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Accelerating Decarbonisation Efforts through On-Board Carbon Capture Systems

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DECARBONIZING THE SHIPPING INDUSTRY

Options to reach IMO target 'net zero' by/around 2050:

- operational efficiencies (speed reduction, vessel utilisation, voyage planning etc)
- technical efficiencies (wind assisted propulsion, air lubrication, PBCF, coating etc)
- low/zero carbon fuels (LNG, LPG, Methanol, Ammonia, hydrogen, fuel cells, batteries, eFuels etc)
- nuclear power

And…

- **Carbon Capture**

ON-BOARD CARBON CAPTURE

Benefits:

- Reduces demand for low / carbon-neutral fuels
- Avoids competition for sustainable biomass / renewable electricity
- Land-based experience

Challenges:

- Storage of CO_2 on board, weight issues
- Few systems in the market

ON-BOARD CARBON CAPTURE

(Post combustion technologies)

- **Adsorption (the process by which a solid holds molecules of a gas)**
- Liquid Adsorption
- Membrane separation
- Cryogenic separation
- Electro Separation
- Variants of above

ON-BOARD CARBON CAPTURE – PILOT PROJECT

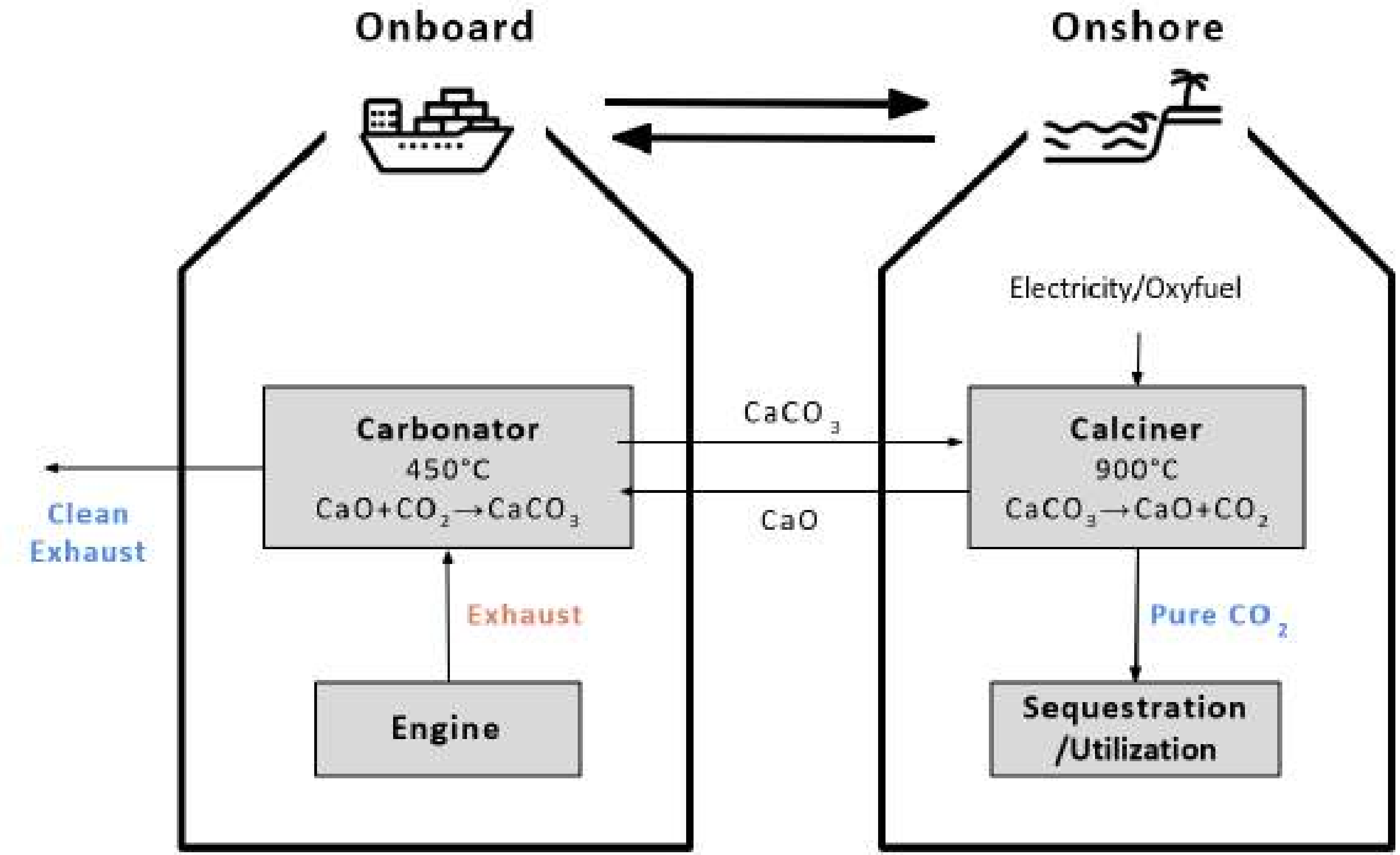
'Ingredients':

SEABOUND carbon capture system using quicklime pebbles (CaO) to adsorb CO2 from exhaust gas. Quicklime turns to limestone (CaCO3)

Cement Carrier 'UBC Cork', 8000mt dwat, trading along Norwegian coast

Norcem/Heidelberg Cement, multinational producer of cementitious products, building material

SEABOUND CARBON CAPTURE SYSTEM

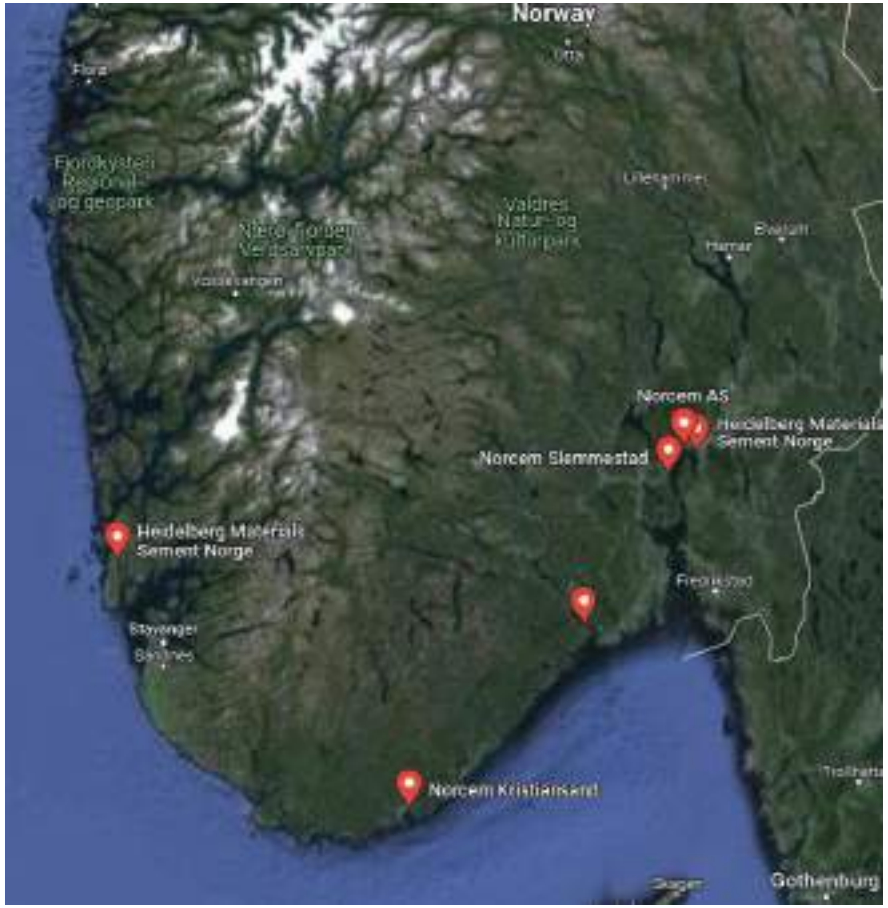


Process highlights:

- Small pebbles of calcium oxide (CaO) react with CO2 in exhaust gas to form calcium carbonate pebbles (CaCO3)
- CO2 remains locked in calcium carbonate pebbles, which are solid at ambient temperature
- Calcium carbonate can be sold for use as building material, or post-processed onshore to utilize/sequester pure CO2 and to reuse calcium oxide pebbles
- Onboard process is exothermic, requiring negligible energy
- No toxic chemicals involved
- Minimal training required for crew

UBC CORK

UBC CORK – TARDING PATTERN



Typical voyage patterns:

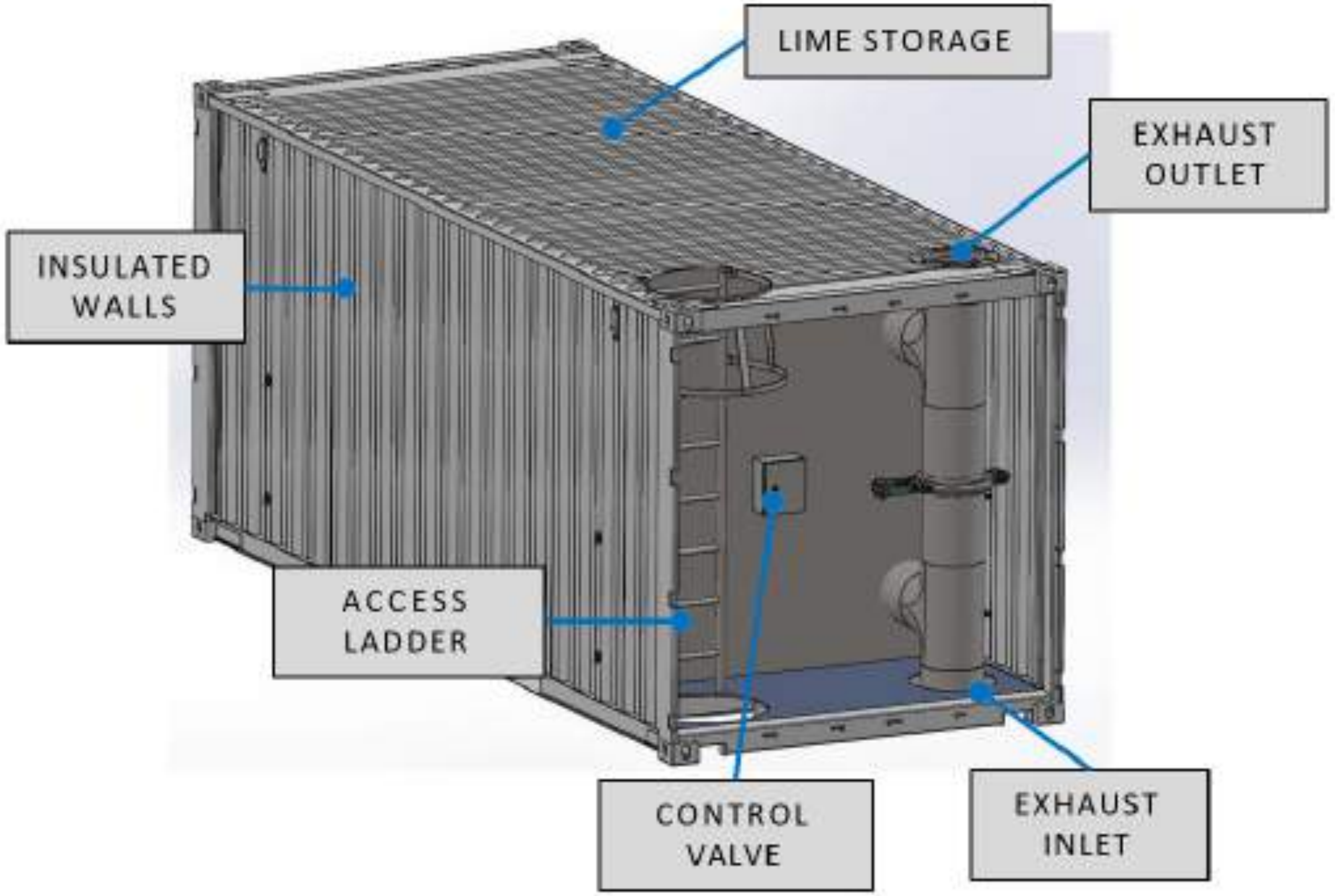
Load port Kjoepsvik

Discharge ports: Trondheim, Alesund, Verdal, Bodoe, Mo-I-Rana, Fjorde, Bergen

Load port Brevik

Discharge ports: Sjursoeya, Bergen

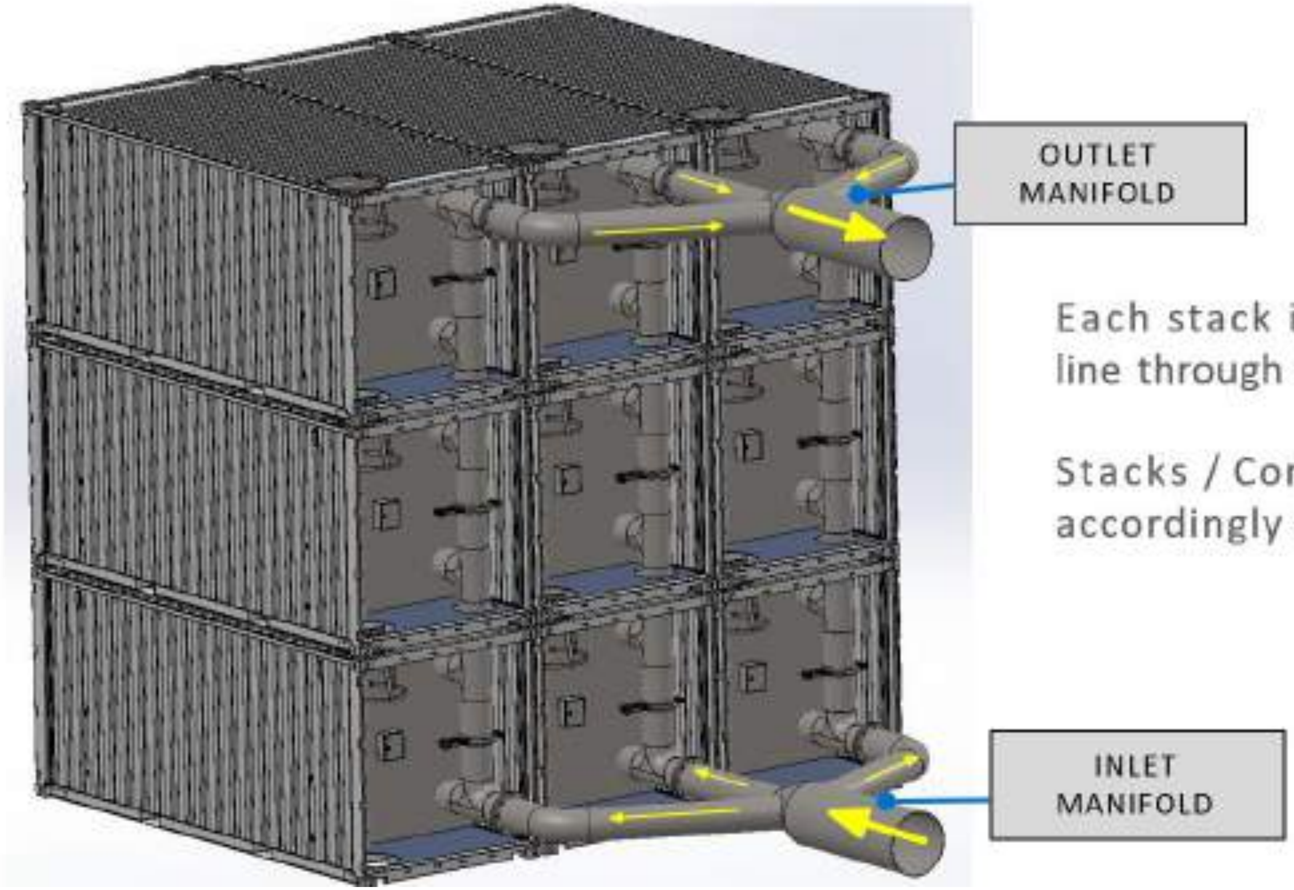
MODULAR / CONTAINERIZED CC SYSTEM



Seabound Containers can be stacked to increase the amount of carbon captured.

- Integrated carbon capture device and storage of captured carbon
- Fully modular and scalable - start with a few Seabound Containers and increase over time
- Limited installation requirements, simple integration design, and lightweight class approvals process
- Low CAPEX

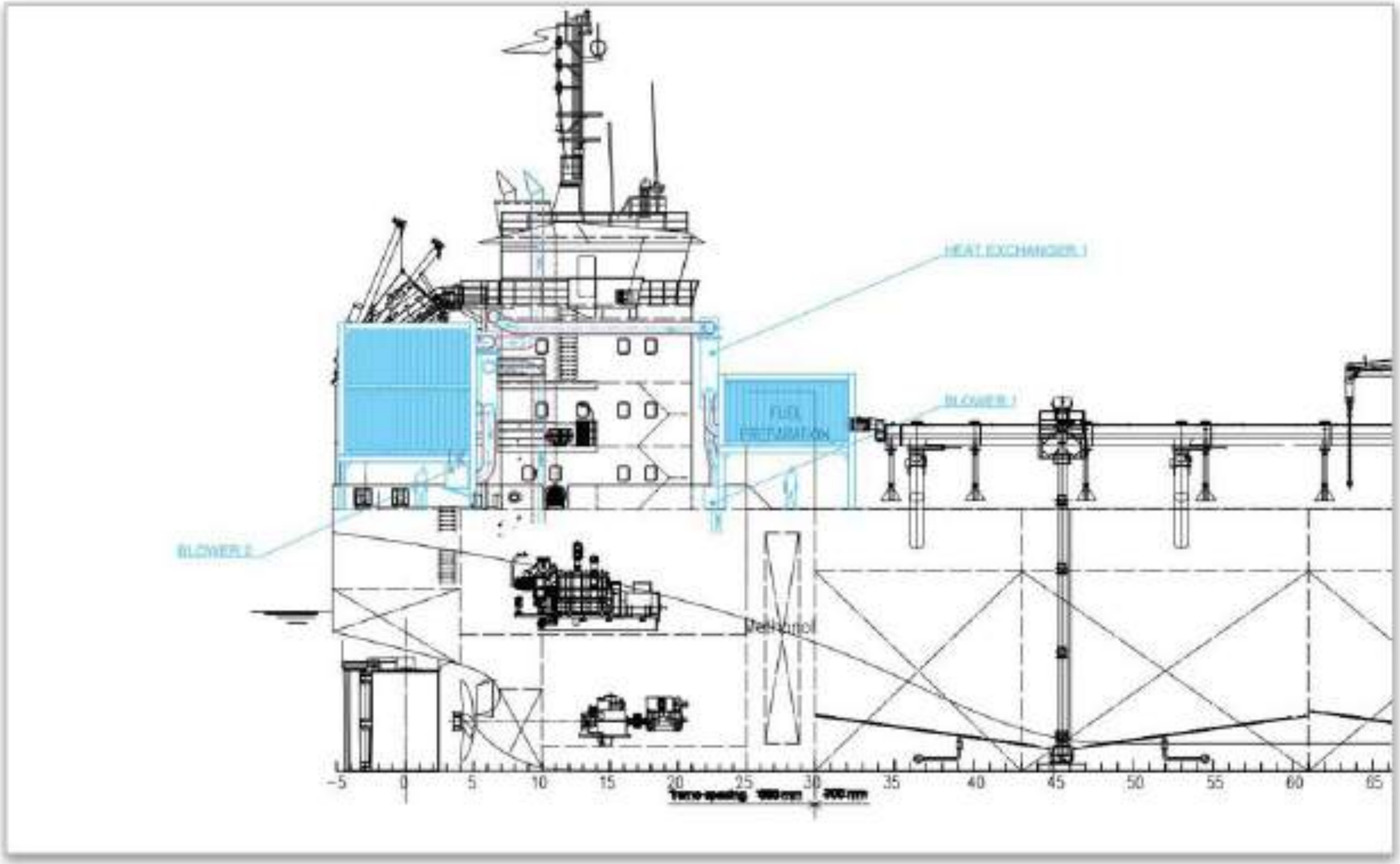
MODULAR / CONTAINERIZED CC SYSTEM



Each stack is connected to the main exhaust line through a manifold.

Stacks / Containers can be activated accordingly to process the total exhaust flow.

INSTALLATION ON BOARD



THE BUSINESS CASE

- Cement producer reduces scope 3 emissions
- Expected cost per mt CO_2 captured: USD 100-150
  (cost during pilot phase: USD 400-500)
- Limestone can be used in cement production
- Short voyages along Norwegian coast (1-5 days) - limited impact on dwcc
- Sufficient space for container storage (aft of superstructure)
- Compressors/blowers on board (booster to overcome backpressure)
- Reduction of SOx

Six Seabound Containers would capture 70-95% of the vessel's CO2 regardless of the fuel type and voyage length.

For voyages up to 2 days in duration, six containers would capture 95% of emissions from all fuel types.

Fuel type	Voyage Length (days)	Amount of CO2 Captured (tons/ Co2)	# of Containers Activated	CO2 Capture rate	Total weight of Containers post-capture	% of DWT
Fuel Oil	1	23.1	3	95%	66	0.9%
	2	46.1	5	95%	131	1.8%
	3	58.3	6	80%	166	2.3%
Methanol and Pilot Oil	1	26.4	3	95%	75	1.0%
	2	52.7	6	95%	150	2.1%
	3	62.4	6	70%	177	2.4%

Inputs/Assumptions:	
Voyage length (days)	1-3
Fuel consumption per day (tons) - ***Fuel Oil***	8.1
Fuel consumption per day (tons) - ***Methanol & Pilot Oil***	7.9 & 4.4
Deadweight tonnage (tons)	7300
CO2 emissions per voyage (tons)	158.4
Key Details:	
CO2 captured per Seabound Container - From 2026 (tons)	10
Seabound Container weight pre-capture (tons)	26
Seabound Container weight post-capture (tons)	28.4

PILOT PROJECT

Start: 1Q25

Installation of fixed piping etc in 1Q25

Delivery on containers / pebbles 2Q25

First trial / results in 3Q25

First use of limestone for cement production: 3Q25

Applied for funding under 'Eurostars' program

Consortium partners: Intership, Seabound, Norcem, CMMI, Nomadic Shipping

THE FUTURE

- Once concept is proven Seabound will market system
- Scaling of installation on UBC Cork to capture max CO_2 (expected 95%)
- Intention: sequestrate CO_2 in Norway or, preferably, use CO_2 for production of blue methanol
- Next generation of cement carriers designed to burn methanol
- Blue methanol supplied to vessels, carbon will be captured on board – and again recycled to blue methanol

→ Carbon negative propulsion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THANK YOU