Carbon Capture:
evoluzioni e tecnologie
per la decarbonizzazione.

Tecnologie di Carbon capture: risultati, studi di fattibilità, applicazioni e usi della CO_2

Filippo Lossani – Director

Rome, 27 November 2023

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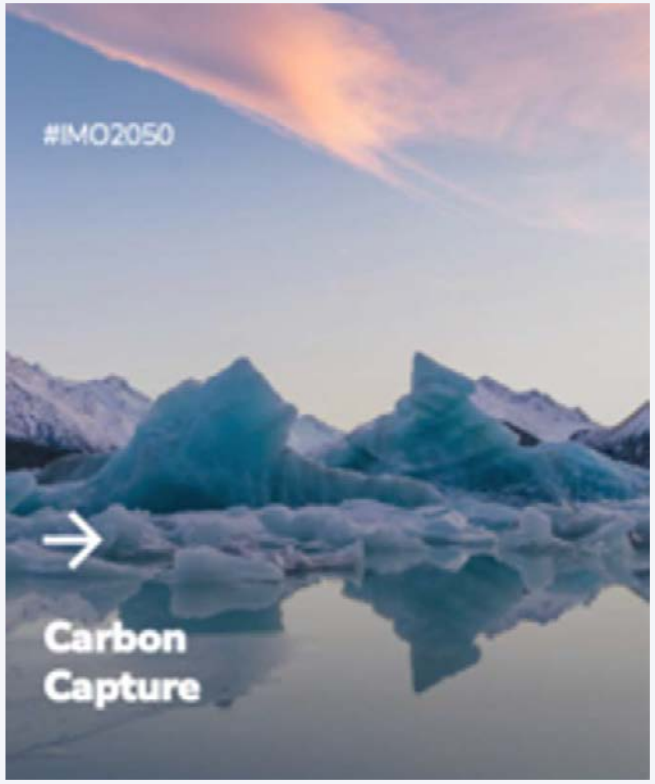
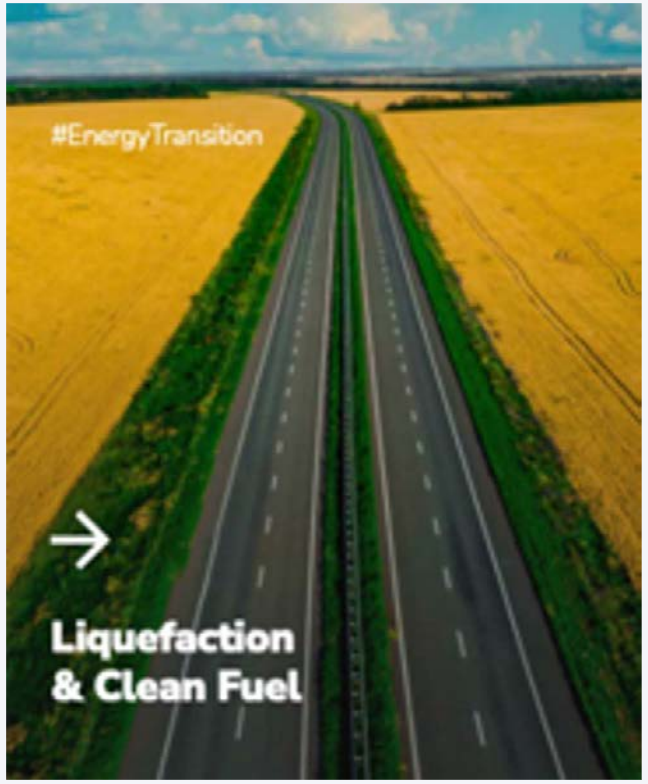
with you for a Zero Emission 2050





… get ready for **decarbonization**

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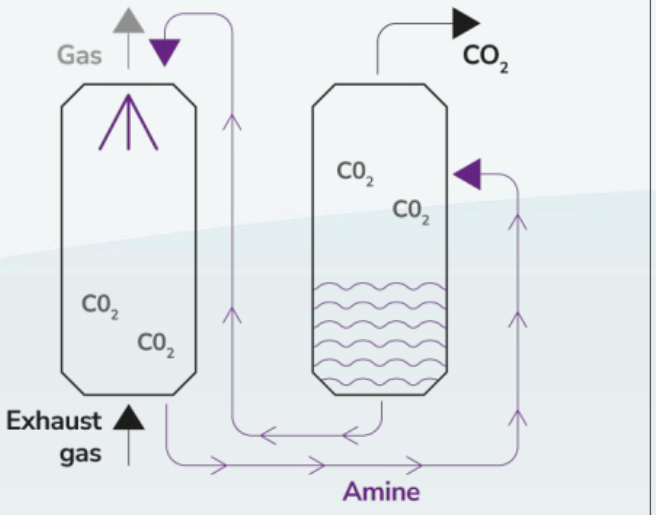
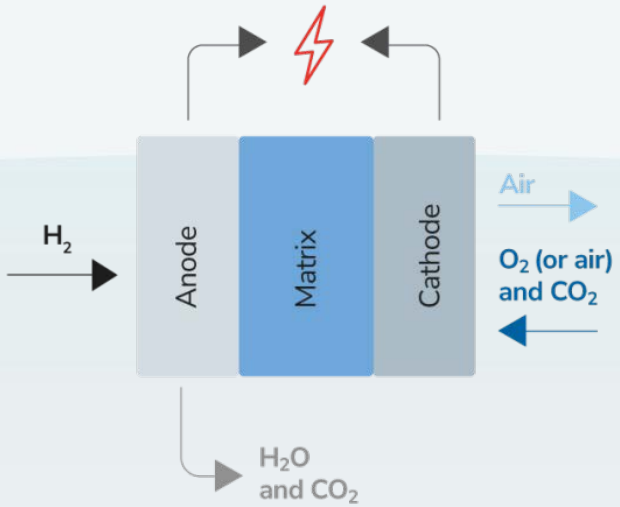
our **Carbon Capture** technologies

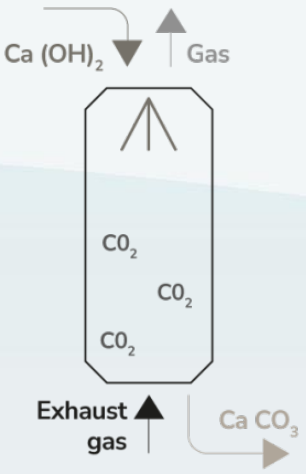
Amines



MCFC



$Ca(OH)_2$



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Road to 2050

Amines and Lime milk-based Carbon Capture pilot plant

Assembling & testing

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Road to 2050 stories

Pilot plant target:

- Verify the process and the selected component when operating in real environment
- Deeply understand the reagent behavior: a finer characterization leads to a better system operation, maximizing the efficiency
- Better understanding of the pilot plant CO_2-capturing limits, defining the best operating conditions

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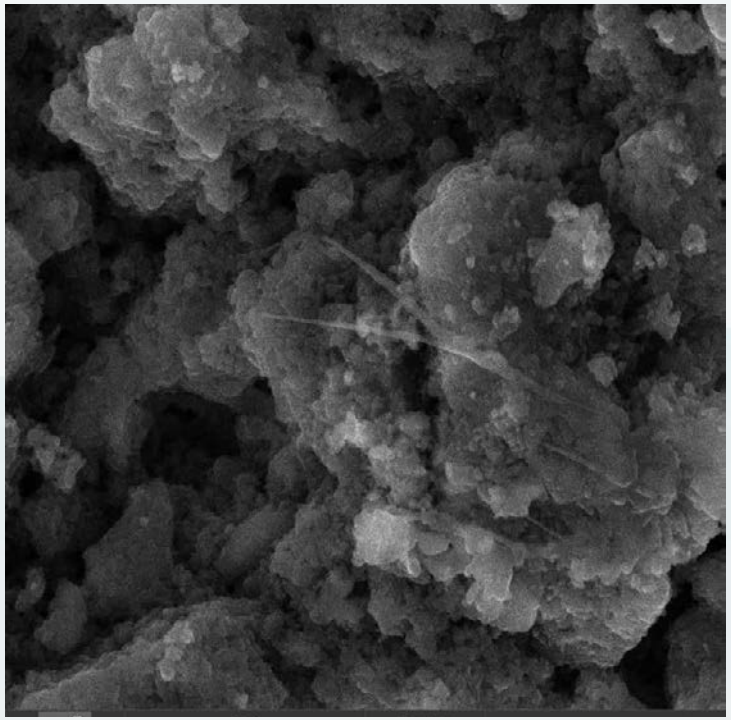
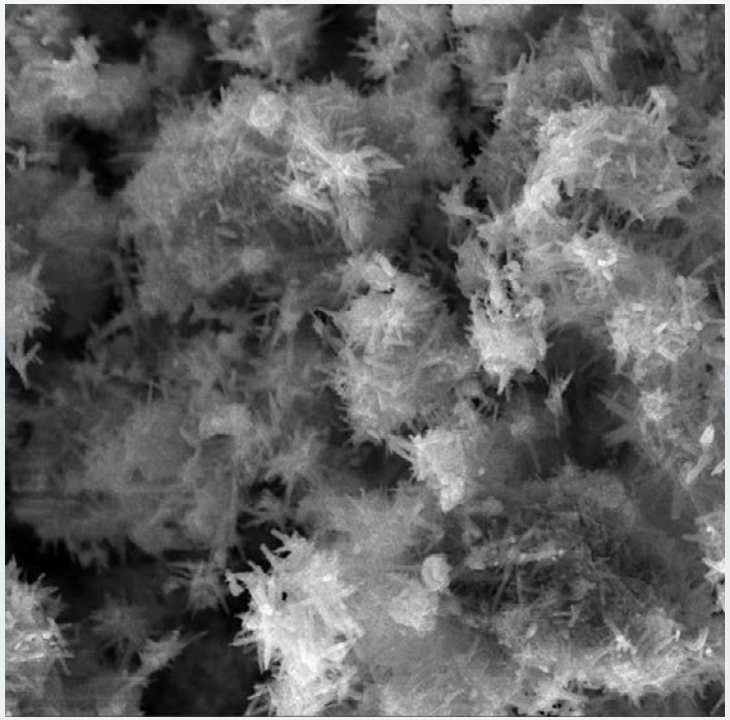
Carbon Capture with **Calcium Hydroxide**

Long-duration tests conducted onboard allowed us to observe the process until the **lime** is almost **completely converted** to limestone (90-95% conversion rate).

Scanning Electron Microscopy:



Agglomerates of **portlandite** – lime milk **before** the reaction with carbonates



Acicular crystal of **aragonite**, a crystalline form of calcium carbonate

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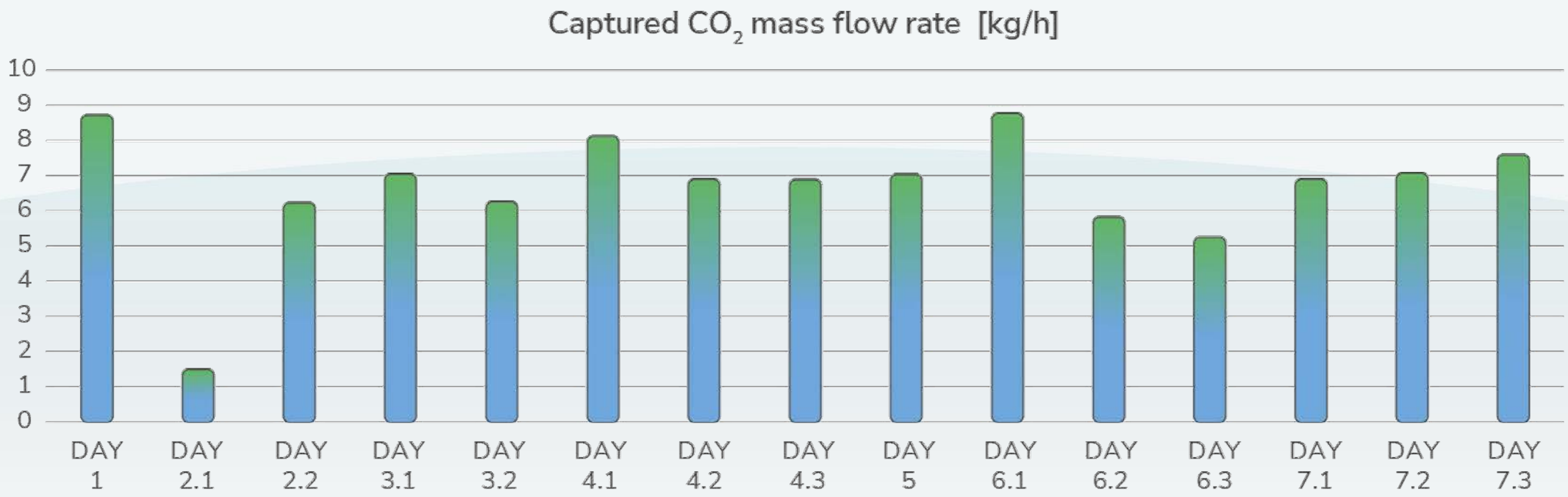
Carbon Capture with **Amines**

Amine- based technology:

In all onboard tested conditions, the pilot plant is able to absorb from 5 kg/h (on 9.9 kg/h CO_2 in exhaust gas from engine) to 8.7 kg/h (on 19.5 kg/h CO_2 in exhaust gas from engine) of **carbon dioxide**. Avg. **48% capturing rate**.



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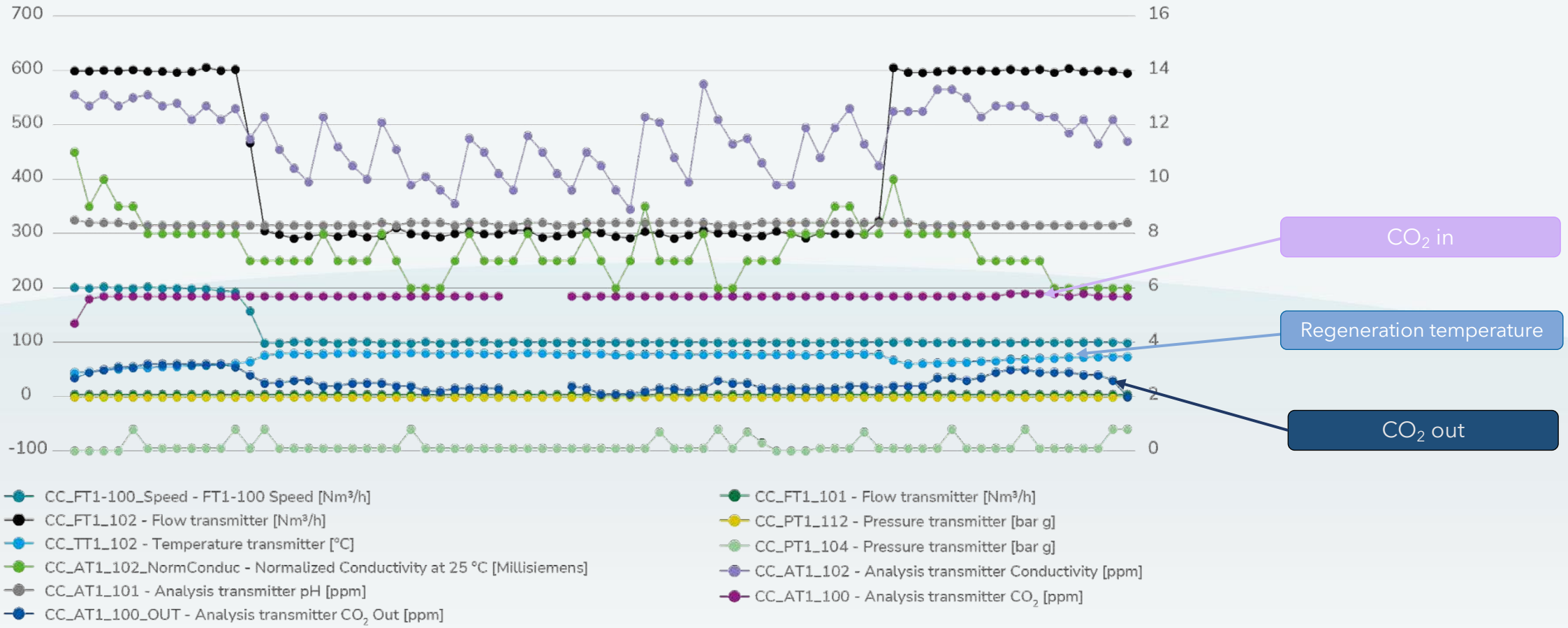
Carbon Capture with **Amines**

The pilot plant demonstrated the feasibility of **low temperature/low pressure regeneration** of the selected amine mixture. In the graph, capturing rate from 45% to 59% and regeneration temperature from 65 ° to 80 °C



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Energy efficiency

63,5K DWT Bulk Carrier – Gross 25% CCS		
Description	**Standard Amine capture process**	**Ecospray**
Effective Power [MW]	6,81	
Tot. exhaust gas flow [kg/h]	51518	
CO_2 Total capture rate [%]	25%	
CO_2 Captured [kg/h]	895	
Steam demand [kg/h]	1200	600
Amine regeneration heat demand [kWt]	/	1600
Electrical consumption [kW]	254	431
Additional CO_2 emission for steam generation [kg/h]	144,0	0 - (available steam capacity)
Additional CO_2 emission for heat generation [kg/h]	0	0 – (heat recovery from cooling system)
Additional CO_2 emission for Electrical Power [kg/h]	158,2	268,4
Fuel used for 1 Ton of captured CO_2 [kg]	**174,3**	**152,9**
Ratio Fuel used / Captured CO_2	**0,1743**	**0,1529**

Ecospray process is **10%-15% more energy-efficient** compared to conventional amine process.

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Carbon Capture Technologies / Amine and Lime Milk
Project Results

AMINE AND LIME MILK TECHNOLOGIES

UNIVERSITÀ DI TORINO

CO_2 CAPTURING RATE UP TO

80%

Milestones

Q1/2023 — Pilot System Lab Testing

Q2/2023 — Pilot System Onboard Testing

Q3/2023 — Full-scale system designed for capturing 2000 tons of CO_2 per single trip

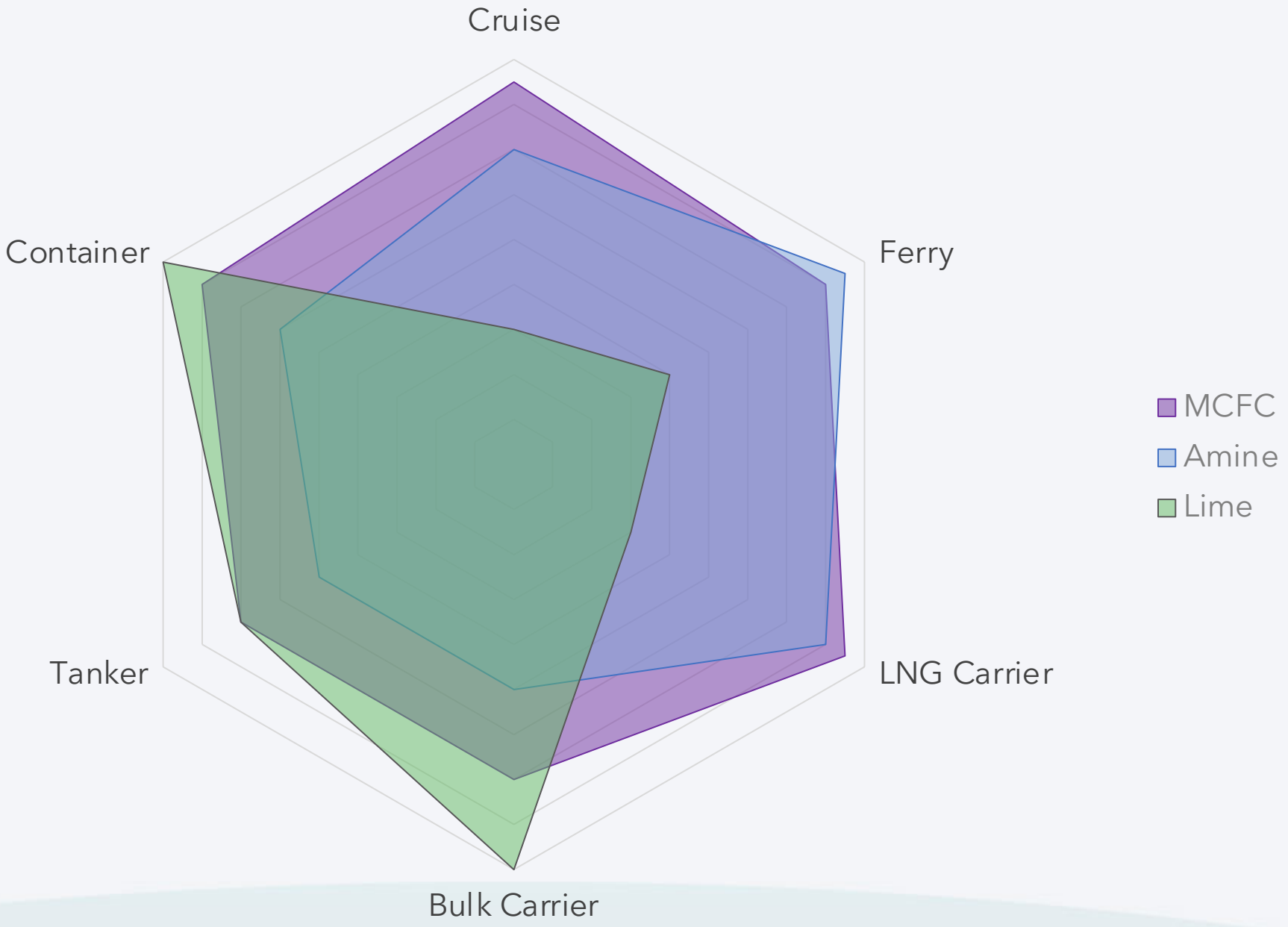
Q1/2024 — **Go to market**

CapLab

CapLab
ELECTROCHEMICAL CELLS

- Shared between **Ecospray** and the Department of Civil, Chemical and Environmental Engineering of the **University of Genoa**
- Aimed to the development of Electrochemical Cells for **Carbon Capture & Energy Transition** (Molten Carbonate Fuel Cells - MCFCs)
- **Research areas**: Capture of CO_2, production of clean energy, production and use of hydrogen, applications in maritime and land-based sectors, integration with renewable sources.

Carbon Capture: **solutions for all needs**



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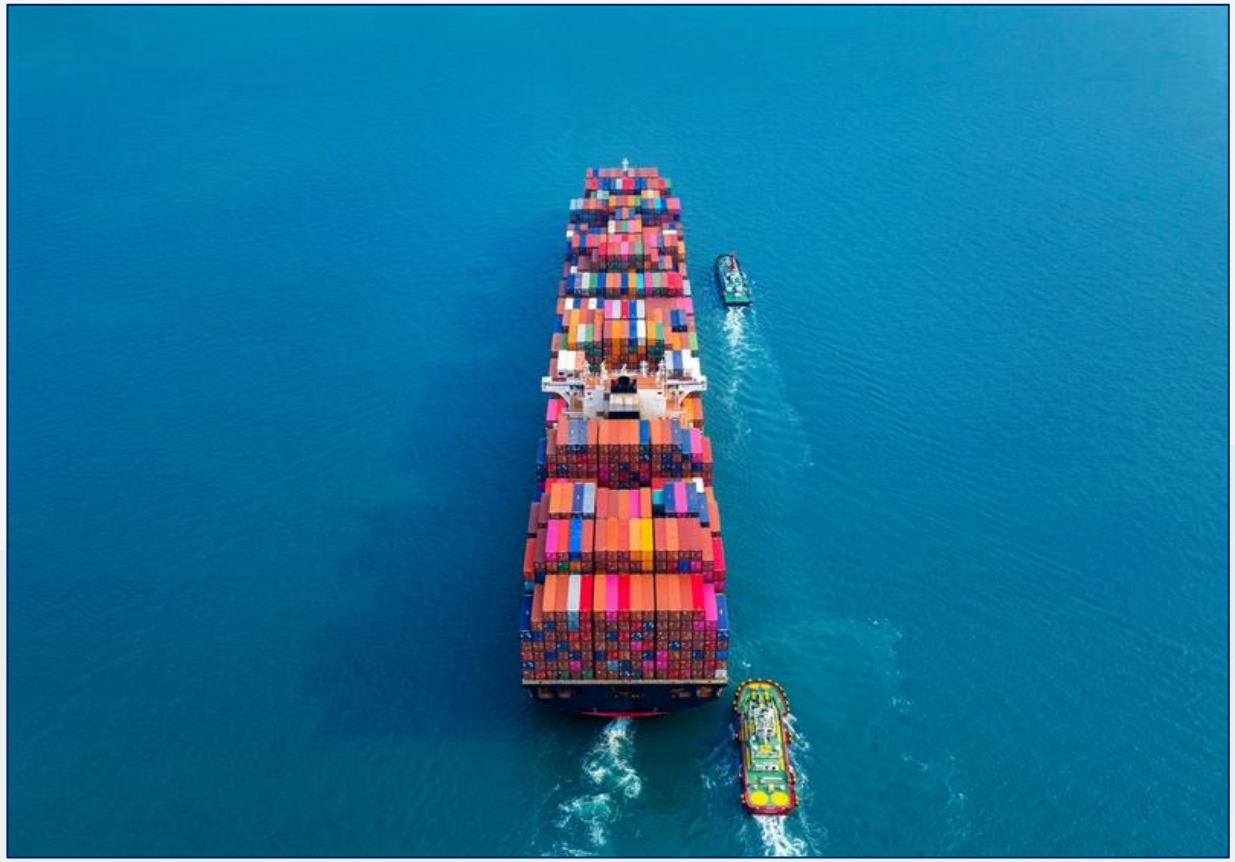
CASE STUDY 1

15K TEU Container ship with Calcium Hydroxide-based CCS



Vessel & CO_2 parameters	
Total engines power	28,0 MW
Type of Fuel	HFO
CO_2 emissions by engines	15,65 t/h
Target NET CO_2 capture rate	50%
Carbon Capture System impact on cargo capacity	1,6% cargo loss
Captured CO_2 storage method	Discharged Overboard as Calcium Carbonate

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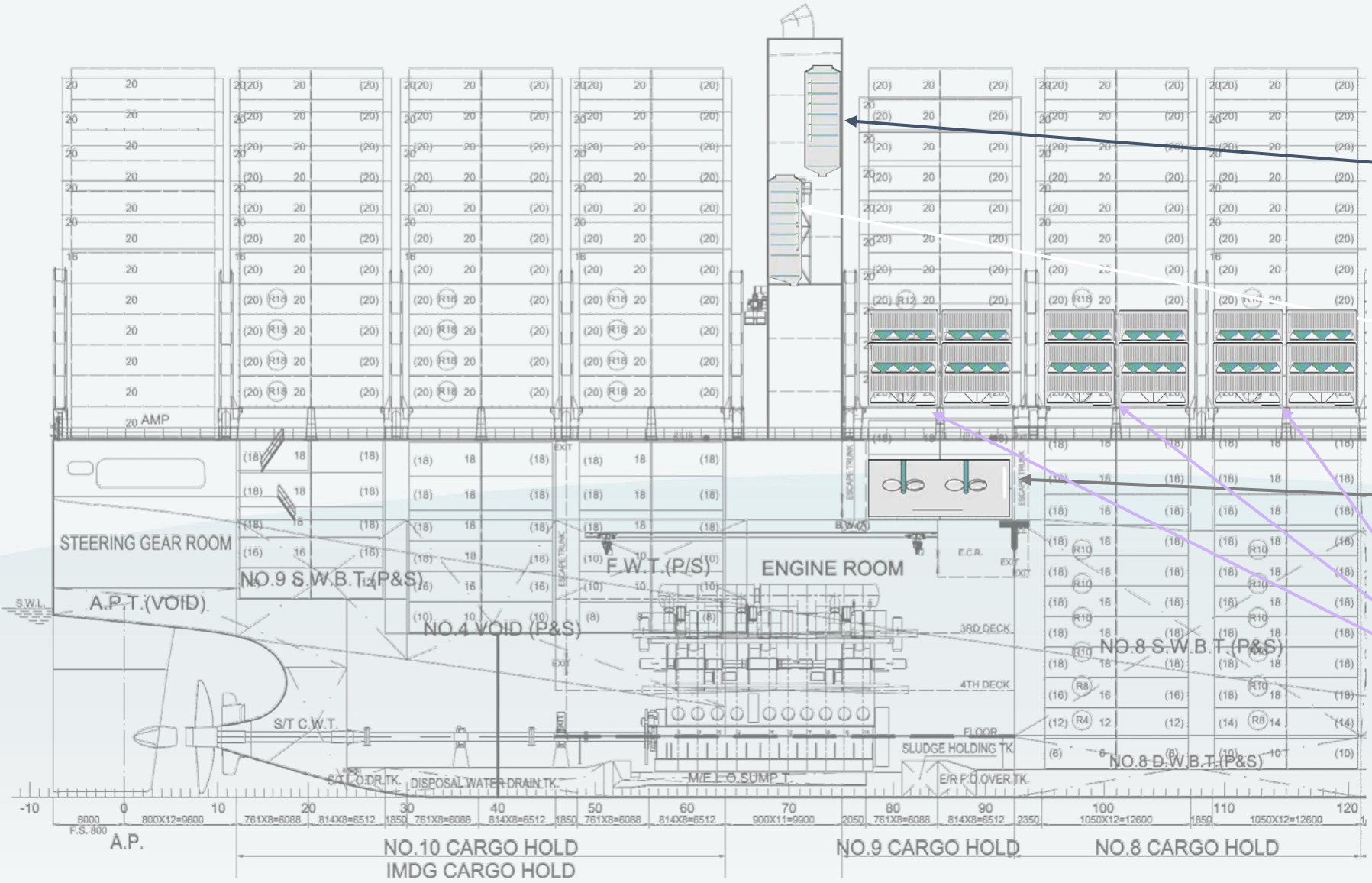
CASE STUDY 1

15K TEU Container ship with Calcium Hydroxide-based CCS



DeCarb SCRUBBER

DeSOx SCRUBBER

LIME PROCESS TANK

LIME SILO-CONTAINERS

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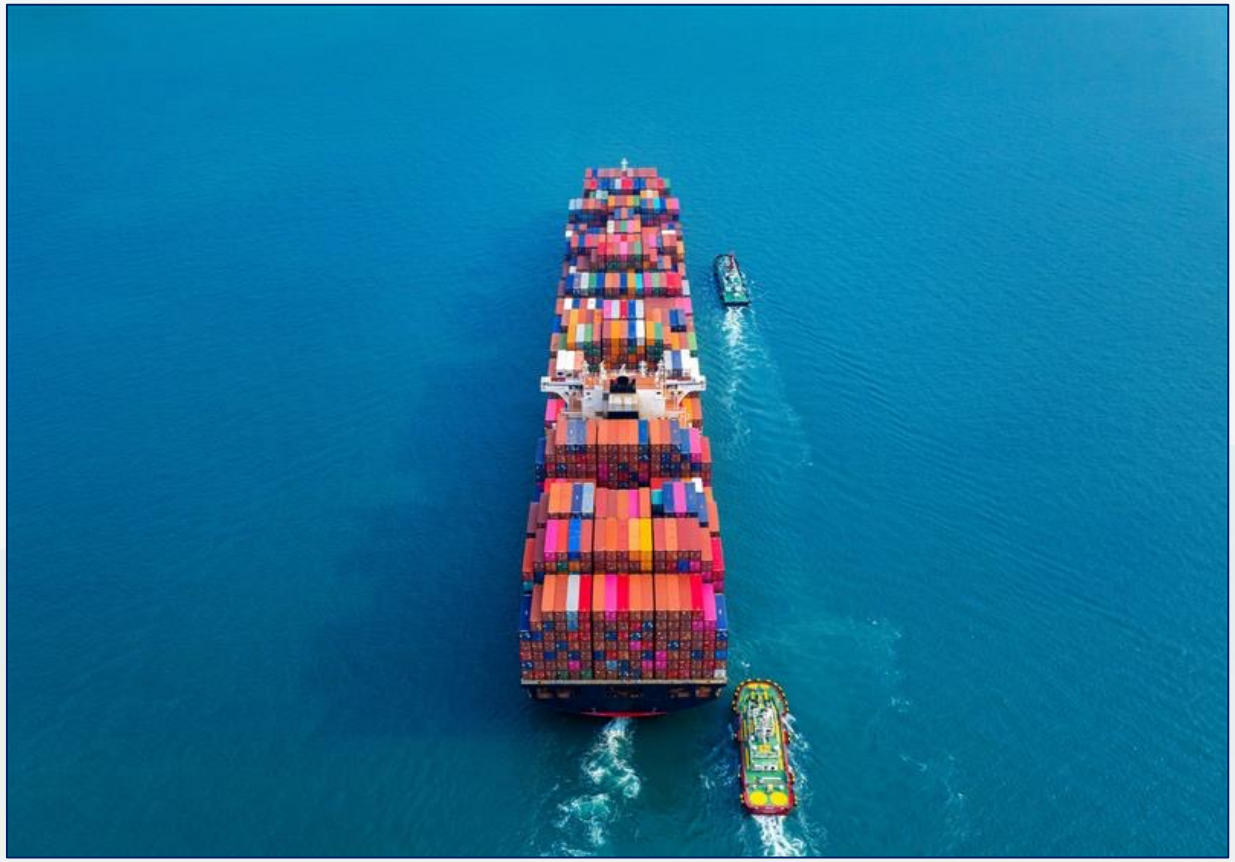
CASE STUDY 2

15K TEU Container ship with MCFC-based CCS



Vessel & CO_2 parameters	
Total engines power	30,0 MW
Type of Fuel	LNG
CO_2 emissions by engines	11,8 t/h
Target NET CO_2 capture rate	50%
Carbon Capture System impact on cargo capacity	1,7% cargo loss
Captured CO_2 storage method	Liquefied and stored onboard

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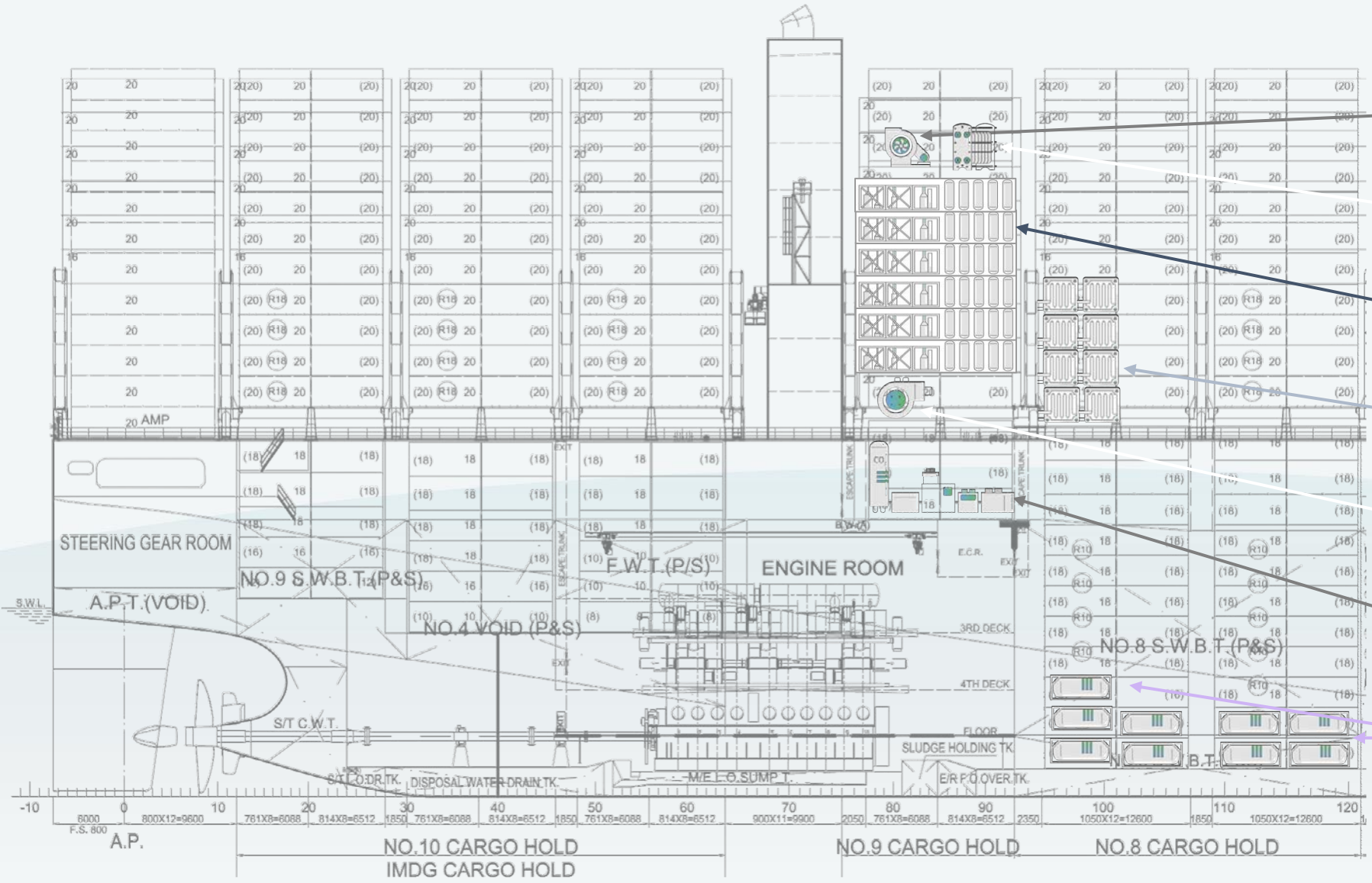
CASE STUDY 2

15K TEU Container ship with MCFC-based CCS



EXHAUST GAS FANS

HEAT EXCHANGERS

STEAM REFORMER UNITS

MCFC UNITS

LNG BURNERS

CO_2 LIQUEFACTION UNIT

LCO_2 ISO TANKS

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CASE STUDY 3

Cruise ship with MCFC-based CCS

Vessel & CO_2 parameters	
Total engines power	9,72 MW
Type of Fuel	MGO
CO_2 emissions by engines	6,1 t/h
Target NET CO_2 capture rate	20%
Carbon Capture System impact on cargo capacity	N.A.
Captured CO_2 storage method	Liquefied and stored onboard

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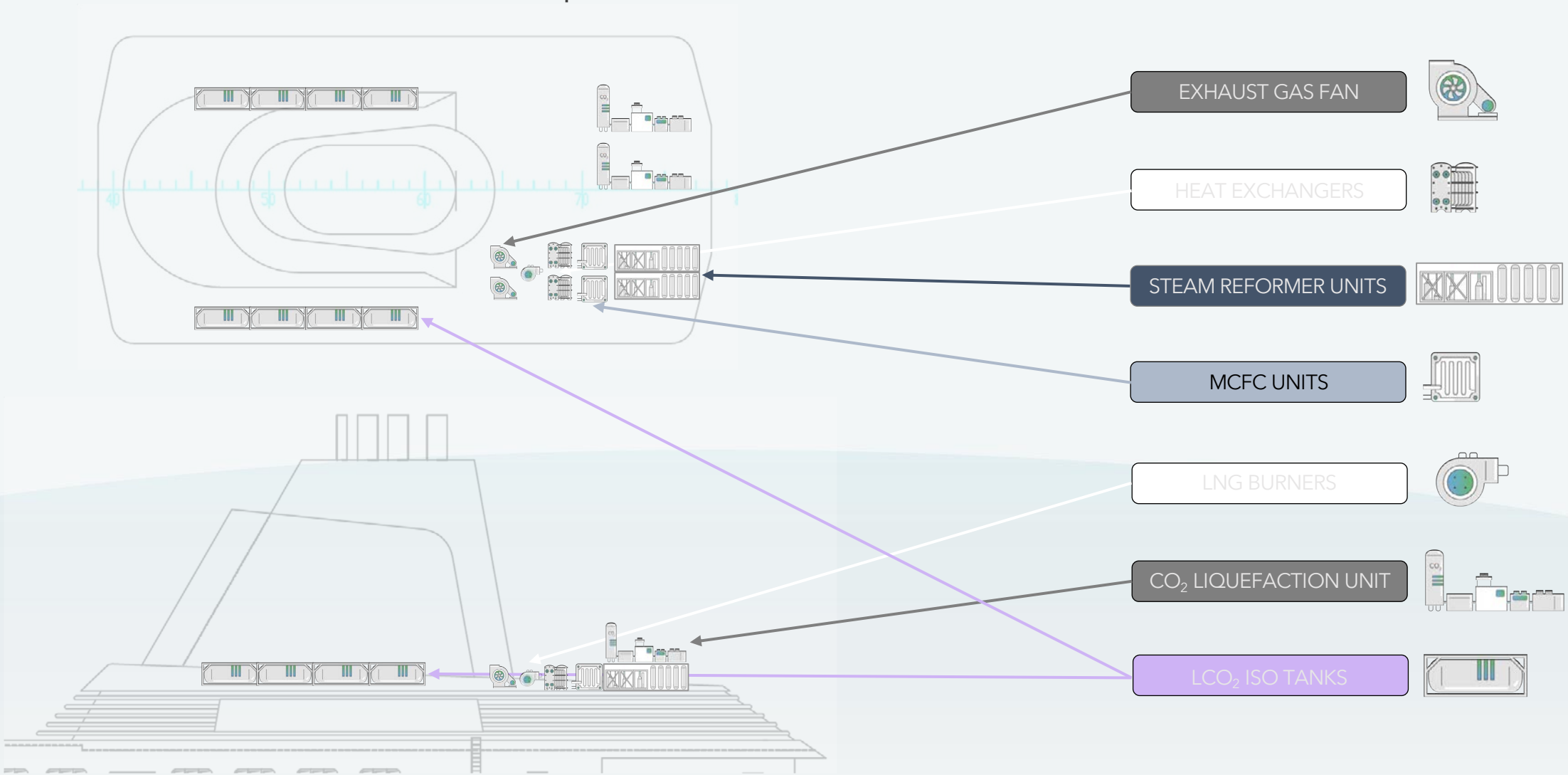
CASE STUDY 3

Cruise ship with MCFC-based CCS



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Detailed feasibility studies for onboard installation

Vessel & CCS parameters		
Vessel type	PCTC	Bulk Carrier
CCS technology	Amine based carbon capture	Amine based carbon capture
CCS target capture rate	40%	20%
Feasibility study status	Completed at medium detailed stage	Completed at medium detailed stage

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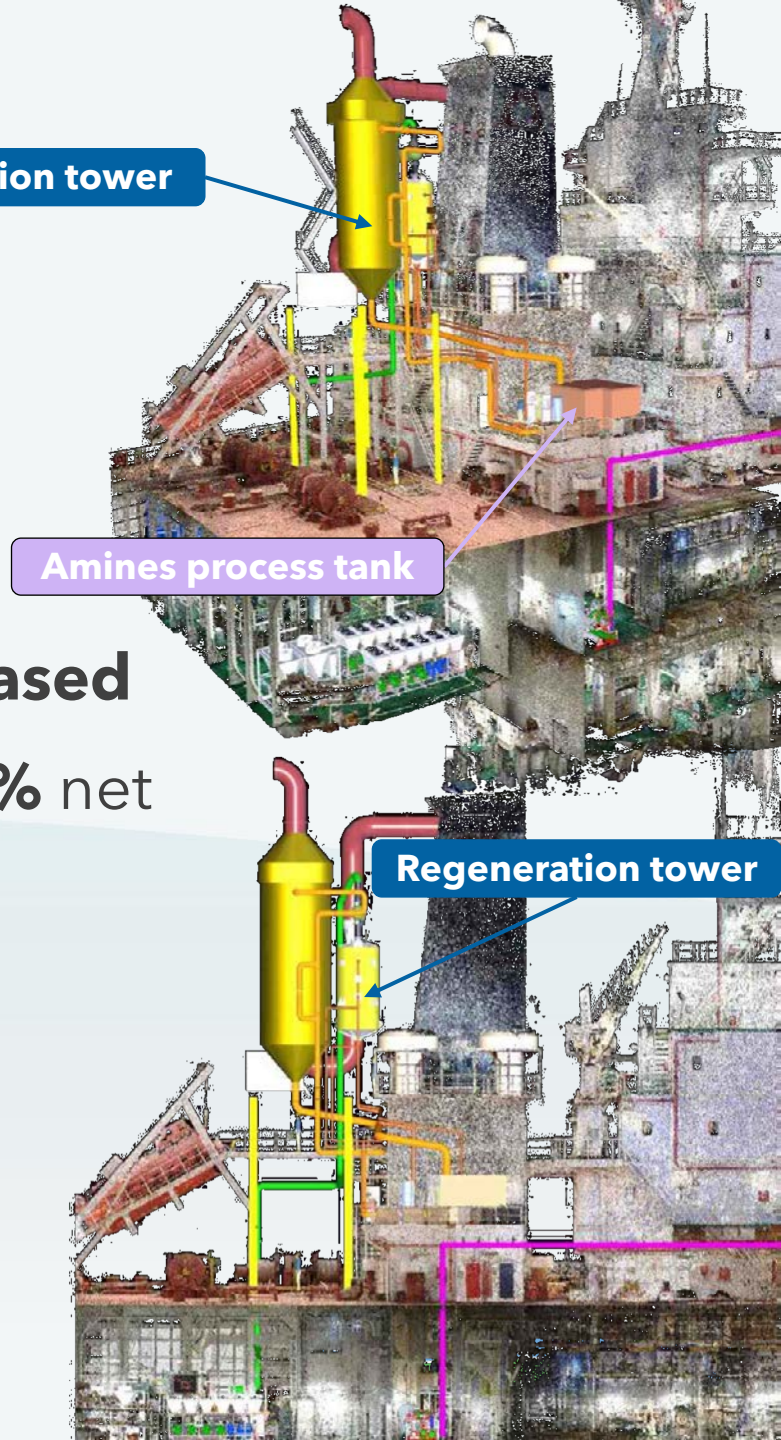
Case study – bulk carrier

- Newcastlemax bulk carrier – DWT 208k mt
- Installed power – 20 MW



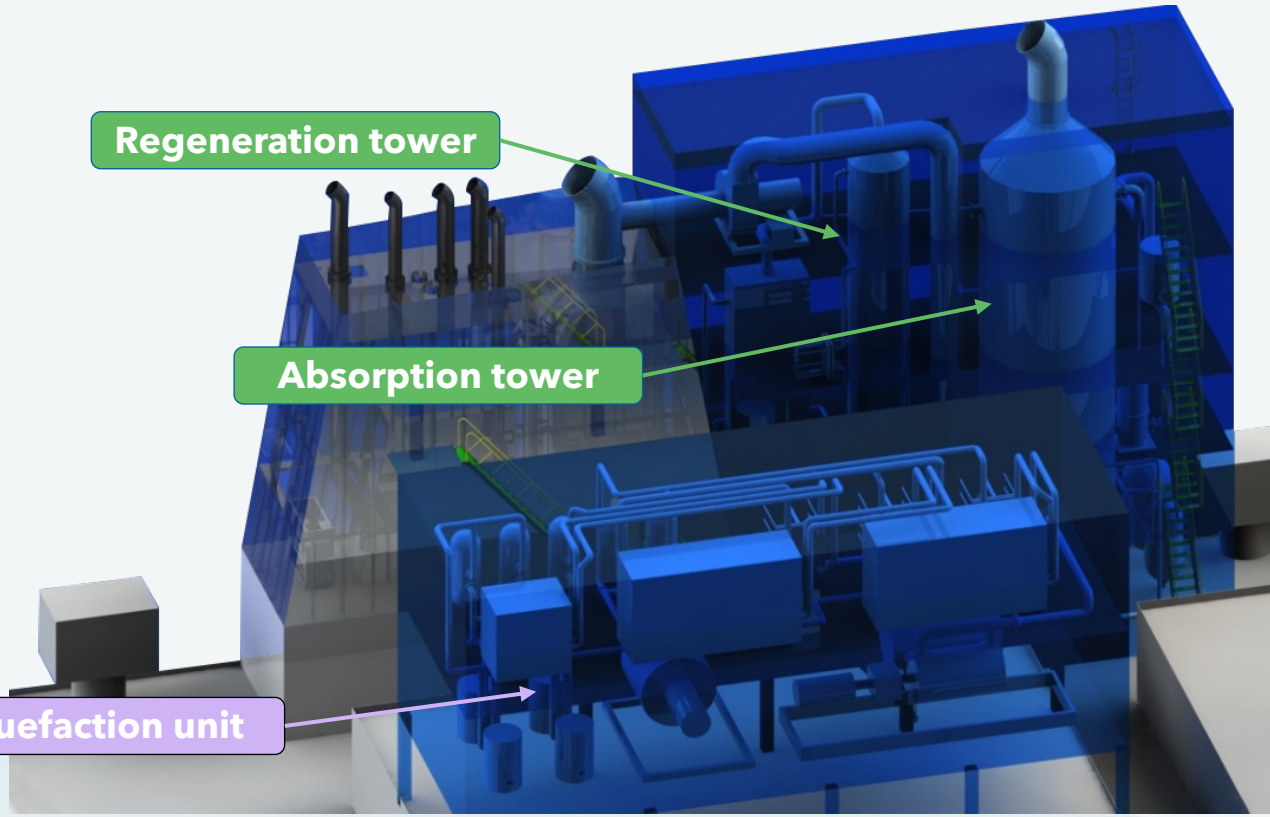
- CO_2 capturing tech. – **amine-based**
- CO_2 capturing target – max **26%** net

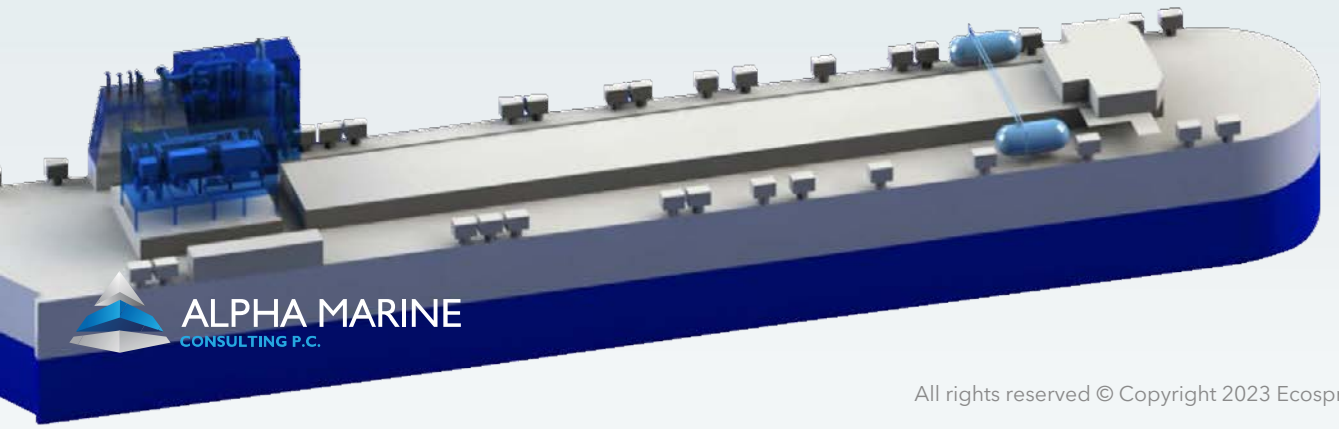
- CO_2 storage capability **1800 m³** (60 days sailing)

GMT
GREEN MARITIME TECHNOLOGY

Case study – PCTC

- Pure car & truck carrier – 11k mt
- Installed power – 17 MW
- CO_2 capturing tech. – **amine-based**





- CO_2 capturing target – **max 40%** net
- CO_2 storage capability – **160 m³** (5 days sailing)

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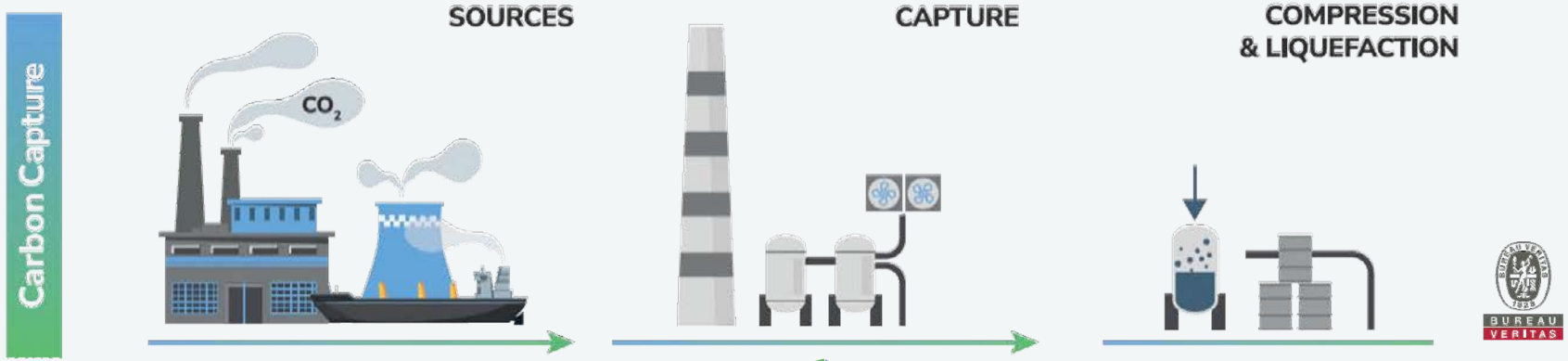
CO_2 HANDLING: *capture, transport, reuse, and segregation*



Source: Bureau Veritas

Direct air capture

Emission reduction

MCFC

Amines

Calcium Hydroxide

Membranes

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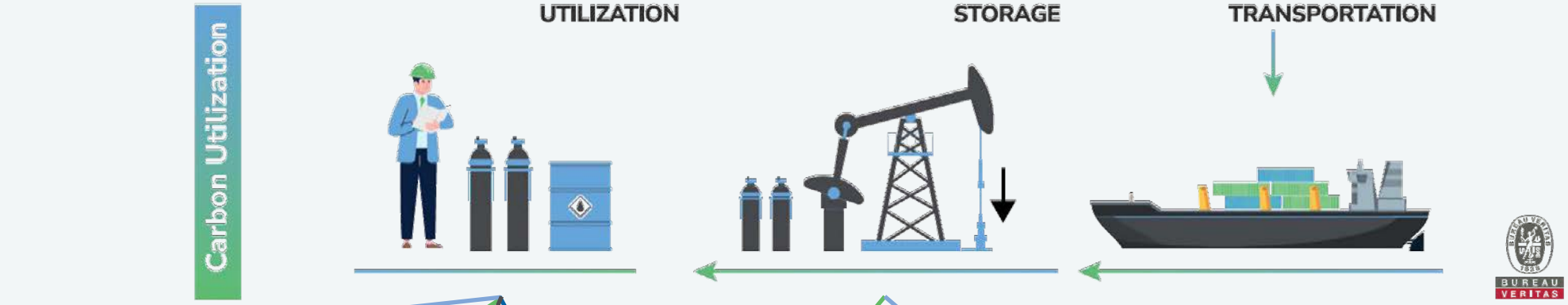
CO_2 HANDLING: *capture, transport, reuse, and segregation*



Source: Bureau Veritas

Food & Beverage

Agricolture

Industry

e-Fuels production
(e.g. *e*-Methanol)

Mineralization

Geological storage

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