First projects target CCS in gas fields

Project	Start	Depth [m]	P _{reservoir} [bar]	Rate [Mt/y]
Porthos	2026	3500	17	2.5
Aramis	2030	~3000	20 – 50	5 → 22

- Gas fields offer two advantages
 - Geology very well known
 - Potential to re-use infrastructure
- But also one big disadvantage: low pressure

Most operational experience: aquifer injection

- Nearly all projects inject into aquifers
- Pressure near hydrostatic gradient (10 bar / 100 m)
- Depth can vary:
 - Sleipner: 1000 m ≈ 100 bar
 - Snøhvit, Quest, Gorgon, Northern Lights > 200 bar
 - All much higher than in depleted gas fields

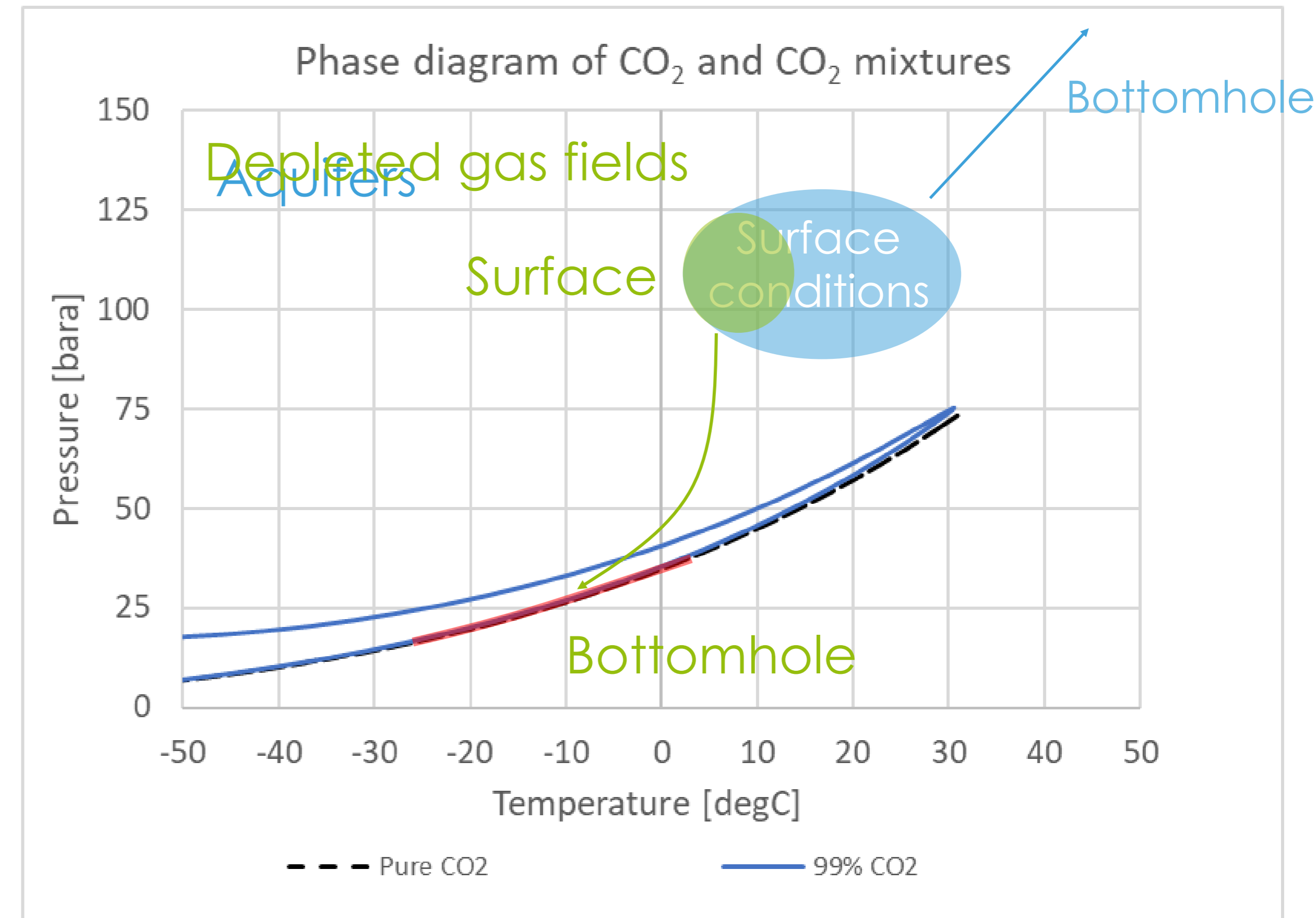
Limited experience in gas fields

- Moomba CCS (AUS): 40 bar reservoir, 1800 m depth
 - Injecting at design rate of 1.7 Mtpa since 2024
- Poseidon CCS (UK): 14 bar reservoir at 1800 m depth
 - Batch injection test in Feb 2025: stable well operation injecting gas and dense phase CO₂
 - Pre-FID, start-up planned in 2029

Why is this low pressure a challenge?

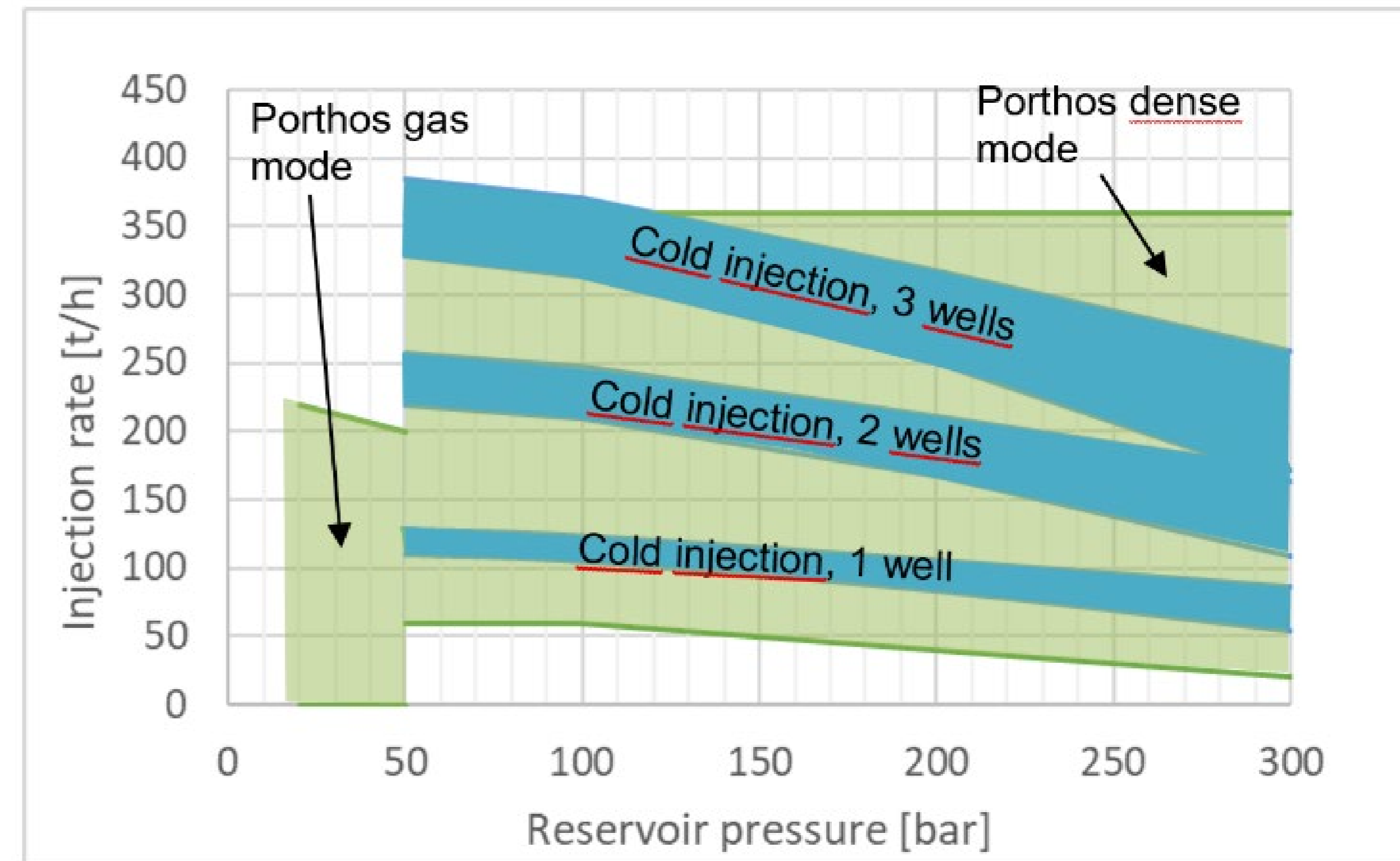


- Transport conditions in liquid or dense phase
- **Reservoir pressure** and **injectivity** determine bottomhole injection pressure
- Aquifers: high pressure throughout system
- Gas fields:
 - Pressure in top of well high (controlled by well sizing)
 - Pressure in bottom dictated by reservoir
- Low injection temperatures
 - Well loads, annulus freezing (existing wells)
 - Potential cement debonding
 - Hydrates



Injection strategies in depleted gas reservoirs

- Reservoir properties strongly affect project
 - Well size
 - Injection strategy
 - Required surface pressure
 - Need for heating or insulation
- Cold pipeline transport: default option
 - CO₂ transported in liquid phase at ambient T
 - Acceptable for moderate P_{res} and injectivity
 - System performance can only be assessed with accurate reservoir & wellbore models
- Gas phase + insulated pipeline
 - Porthos: low P_{res} and very high injectivity → low BHP!
 - 17 bar reservoir: system operated in gas phase
 - At 50 bar reservoir pressure, switch to dense phase
- Shipping + direct injection
 - Option if BHP sufficiently high (similar to cold transport)
 - Intermittent injection: large transient well loads

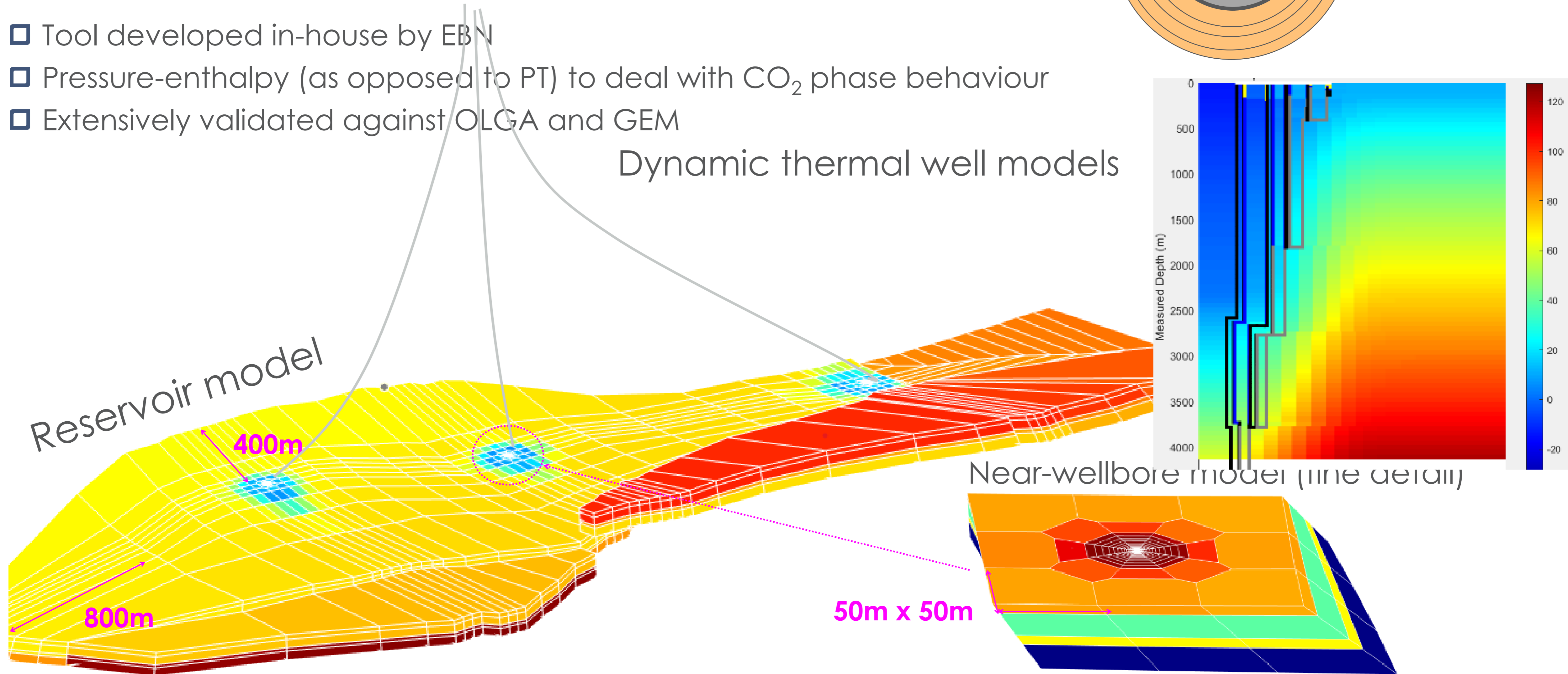
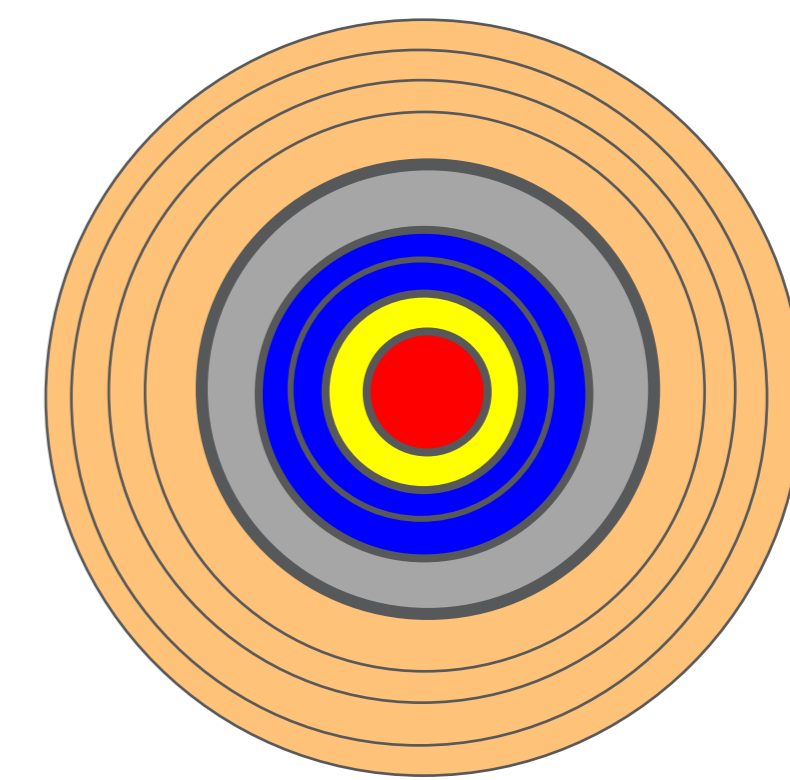


Calysto: integrated CO₂ modelling

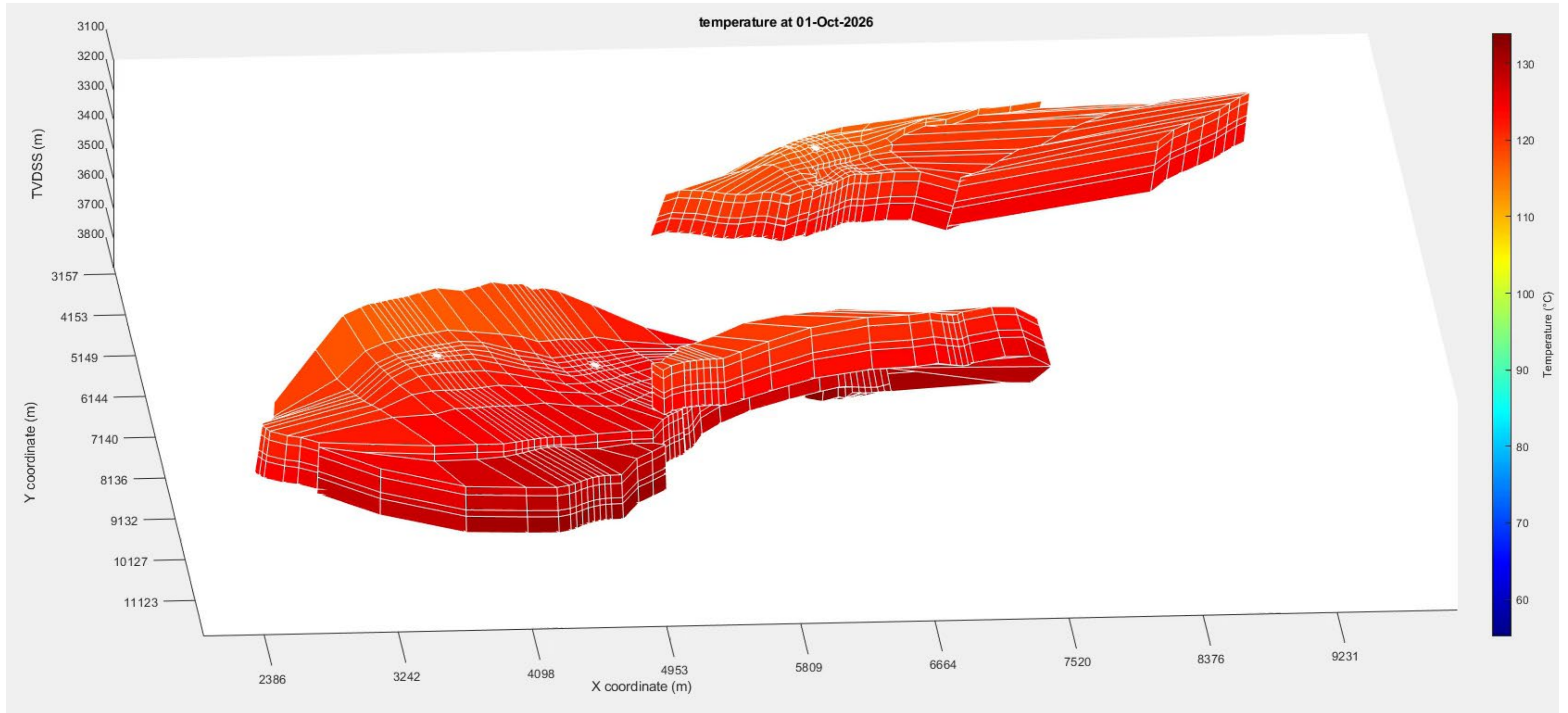
Carbon Low enthalpy Simulation Tool

- Tool developed in-house by EBN
- Pressure-enthalpy (as opposed to PT) to deal with CO₂ phase behaviour
- Extensively validated against OLGA and GEM

Dynamic thermal well models



Example application: propagation of cold CO₂



Summary: integrated modelling using Calysto



- ❑ Reservoir behaviour plays an important role for CCS in gas fields
- ❑ Previous approach: separate reservoir and well simulations
 - Cumbersome iterative process!
 - Well simulations use injectivity curves obtained from reservoir model
- ❑ Other reservoir models cannot handle low injection temperatures

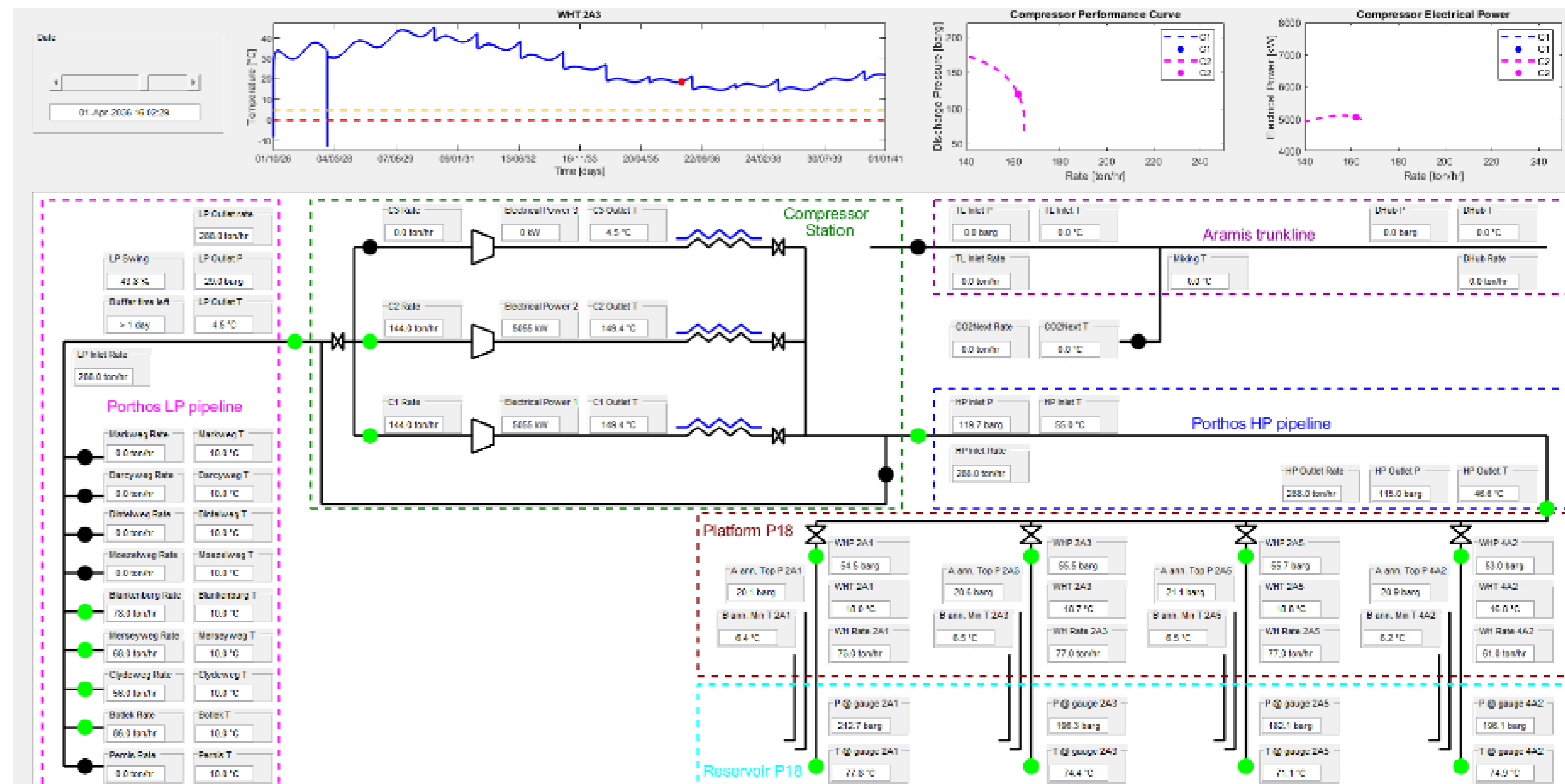
Integrated model for operator support

- ❑ Applications of Calysto:

- Evaluating injection strategies
- Propagation of cold front in reservoir
- Integrated model for operator support
- ...

- ❑ Calysto will soon be made available to external parties

- Limited version intended for feasibility studies



Thank you for your attention

Contact: wouter.schiferli@ebn.nl

The logo for 'ebn' is located in the bottom right corner. It consists of the lowercase letters 'ebn' in a white, sans-serif font, centered within a dark blue square with rounded corners.

ebn

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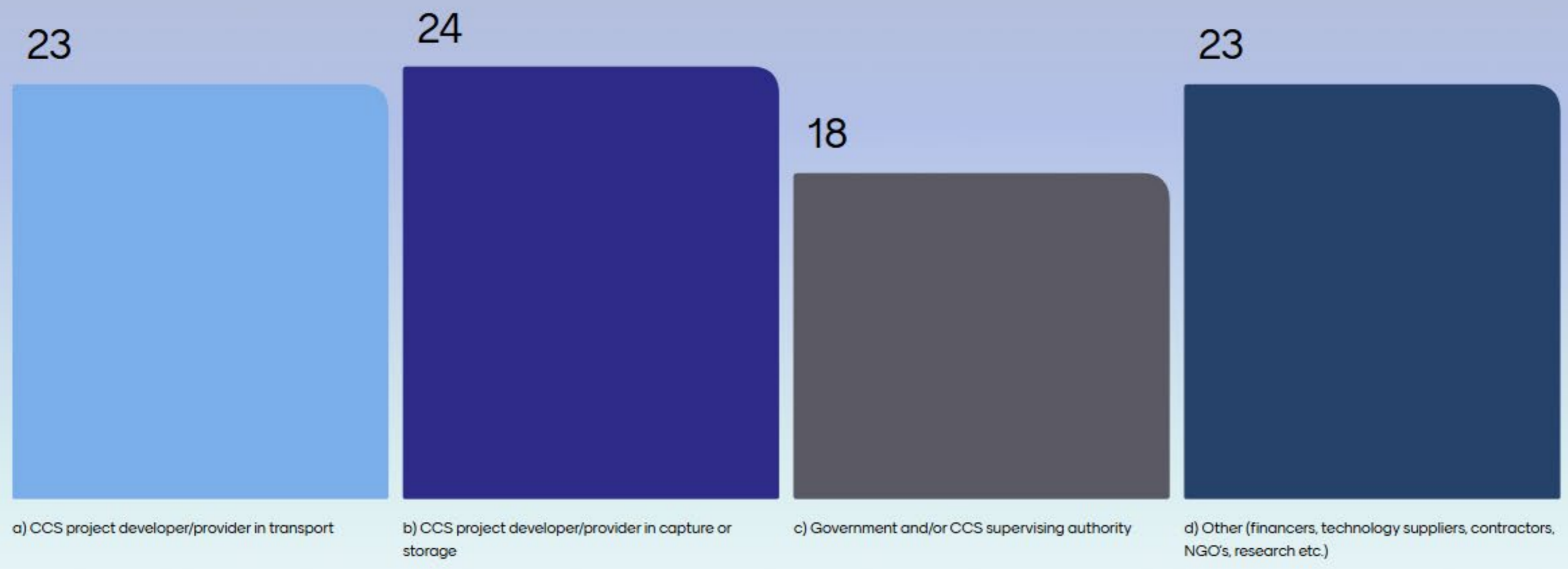
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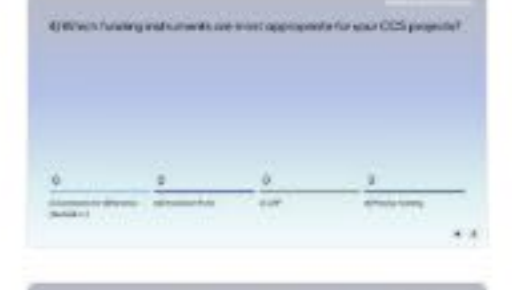
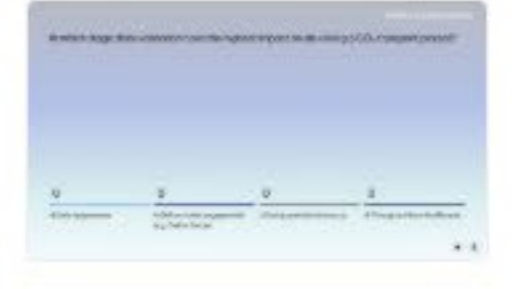
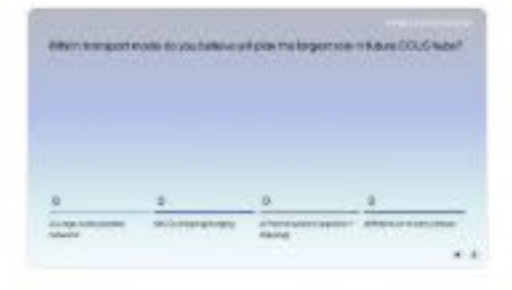
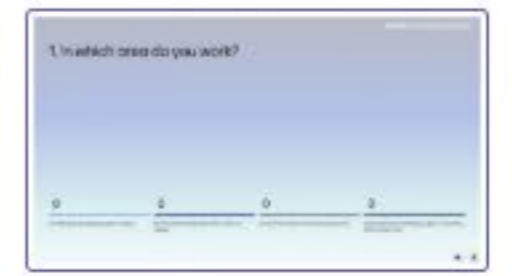
1. In which area do you work?



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Workshop #1 (Transport)

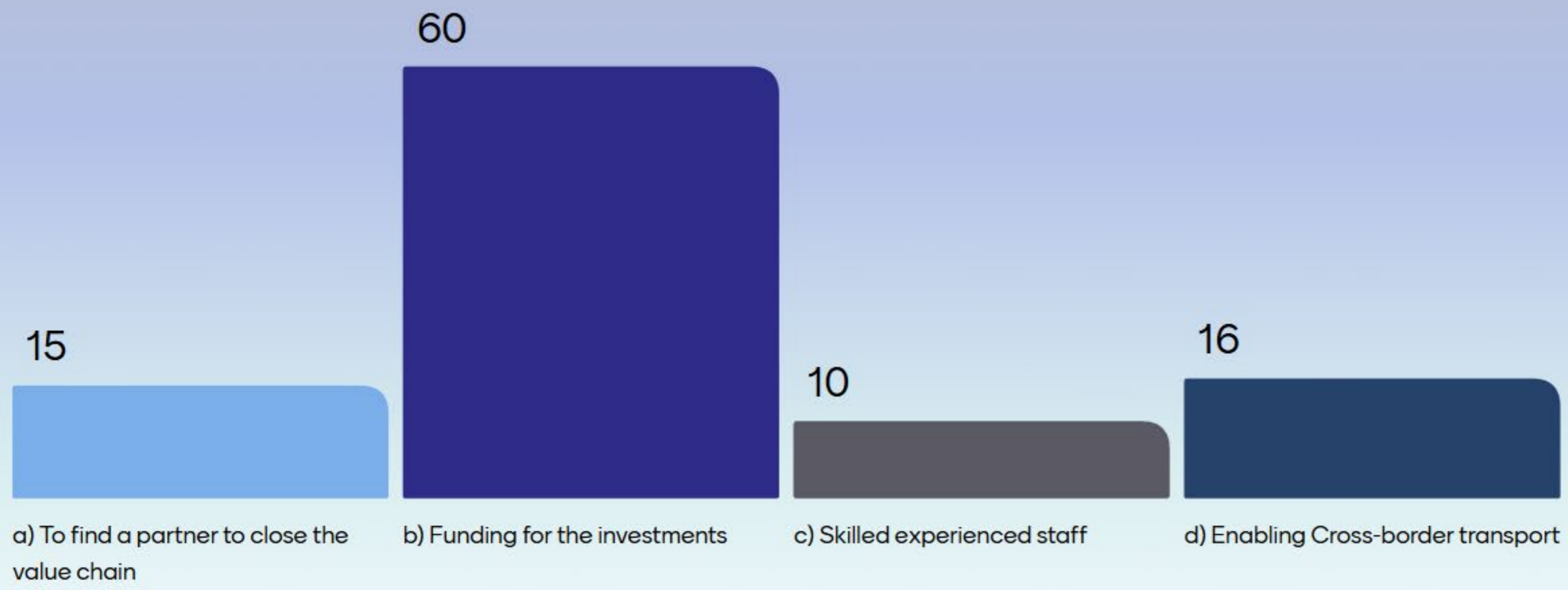
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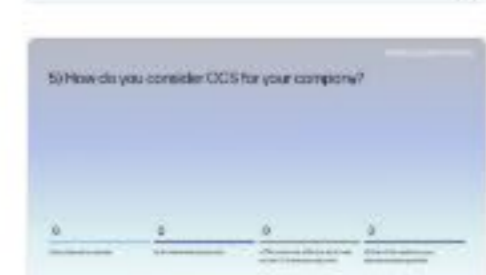
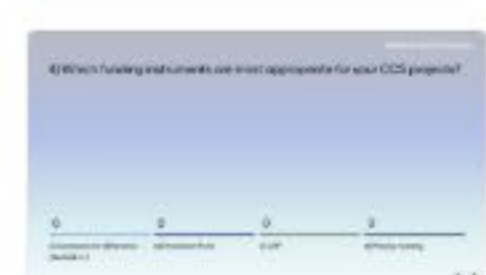
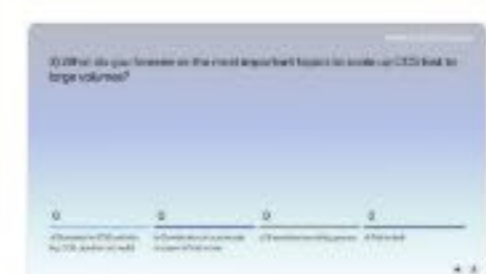
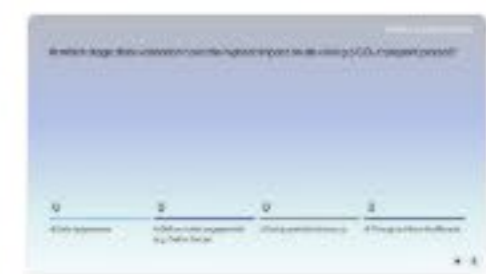
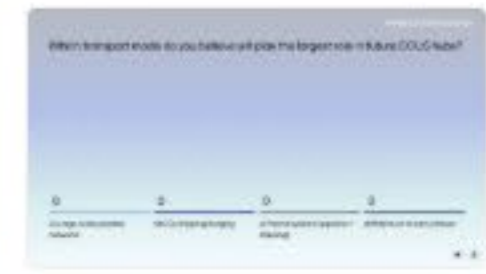
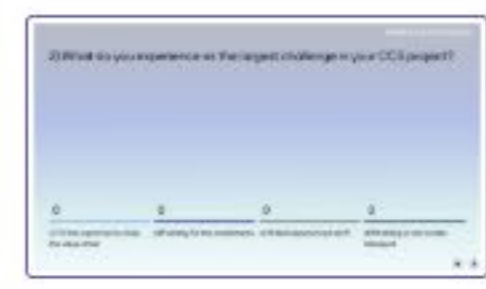
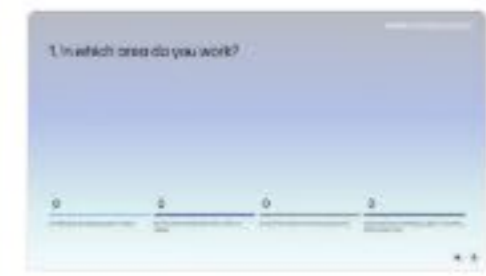
2) What do you experience as the largest challenge in your CCS project?



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Workshop #1 (Transport)

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Anil Erdoğan Basaran

Anil Erdoğan Basaran is CCS Project Manager at EBN, contributing to Aramis, an open-access CO₂ transport infrastructure connecting industrial clusters to offshore North Sea storage. Her work spans technical validation, commercial readiness, helping de-risk dense-phase CO₂ transport and support safe, reliable, scalable decarbonization for hard-to-abate industry.



Co-funded by
the European Union



ARAMIS

Workshop #01
From Validation to Delivery: De-risking CO₂ Transport
In Aramis

Sandefjord, 15 April 2026



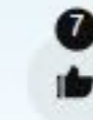
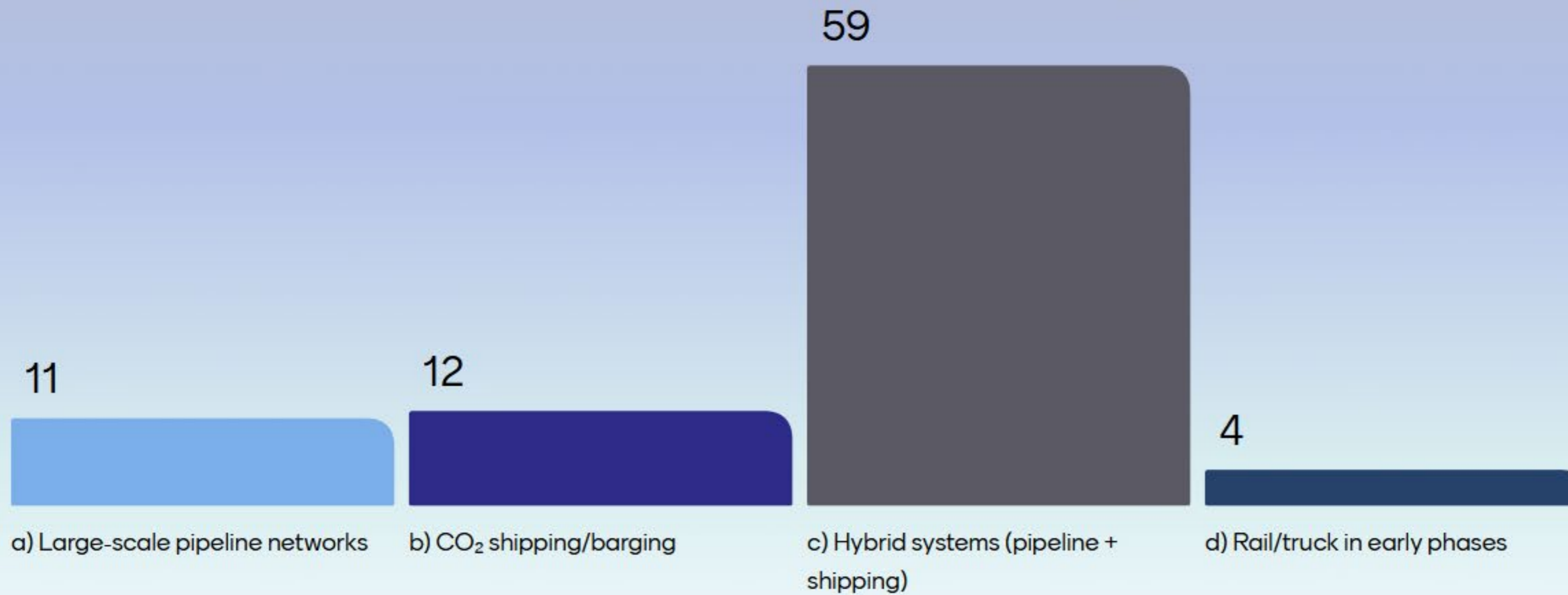
Anil Erdogan
Project Manager
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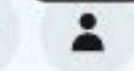
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Which transport mode do you believe will play the largest role in future CCUS hubs?



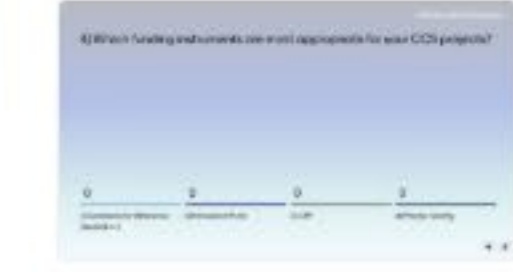
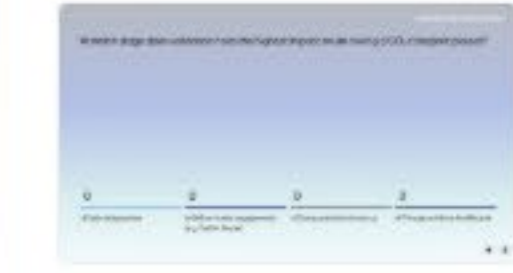
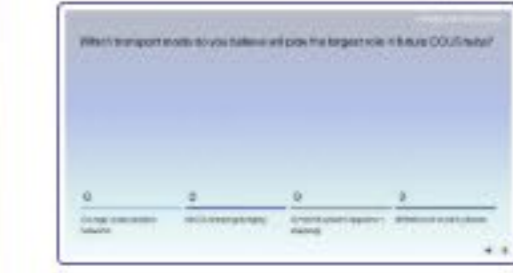
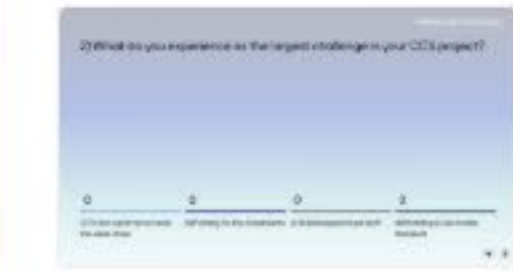
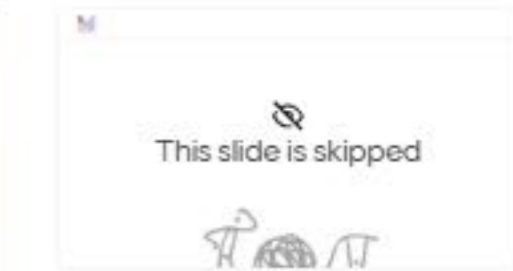
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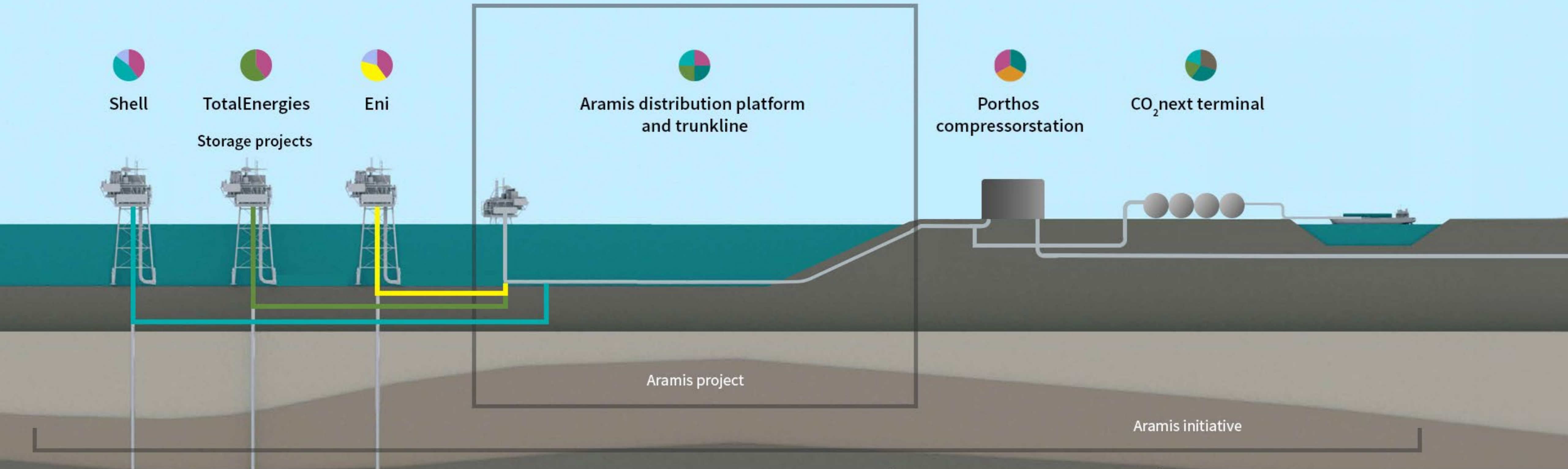
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Workshop #1 (Transport)

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ARAMIS INITIATIVE



ARAMIS INITIATIVE

The Aramis initiative focuses on creating a new infrastructure for the transport and storage of CO₂, from capture on land to storage in depleted offshore gas fields. The Aramis initiative includes the collaboration between six related CCS projects: the Aramis project (transport of CO₂), the expansion of compression capacity on the Maasvlakte of Porthos, the CO₂next project (liquid CO₂ terminal) and storage projects of Shell, TotalEnergies and Eni.

Partners



- EBN
- TotalEnergies
- Eni
- Vopak
- Gasunie
- Port of Rotterdam
- Shell
- Other

ARAMIS PROJECT

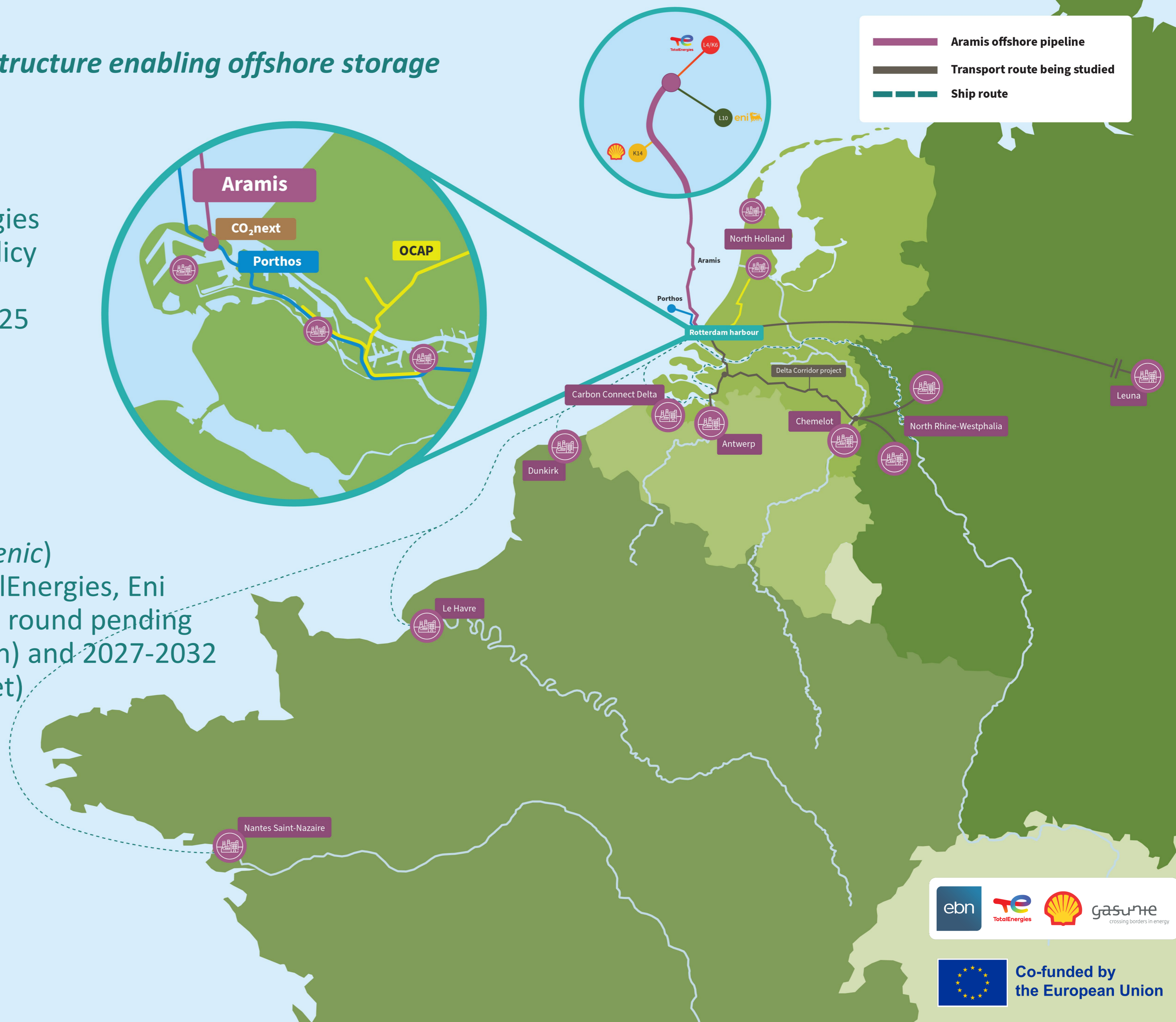
The Aramis project (EBN, Gasunie, Shell and TotalEnergies) focuses on the construction of an offshore pipeline from the Maasvlakte to the distribution platform in the North Sea. The Aramis project consists of the offshore pipeline and the distribution platform.

The partnership

- **Public private:** EBN, Gasunie, Shell and TotalEnergies
- Support from and in line with **NL Government** policy
- Value Chain Alignment is crucial
- Government announced **additional support** in 2025
- **Public ownership** infrastructure after FID

The project

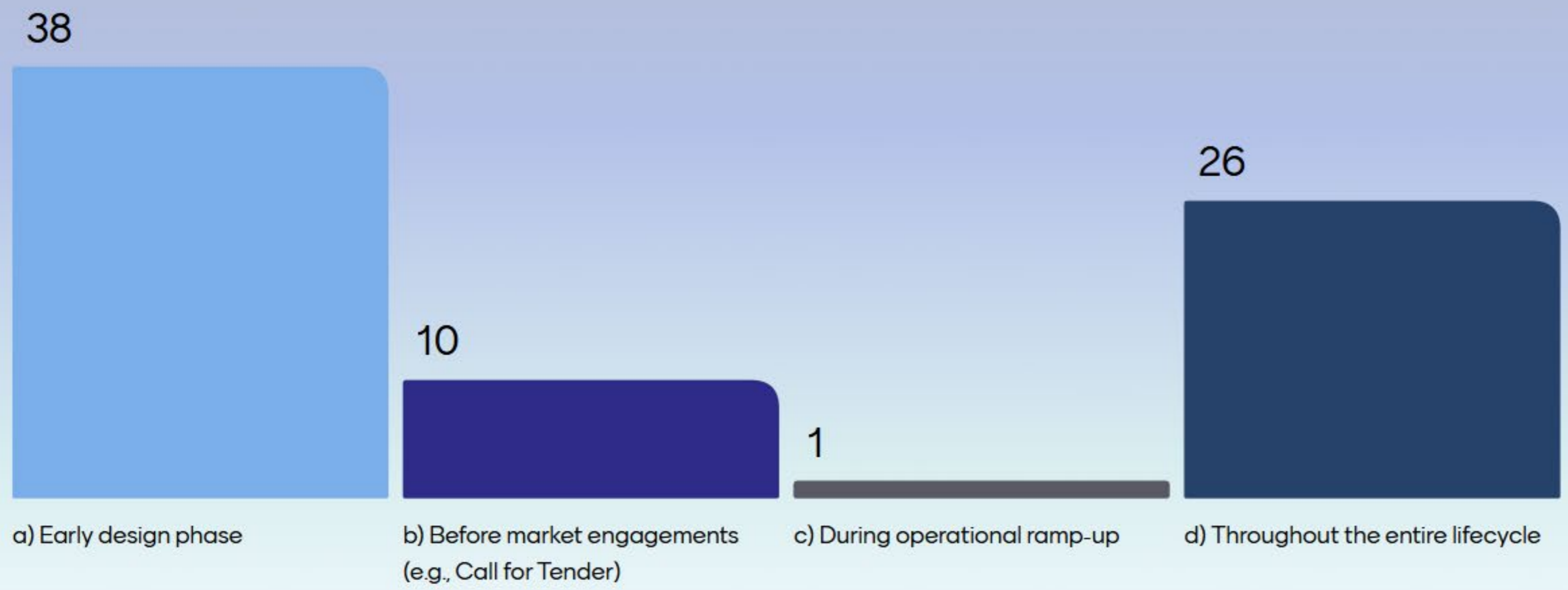
- Offshore pipeline capacity **22 Mtpa** (*dense phase*)
- Connected to **Porthos** (*gaseous*), **CO2next** (*cryogenic*)
- Offshore storage in **depleted gas fields** Shell, TotalEnergies, Eni
- Emitters have received **SDE++** in 2022-2024. 2025 round pending
- New SDE++ budget announced for 2026 (€8 Billion) and 2027-2032
- **Final permits** awarded in 2025 (not irrevocable yet)
- Working towards **FIDs in 2027**, operational **2030**



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At which stage does validation have the highest impact on de-risking a CO₂ transport project?



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Workshop #1 (Transport)

Select which slide to add

- This slide is skipped
- 1. In which areas do you work?
- 2) What do you experience as the biggest challenge in your CCS project?
- When transport mode do you believe will play the biggest role in future CCS hubs?
- At which stage does validation have the highest impact on de-risking a CO₂ transport project?
- 3) What do you consider as the most important factors for scaling up CCS to large volumes?
- 4) Which funding instruments are most appropriate for your CCS project?
- 5) How do you consider CCS for your company?

Why Aramis Conducted Full-Scale Running Ductile Fracture (RDF) Testing

Dense-phase CO₂ behaves differently from natural gas and requires dedicated full-scale validation to prove safe pipeline transport.

What the Full-Scale Test Confirmed

The Sardinia test demonstrated that the Aramis pipeline design naturally arrests fracture propagation, validating that pipeline integrity is maintained design conditions

Why This Validation Was Critical Before Tendering

Before issuing the Call for Tender (CFT) for linepipe (EU public tendering), Aramis needed to ensure that all design requirements were proven and validated. The RDF test results were therefore incorporated into the CFT documentation.



Aramis Running Ductile Fracture Test (April 2025) – RINA Site at Sardinia, Italy



Aramis Running Ductile Fracture Test – RINA Site at Sardinia, Italy



17 11 2025

ARAMIS OPENS TENDERING PROCEDURE FOR OFFSHORE PIPELINE

An important step in the development of the Aramis project was taken on 7 November 2025. As part of the EU tendering procedure and following a market consultation and a pre-announcement on 11 September 2025, EBN and Gasunie, as the future investors in the Aramis project, have opened the tendering process for the construction linepipe supply for the Aramis offshore pipeline and is inviting linepipe Suppliers to provide their bids. The 200 km Aramis CO₂ transportation pipeline, with a 22mtpa capacity, will connect the collection hub at the Maasvlakte to the offshore storage sites. It will serve as a crucial element in the development of the Aramis project and the further value chain, which intends to provide a decarbonization route via carbon capture, transport, and storage to hard-to-abate industries in the Netherlands, our neighboring countries and beyond.

Annemarie Manger, Program Manager Aramis: 'We are delighted that after extensive preparations by our project team and partners EBN, Gasunie, Shell and TotalEnergies we can go to the market and engage with the companies that will build the project and join forces in achieving this crucial North West European energy and industrial transition project. I'm proud of the efforts of our team, which will continue to work with our partners on opening further tenders as soon as possible.'

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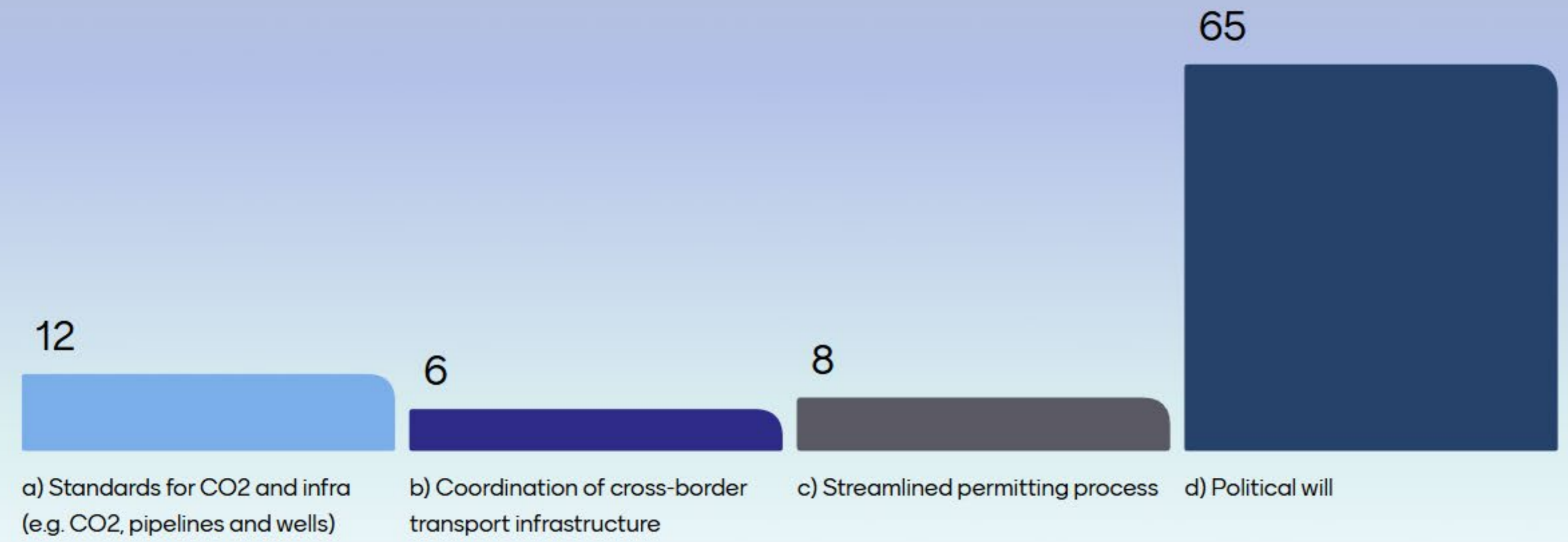
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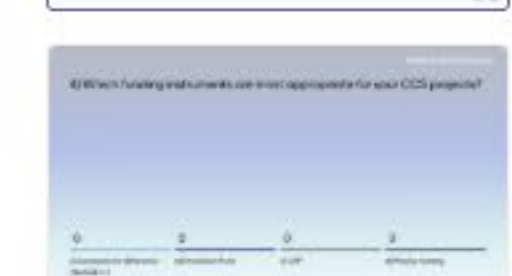
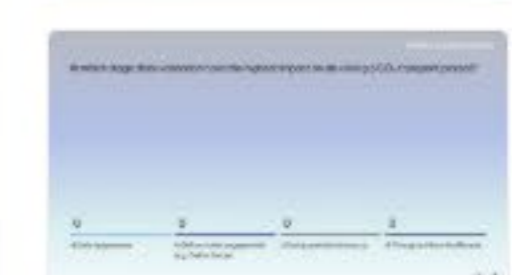
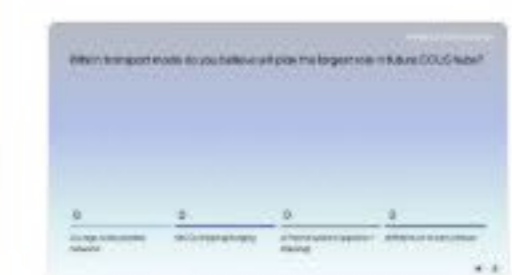
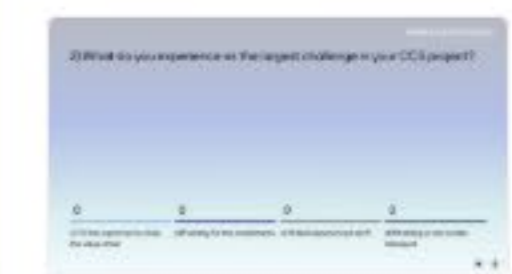
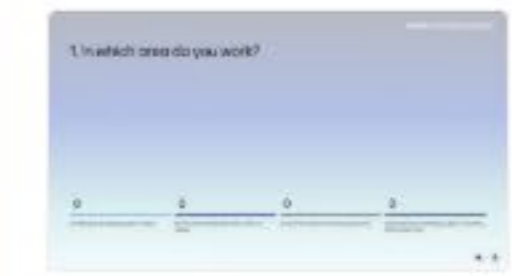
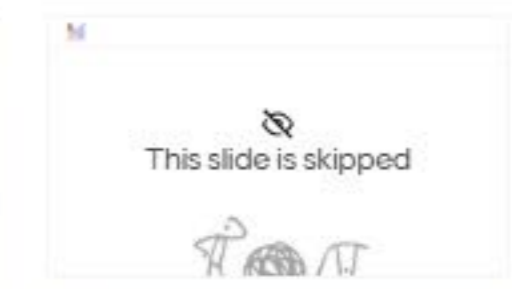
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3) What do you foresee as the most important topics to scale up CCS fast to large volumes?



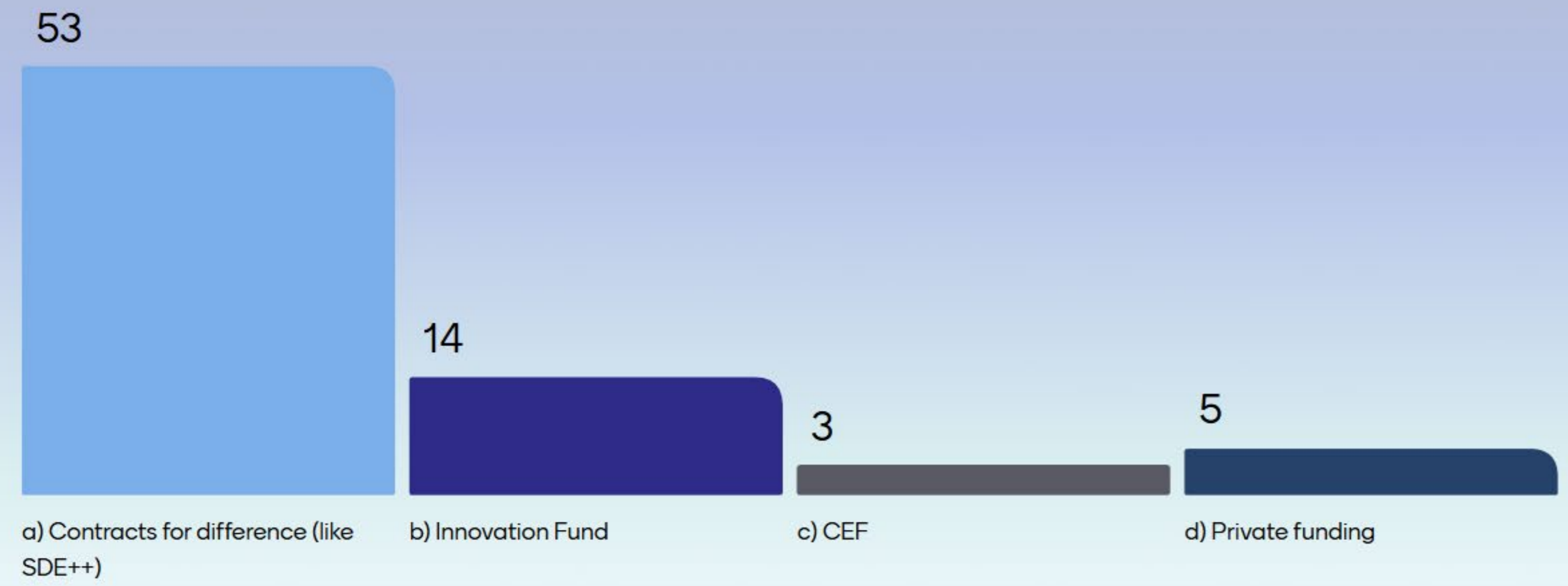
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4) Which funding instruments are most appropriate for your CCS projects?



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- 1. In which area do you work?
- 2. What do you experience as the biggest challenge in your CCS project?
- 3. Which transport mode do you believe will play the biggest role in future CCS hubs?
- 4. Which stage of the carbon capture process is the most important to develop in your CCS project?
- 5. What do you foresee as the most important factor to make an CCS that is large volume?
- 6) Which funding instruments are most appropriate for your CCS projects?
- 7) How do you consider CCS for your company?



Kleopatra Avraam

STRATEGIC PLANNING SENIOR DIRECTOR

DESFA

Kleopatra has been working in both the electricity and natural gas sector for the last 14 years mainly focusing on business development and business planning. Starting as an Energy Trader dealing with electricity transaction mainly between Greece and Bulgaria, she moved in the strategy team of the National Natural Gas Transmission System Operator (DESFA).

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Knowledge Sharing 2026 CCS&CDR Summit

APOLLOCO2 Project

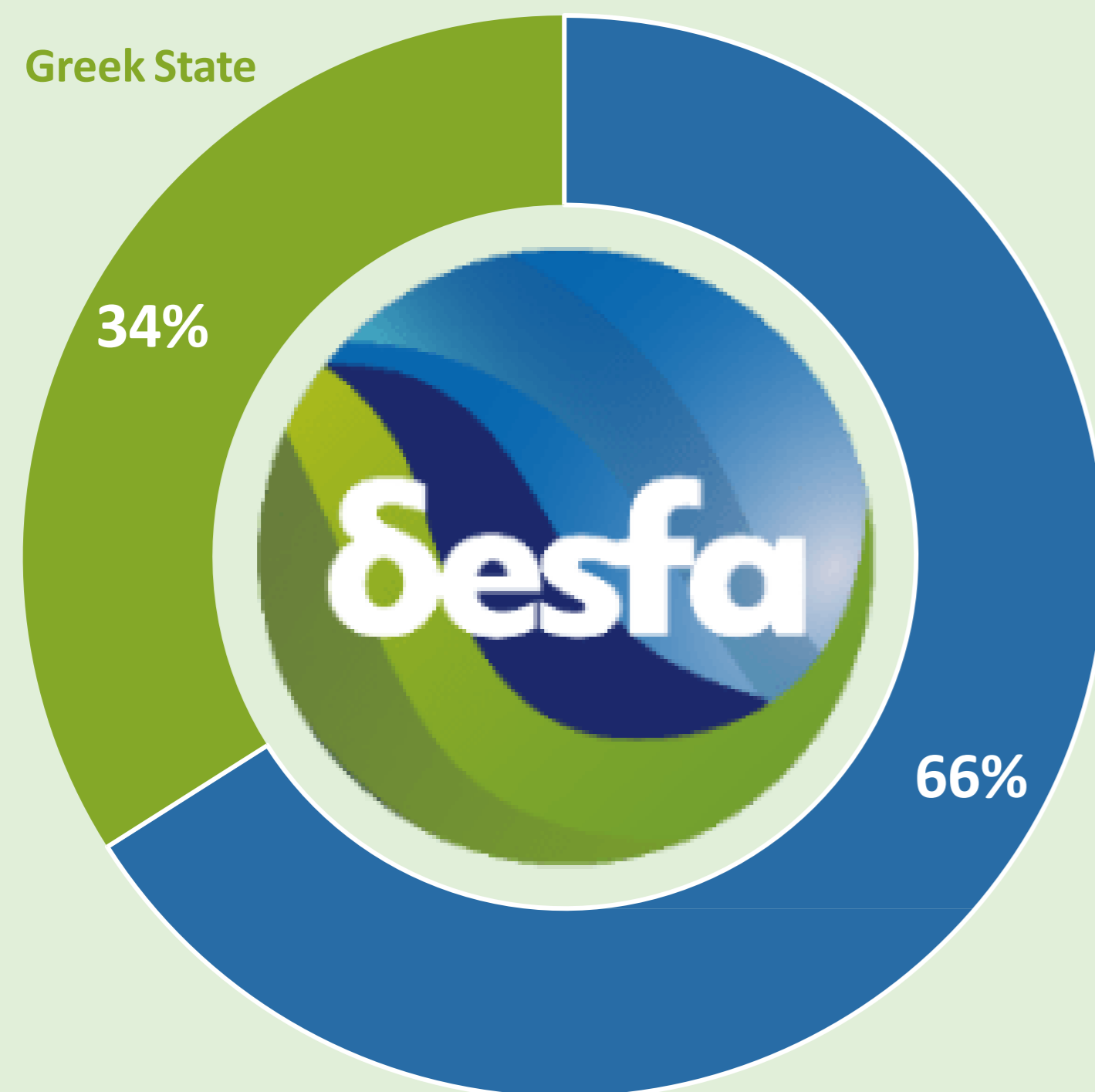
15 April 2026



DESFA counts over 18 years of successful operation



Greek State



Senfluga



Who is DESFA

DESFA

- Established in March 2007, DESFA owns & operates the Greek Natural Gas System (NNGS), which consists of the National Natural Gas Transmission System & the LNG Terminal in the islet of Revithoussa
- DESFA operates, maintains & develops the Greek NNGS in a safe, reliable, and economically efficient way, offering Third Party Access services in a transparent and non-discriminatory way, as well as a range of other services to a number of national & international clients
- DESFA holds a 20% stake in the Alexandroupolis FSRU Terminal (Gastrade) and a 7% stake in the Hellenic Energy Exchange (HEEx)

Milestones



DESFA focuses on three main pillars to address the existing challenges as well as to support EU succeeding in its climate targets



I Natural Gas

Security of Supply



DESFA is implementing a Development Plan with NG investments of utmost importance for Greece's establishment as a hub for the whole SEE Region

II CCS

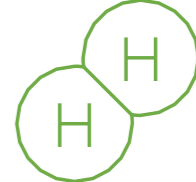
Affordability



DESFA focuses on being integral part and constituting a vital role of the development of CCUS business in Greece, activated in the transmission, liquefaction and storage part of the value chain

III Hydrogen

Sustainability

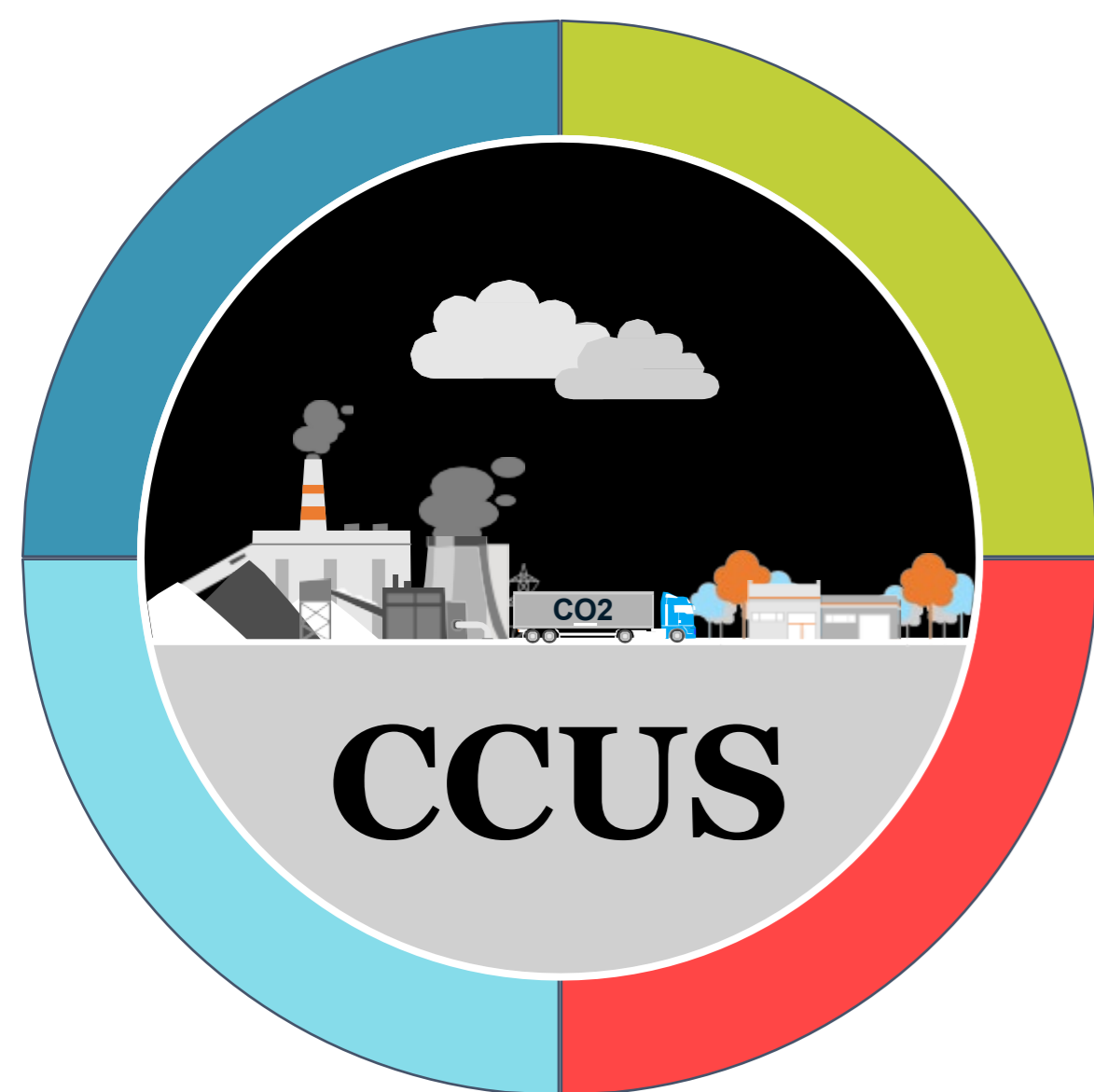


Based on EU targets, the Greek TSO has set as one of its main strategic goals the development of H₂ sector in Greece through the assessment of Smart Gas Grid and H₂ pipelines projects



Greece's CCUS Momentum: Positioning for a Low-Carbon Future

The accelerating CCUS momentum in Greece is translated through development in several factors



Stakeholders/ market

- Greek industrial emitters have progressed significantly with **the majority of the volumes located in Southern Greece**, where the Attica and Central Greece region concentrate ~15 MTPA
- Out of the total emissions, **~9 MTPA are envisaged to be captured out of which ~4.5 MTPA by 2035** coming from cement and refining sectors
- **Four CCS projects in Greece have received funding support from European Commission incl. DESFA's Project, namely APOLLOCO₂-LT**
- One of the Med-based storage facilities, Prinos, is located in Greece and is expected to operate by 2029 accommodating ~2.8 MTPA. The project has received grants of ~€150mn from RRF and ~€120mn from CEF

Policy

- The endeavor for the maturing and **development of the Greek CCS sector is included also in the recent Greek National Energy and Climate Plan** notably, APOLLOCO₂ along with the Prinos CO₂ storage initiative, underscoring the critical role of CCS in Greece's decarbonisation strategy
- The APOLLOCO₂ and Prinos CO₂ are PCIs, included in the latest PCI/ PMI list (number 13.11)

Regulatory

- **Greece published its dedicated CCS Law (5261/2025) on 12 December 2025**, establishing the country's first legal framework for CCS. This marked Greece's formal transposition of the EU CCS Directive and the launch of a comprehensive national regime for CO₂ storage.
- Furthermore, the secondary legislation that will govern CO₂ storage activity is approved in regards to tariff methodology, capacity allocation and market test

Partnerships

- **Greece has signed MoU with Egypt to promote strong and long-term ambition in the development of CCS sector**
- **Greece, Italy and France have developed a CCS cooperation framework through their PCIs to boost further the maturity of the sector**

Focusing on southern Greece, the Attica region includes ~9 MTPA of industrial emissions, however additional capacity besides Prinos will most likely be required

BUBBLES SIZE INDICATIVE

Northern Greece cluster 1.5 – 2 MTPA

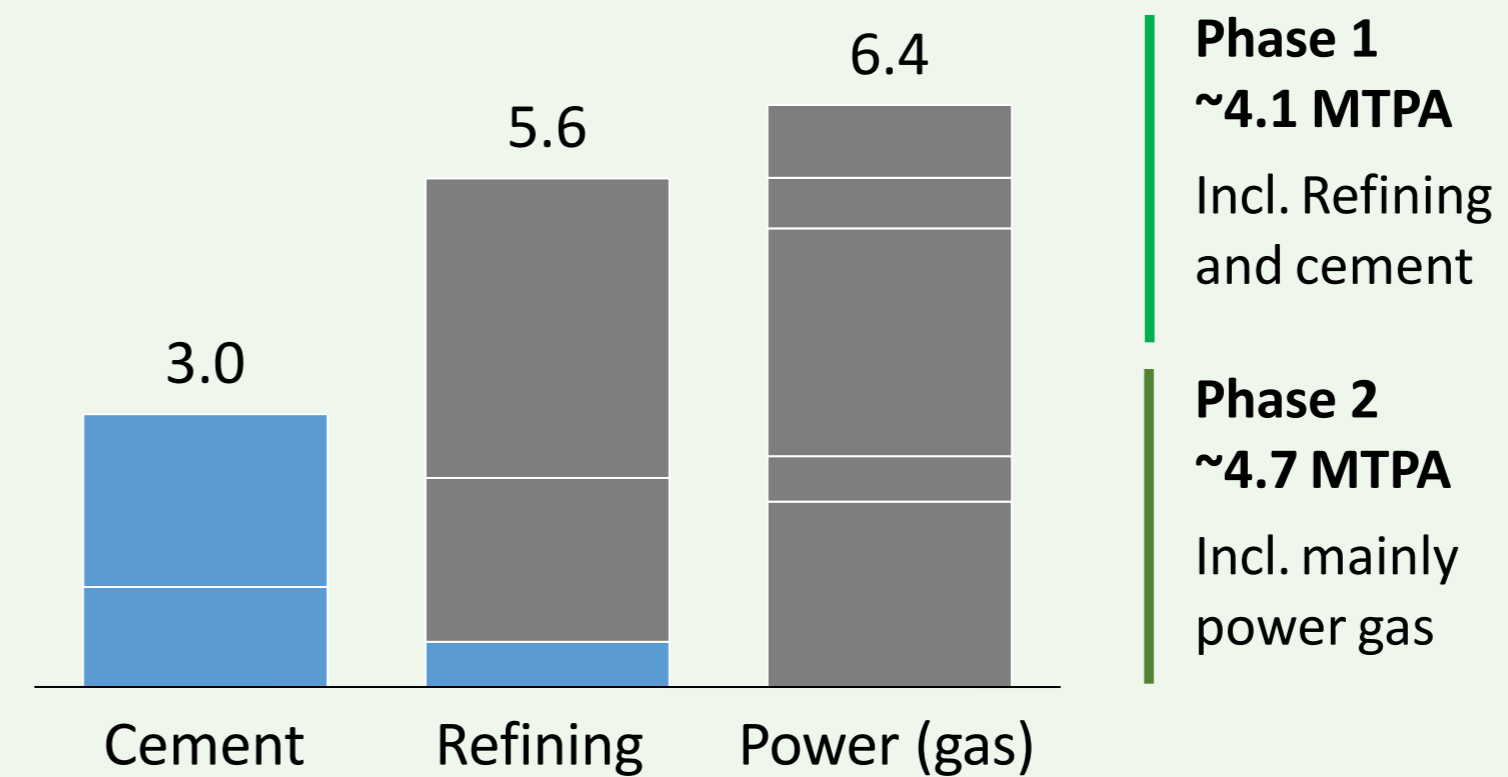
B

A

Attica and Central Greece cluster 5 - 10 MTPA

Industries ○ Refining ○ Cement ○ Power-Gas ■ Emissions for which EU IF grant was awarded

Attica and central Greece cluster emissions, MTPA

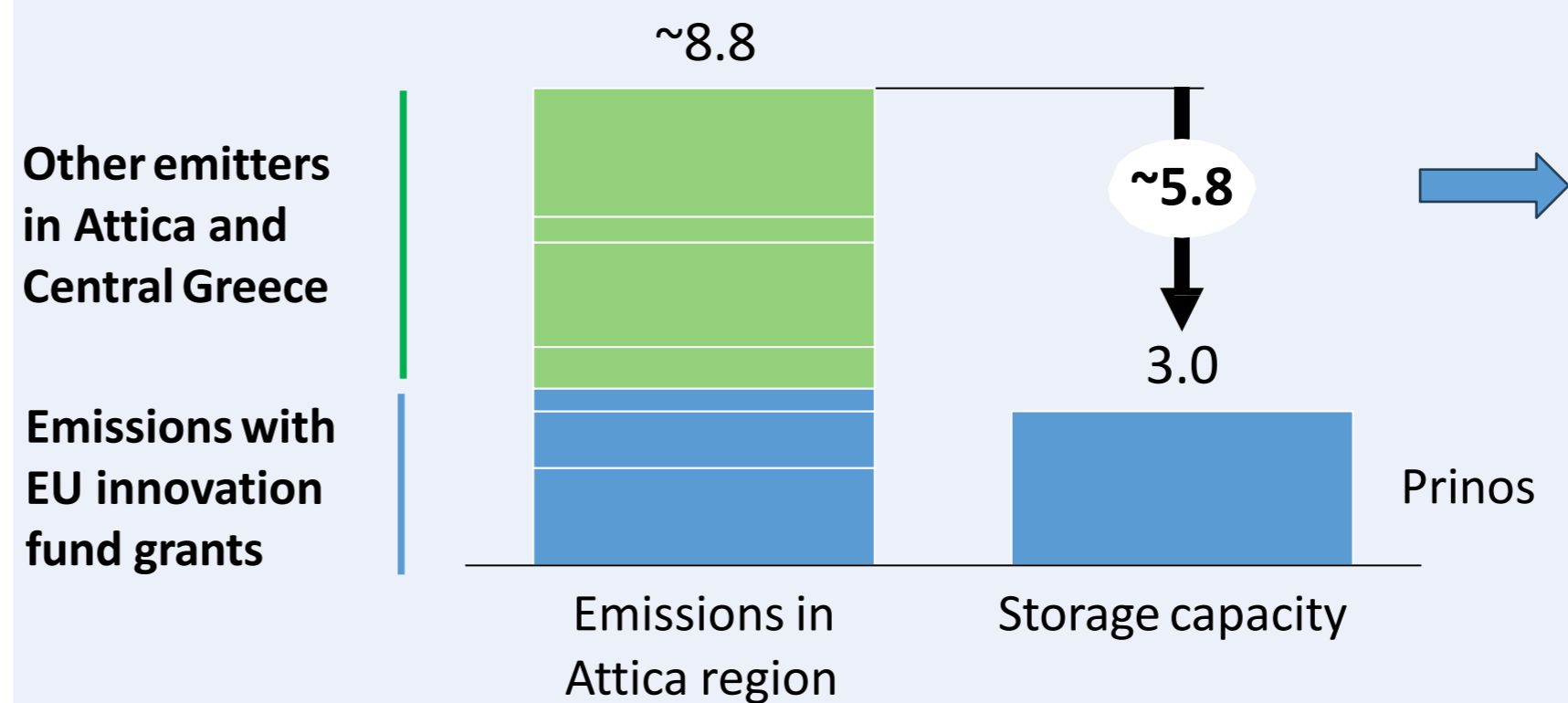


Phase 1
~4.1 MTPA
Incl. Refining and cement

Phase 2
~4.7 MTPA
Incl. mainly power gas

Out of the total emissions ~8.8 MTPA to be captured

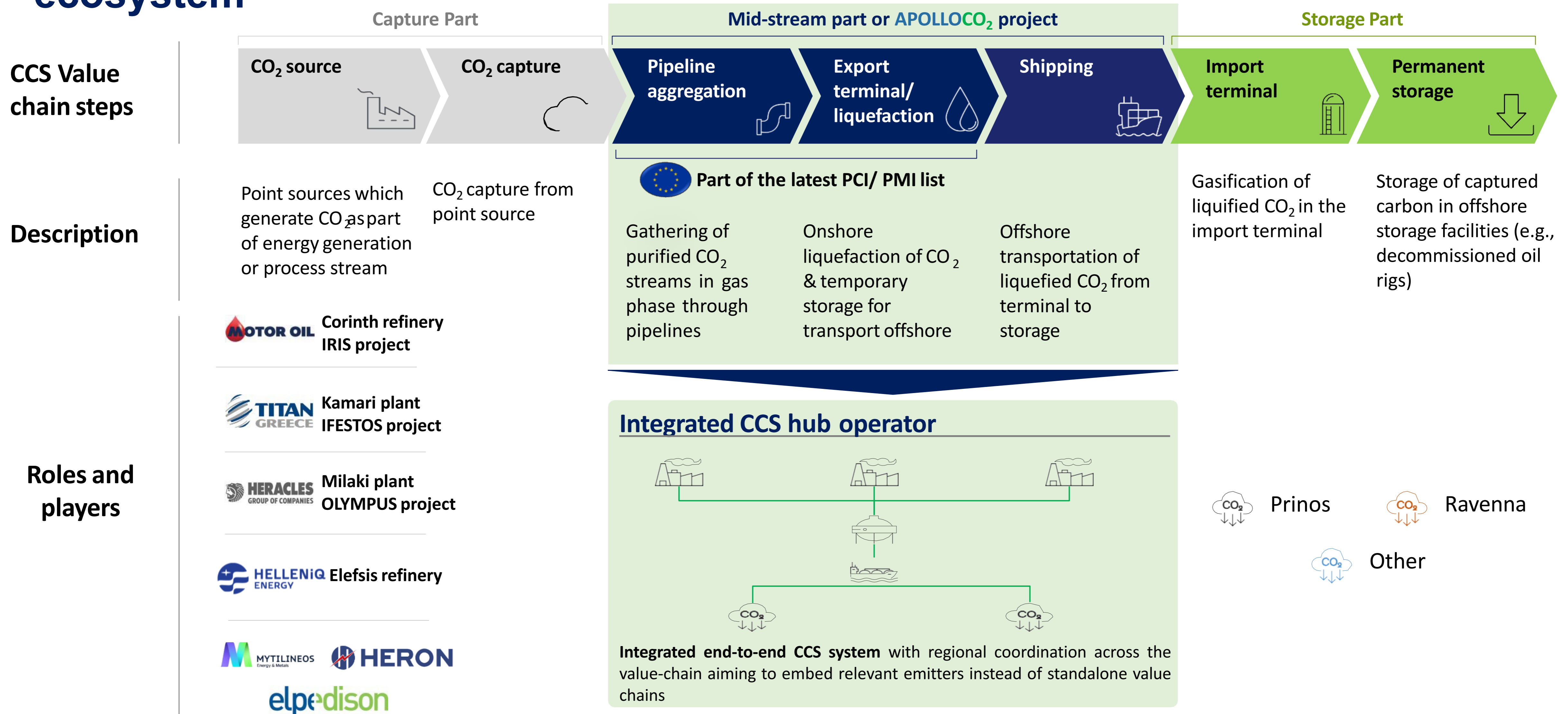
Emissions and sequestration capacity in Greece, MTPA



Indicative **storage shortfall** of up to ~5.8 MTPA

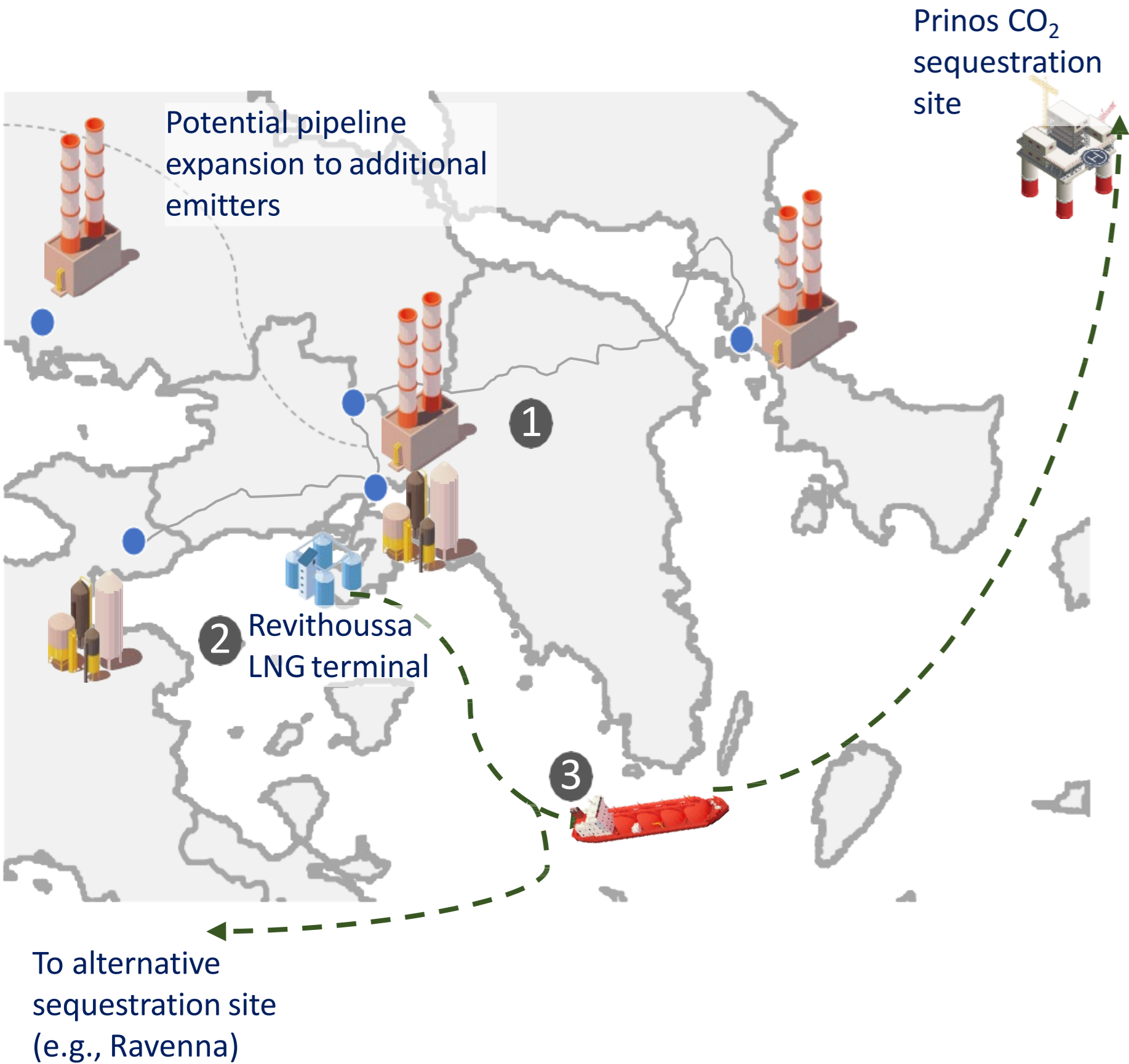
Alternative storage options will need to be unlocked

In line with Greece's climate targets and through APOLLOCO₂ project, DESFA takes the opportunity to orchestrate the midstream part of CCS ecosystem



APOLLOCO₂ stands as the first midstream aggregation CCS project in Southern Europe

APOLLOCO₂ CCS hub schematic



Details of core value-chain assets

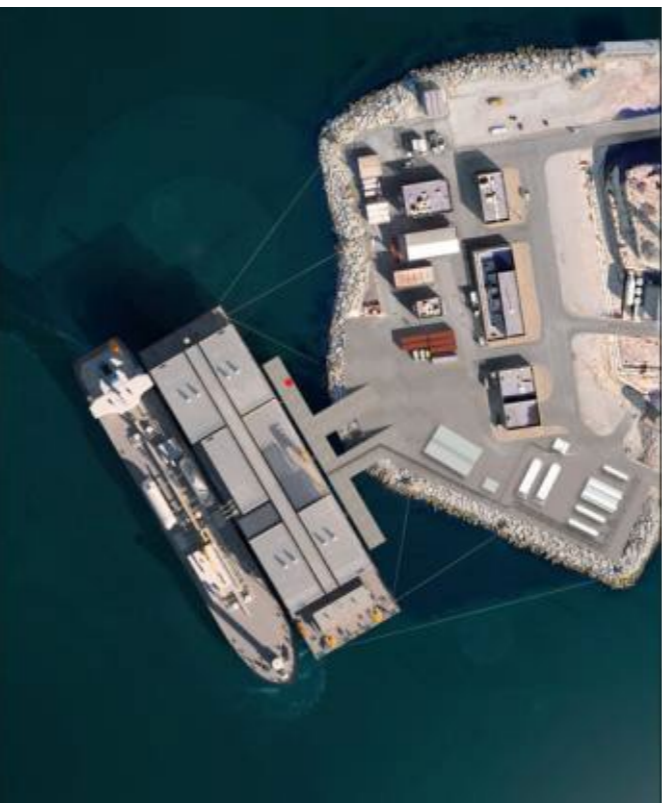
1 Pipeline network to integrate key emitters in South Greece (APOLLOCO₂ PL)

- Gradual development of the network starting from Attica and Voiotia and expanding further to Central Greece
- FEED already finalized and ESIA submitted for approval



2 CO₂ liquefaction facility with synergies with Revythoussa LNG terminal (APOLLOCO₂-LT)

- Scalable solution (3+2 MTPA) able to accommodate several emitters in alignment with the pipelines
- The facility will include an onshore and an offshore part i.e., FLSU for the temporary storage and back-up liquefaction of the CO₂
- ApolloCO₂ – LT was submitted and awarded appx. 170mn EUR grant within the 2024 Innovation Fund call



3 Large-scale liquid CO₂ vessel

Project aspiration

≈9 MTPA CO₂

~3 MTPA in Phase 1

~5 MTPA in Phase 2

>10

participating companies

Project of  common interest

Awarded Innovation Fund

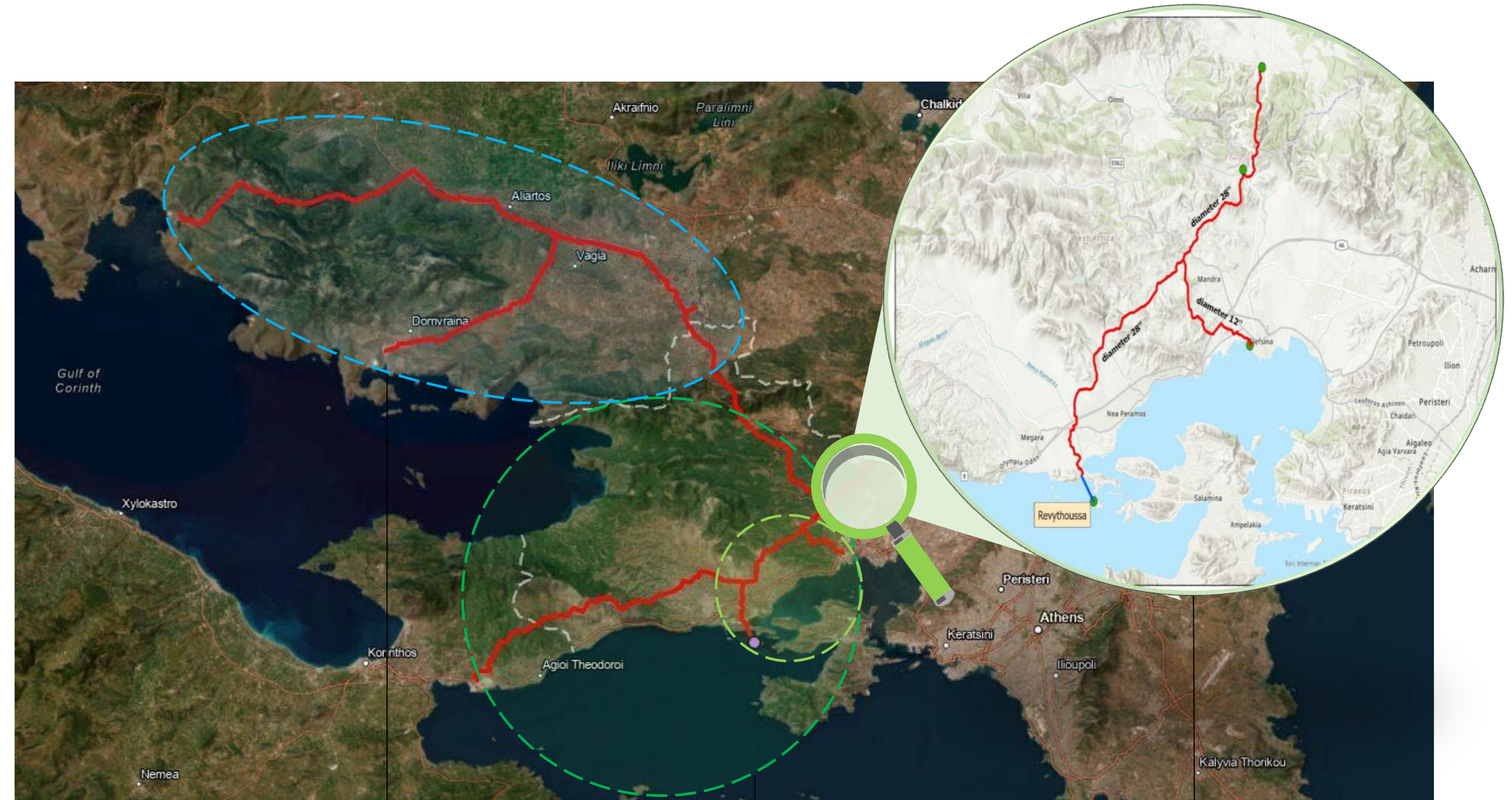
Basic design of the pipeline element of the project has already been developed



Main technical characteristics of CO₂ pipeline network

- Total network length of **215km**
- **Gaseous pipelines**
- Mainly **parallel to natural gas pipeline**
- **Pipeline diameter 12" – 28"**
- Maximum technical capacity: **10 MTPA**
- Inlet pressure apprx. **30 barg**

- The ESIA for the pipelines is expected to be submitted by September 2025



Phase 2: Viotia region

Phase 1: Attica region

Phase 1 mature emitters to start operations by 2030

APOLLOCO₂-LT
area



APOLLOCO₂ - LT onshore element components

Inlet gas CO₂

Heat exchangers



APOLLOCO₂ - LT offshore element components

CO₂ Storage Tanks
Cargo Containment System

Topside

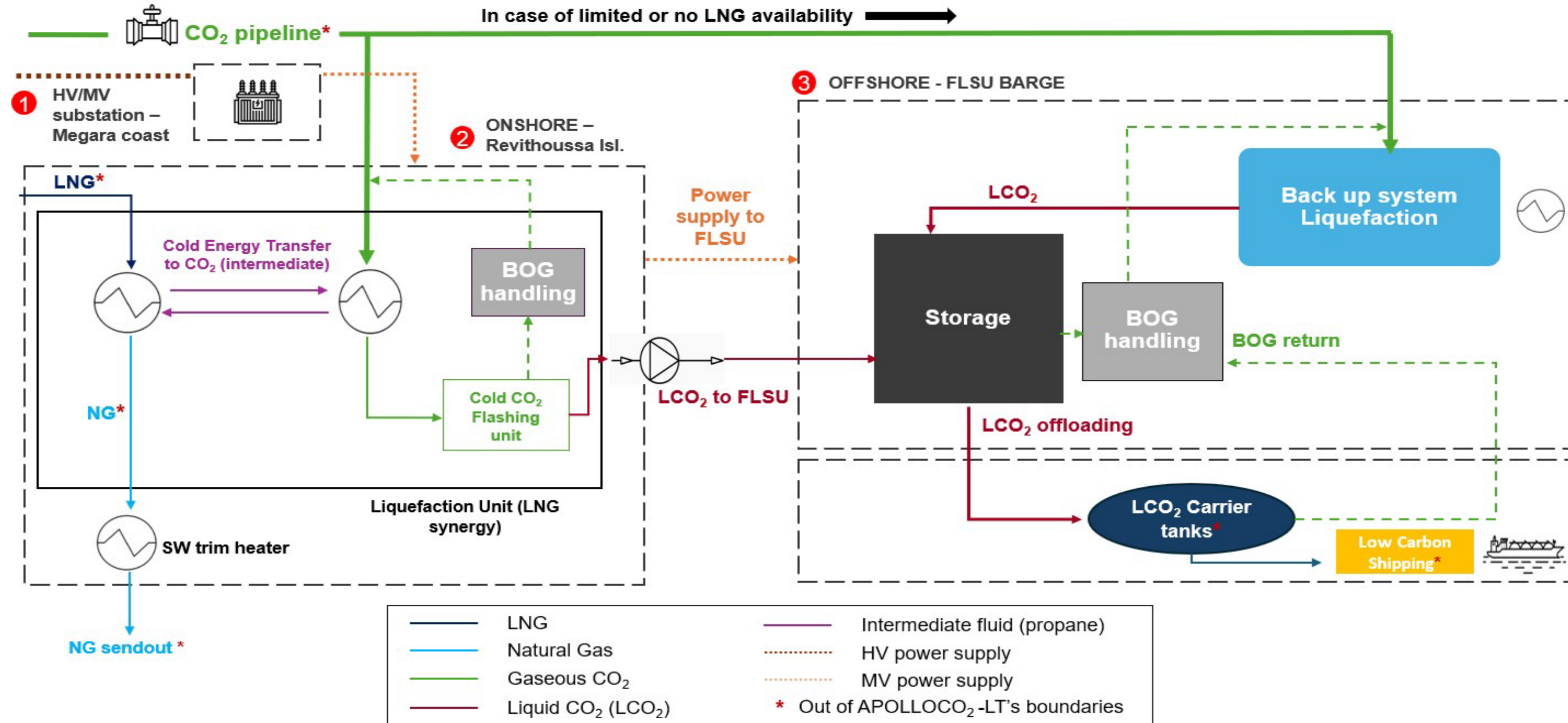
Hull



In a nutshell, designing a liquefaction terminal that ensures innovation, cost efficiency and reliable supply

TECHNICAL DESIGN





APOLLOCO₂-LT



CO₂ Liquefaction using LNG Cold Energy onshore Revithoussa island with offshore installation for backup liquefaction & temporary storage

ONSHORE ELEMENT

Context

- Innovative low-pressure liquefaction process followed through the installation of heat exchanger system
- This process exploits the cold energy available from the adjacent LNG regasification unit to pre-cool the CO₂.
- Two trains of 1.67 MTPA each are planned to accommodate 3 MTPA capacity
- Propane will be used as intermediate fluid with its vaporisation absorbing the necessary heat from the CO₂.
- Inlet Design conditions:
 - CO₂  P 20 - 30bar, Temp >15 °C
 - LNG  P 67bar, Temp – 150 °C
- Outlet Design conditions
 - LCO₂  P 6 – 8.5bar, Temp -42 °C
 - NG  P 65bar, Temp > 5 °C
- The design allows for a capacity expansion of 2 additional MTPA with relevant investment. The components of this future expansion have already been considered and included in the design of the infrastructure.

OFFSHORE ELEMENT

CO₂ liquefaction process

Hull

- The barge is designed as double hull construction, with a design that includes four CO₂ cargo tanks in different compartments under deck
- Length 150m, breadth 44m, depth 21m, draught 21m; no accommodation considered onboard
- Permanently moored

Storage Tanks

- FLSU capacity of 30,000m³ consisting of four LP tanks each having capacity of 8,350 m³

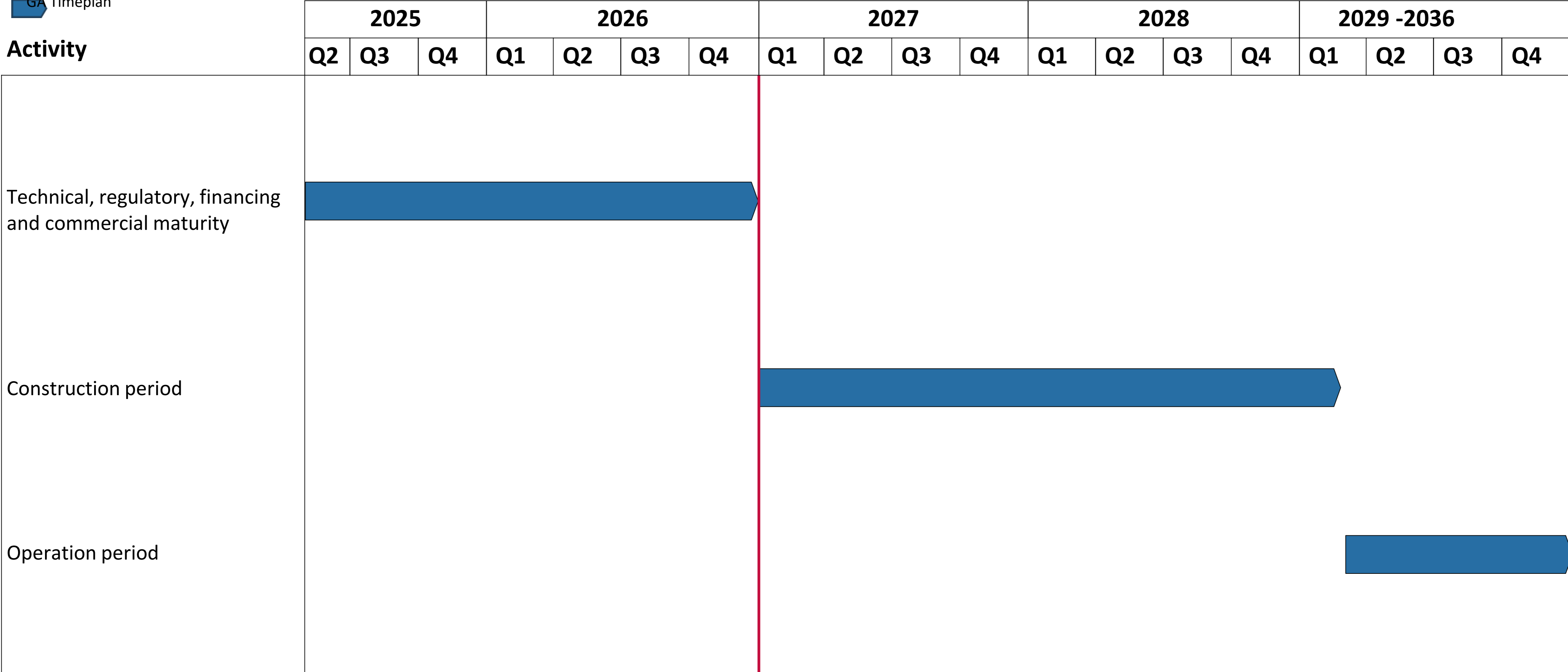
Topside

- Independent refrigeration system onboard FLSU allowing the continuous operation of the terminal
- Trains set-up: 3 x 1MTPA (+ 2 x 1 MTPA provisioned for the potential upgrade of the terminal's capacity to 5 MTPA)
- Several refrigerants (acting intermediate fluids similar to the onshore configuration) are considered; to be finalized during FEED phase

APOLLOCO₂ Timeplan as of the GA



GA Timeplan



DESFA FID

CCS Law Provisions (Law N. 5261/2025)

1	Due to RRF’s deadline expiring in the end of the year, the draft law focuses on regulating the CO2 underground permanent storage
2	Regulates the transportation of CO2 via pipeline; still needed (i) a ministerial decision for the issuance of the transportation license and(ii) RAAEY’s decision for the issuance of the CO2 network code and tariff regulation
3	Transportation of CO2 via pipeline qualified as a regulated activity
4	CO2 liquefaction definition is included, which provides consistency with the rest of the CCS value chain
5	State aid to bridge the financing gap of CO2 transportation grid, subject to EU clearance; no further information is foreseen about the form of the aid
6	Activities of CO2 transportation, liquefaction, and storage carried out within the Hellenic Republic are of public interest; this will facilitate the pipeline routing and licensing procedures for the implementation of DESFA’s project

Thank you !

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Funded by the European Union
Emissions Trading System
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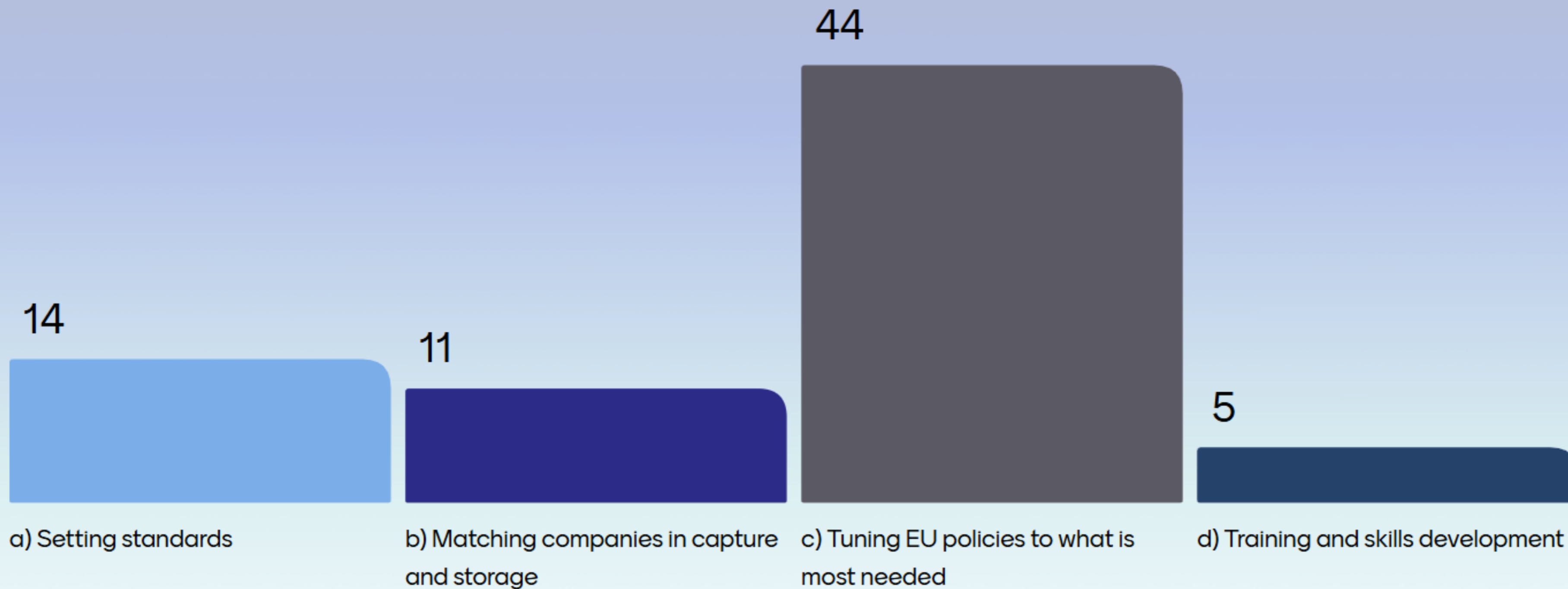
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6) Where should authorities and state owned enterprises focus on?





Fred Lockwood

PRESIDENT

OCEOS (AIR LIQUIDE)

Fred Lockwood is President of OCEOS, an Air Liquide/Sogestran joint venture focused on CO₂ shipping and barging for CCUS projects across Europe. Previously, at Air Liquide, he was deeply involved in the initial technical and commercial development of Cryocap™ technology. He also led the LNG product line within Air Liquide's Engineering division.

GASSNOVA 



CO₂ shipping and barging - key considerations in project development

Gassnova Knowledge Sharing Summit 2026

Fred Lockwood, President - OCEOS



Contents

1. Who is OCEOS?
2. Air Liquide & CO₂ capture
3. Keys for successful project development
4. Conclusions

Complementary partners



- **Industry leader in CO₂ processing technologies**
- **Track record in managing major industrial innovation**



- **Leader in maritime and inland transport of high value added goods**
- **Track record of transport of gas & chemicals for O&G majors**



Sogestran Group

- Founded in 1948, **HQ in Le Havre France**
- Owns and operated a **fleet of Maritime vessels** including tanker units carrying a range of **complex/high value added goods** (CPPs, DPP, hard chemicals..)
- **>160 inland barges** carrying a range of complex/high value added goods (LNG, chemicals, bitumen..)
- **Strong track record** with O&G majors
- **Track record and appetite** for innovation



Innovation and expertise

Proven track-record of transporting complex products

- Very cold - LNG
- Very hot - Bitumen
- Very corrosive - Hard chemicals



Innovating for cleaner ships

- Wind assisted propulsion
- Hybrid electric - dieselship
- H2 fueled barges
- Bio fuels



Leveraging AL know-how for OCEOS

**Deep experience in CO2 capture,
processing & liquefaction**



**Materials selection, welding, CO2 loading &
unloading, terminal interfaces**

**Turbo-Brayton
Advanced technology for ships**



**Development of advanced liquefaction
systems in a marine environment**

Air Liquide Cryocap™ technologies

More than 20 years of legacy & learning

Conceptual Studies



GREEN SMR TF
CRYOCAP™ H2

2006



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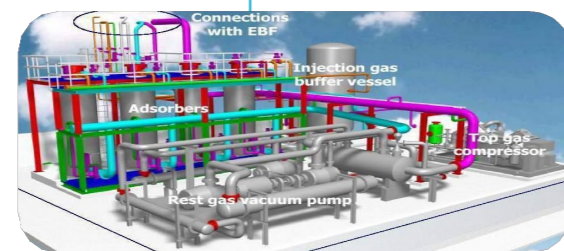
Individual Technology Testing



SBS 2
75 tpd CO₂
Dust filtration



TOTAL LACQ
240 tpd CO₂
Dryers



MEFOS PILOT 70 tpd CO₂
CRYOCAP™ Steel

2008

Comprehensive Pilot testing



CALLIDE
75 tpd CO₂
CRYOCAP™



CIUDEN
200/10 tpd CO₂
CRYOCAP™ Oxy

2012

Operating Plants



PORT JÉRÔME
300 tpd CO₂
CRYOCAP™ H2

2015



STEELANOL
800 tpd CO₂
CO2 PSA

2025



GRAND PUIITS
340 tpd CO₂
CRYOCAP™ H2



ERAMET Saouda
1 tpd
CO2 PSA

Under Execution



PORTHOS
1,700 tpd CO₂
CRYOCAP™ H2



Stockholm Exergi
3,500 tpd CO₂
CRYOCAP™ LQ



SMR - Korea
CRYOCAP™ H2

A unique, world-first cryo carbon capture plant in operation - Port-Jerôme, France



Machines

- 8 stages centrifugal compressor
- Advanced control to manage and smoothen fluctuations from PSA tail gas pressure
- Very reliable compressor
- First major maintenance 8 years after FIP

Driers

- Moisture removal down to 1 ppmv
- Advanced control to manage fluctuations
- No noticeable ageing
- No replacement over years

Cryogenic section

- Operation close to the triple point
- Advanced control to manage fluctuations
- 99.5% CO2 purity stable
- No incident in operation, no freezing

Membranes

- Boosted H2 recovery (+13%)
- No noticeable ageing
- No replacement over years

10 years of successful operational experience benefiting all Cryocap™ projects

Keys for successful project development

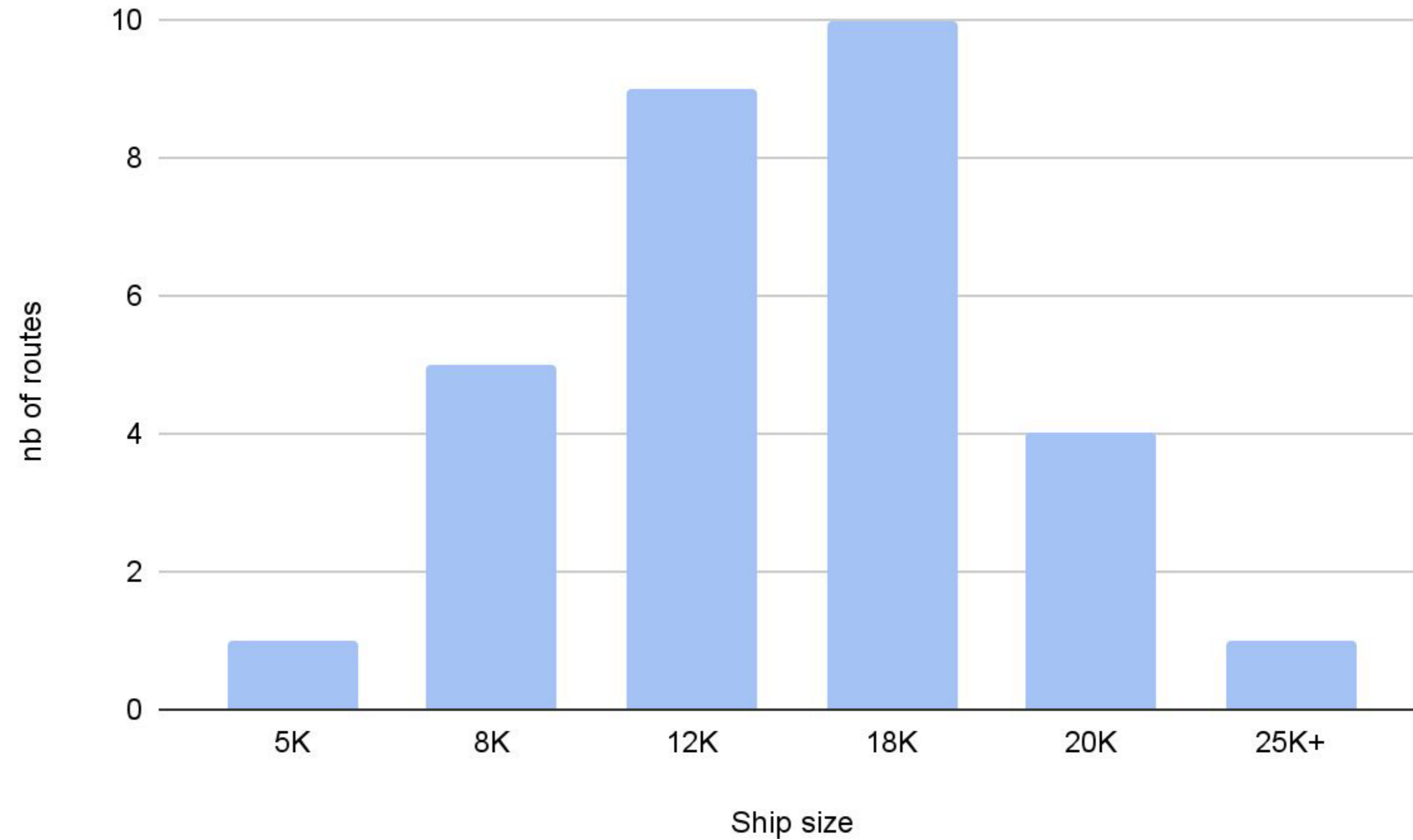
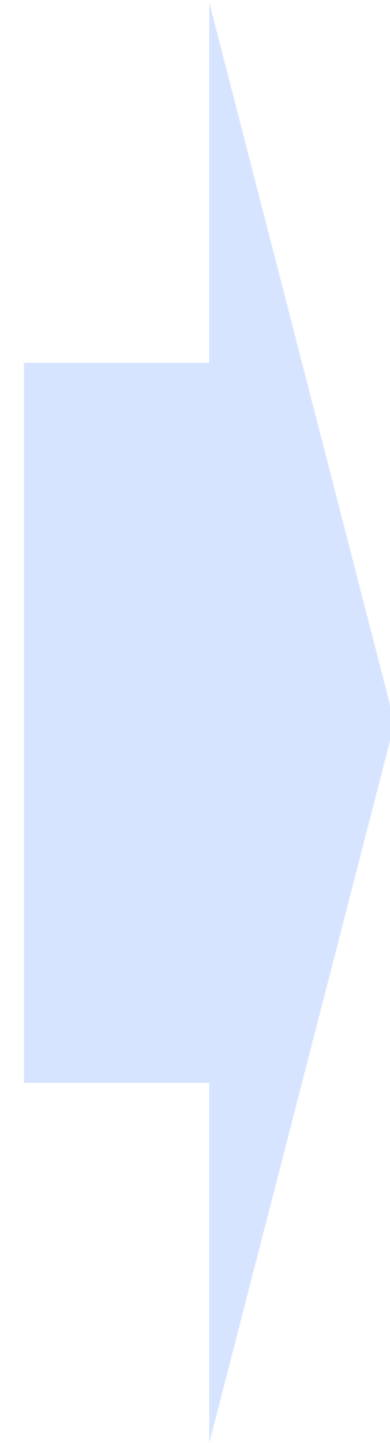
Collaborate early

Collaborate across the chain



Collaborating early - which ship size?

OCEOS experience from working on >20 CCS projects across Europe



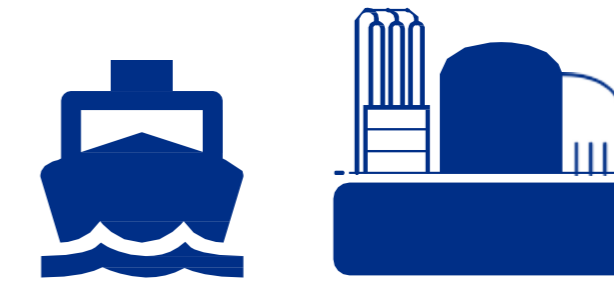
**One size fits all doesn't work...
Early collaboration necessary to find the right one**

Collaborating early - Technology robustness



Cargo tank design & manufacturing

Cargo tanks are critical and still limited suppliers with references/know-how. Qualify them early.



Terminals

Interface reviews with terminals - don't wait until after FID or FEED



CO₂ Purity

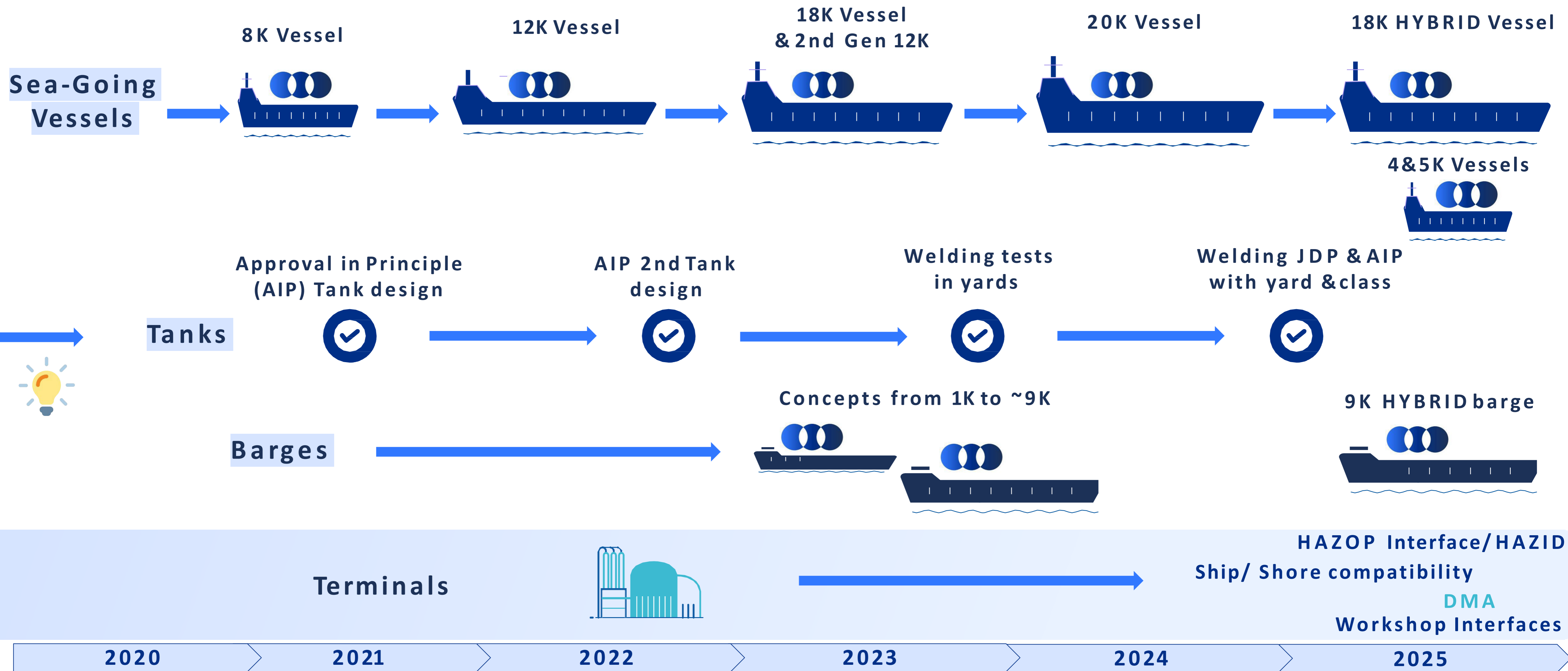
Liquid purity and gas constraints and impacts at each step of the chain to be shared early.



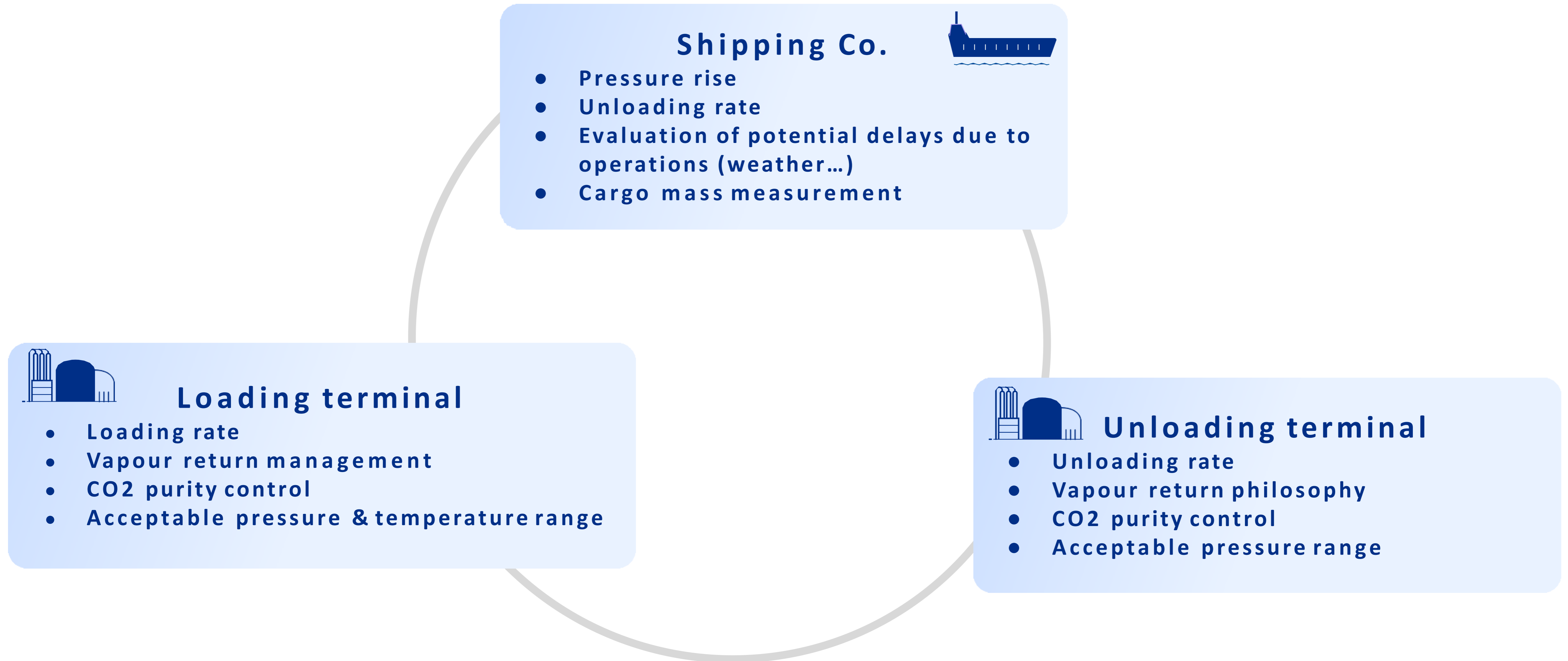
Pressure

Discussions across the chain to determine pressure regime (LP/MP/EP as early as possible)

OCEOS Technology development focus



Collaboration along the chain



Collaborating early & across chain - Contracts

Technical specificities

LNG/LPG contracts require significant adaptation for LCO₂.



Liabilities

Managing new risks.

Project maturity

Defining technical annexes and contractual consequences when terminal designs are not yet finalised...

**Contracts on FOAK projects take time
Start early!**

Conclusions



**CCUS Projects are like a large puzzle.
Not easy but doable and easier if you start early and
collaborate.**

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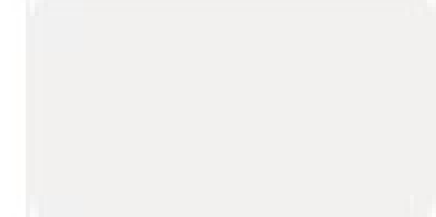
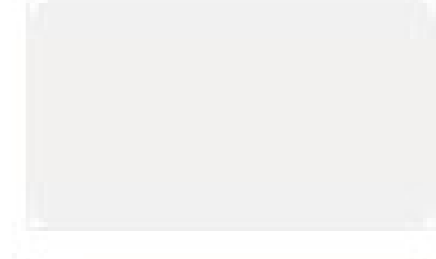
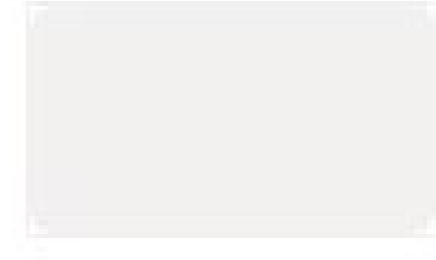
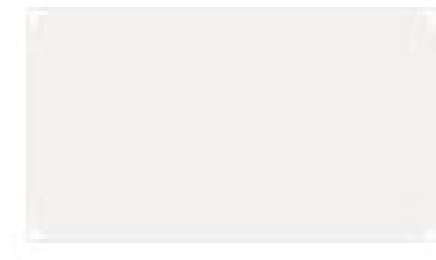
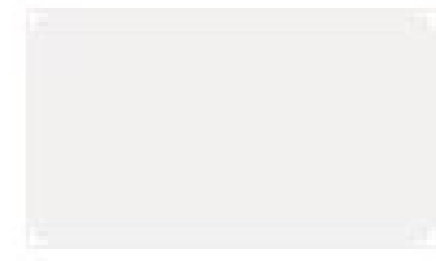
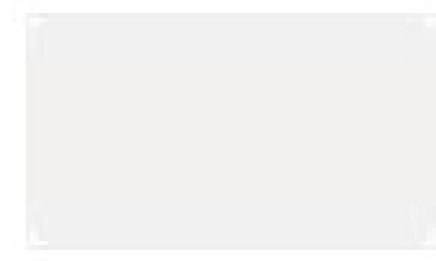
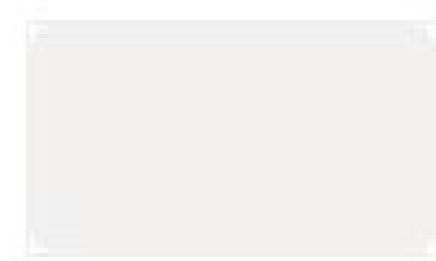
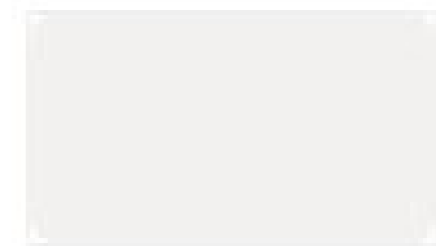


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Workshop #1 (Transport)  

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