BLUESTREAK CO2

THE VERSATILE AND COMPLETE NON-PIPELINE TRANSPORT (NPT) SOLUTION

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WHAT IS BLUESTREAK CO2?

1. A hub-based CO2 Collection Company

2. A ‘one-stop-shop’ for emitters to abate their CO2

3. Particularly serving those that are ‘stranded’ where ‘mega-cluster’ projects cannot cater for them

4. Leverages expertise in each part of the value chain focusing risks & skills on those who know how to do it best

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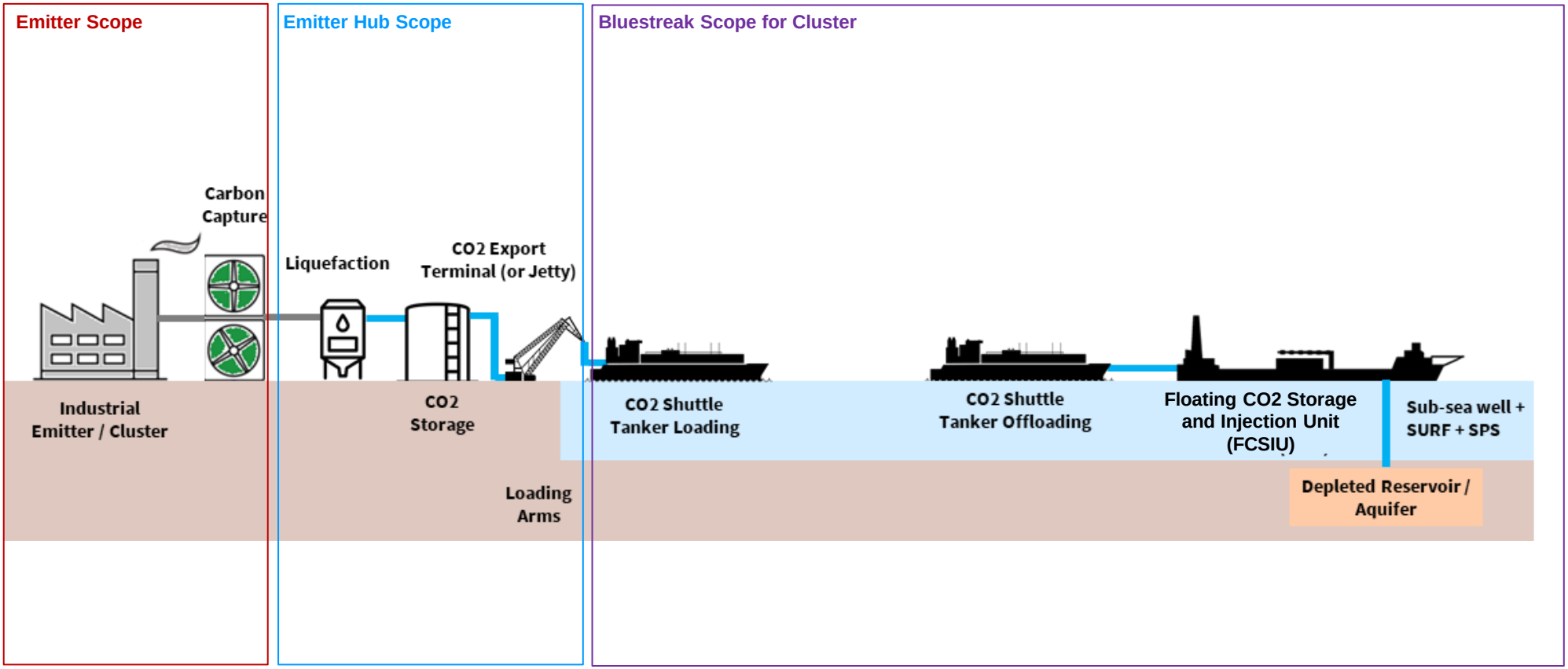
THE CONFIGURATION



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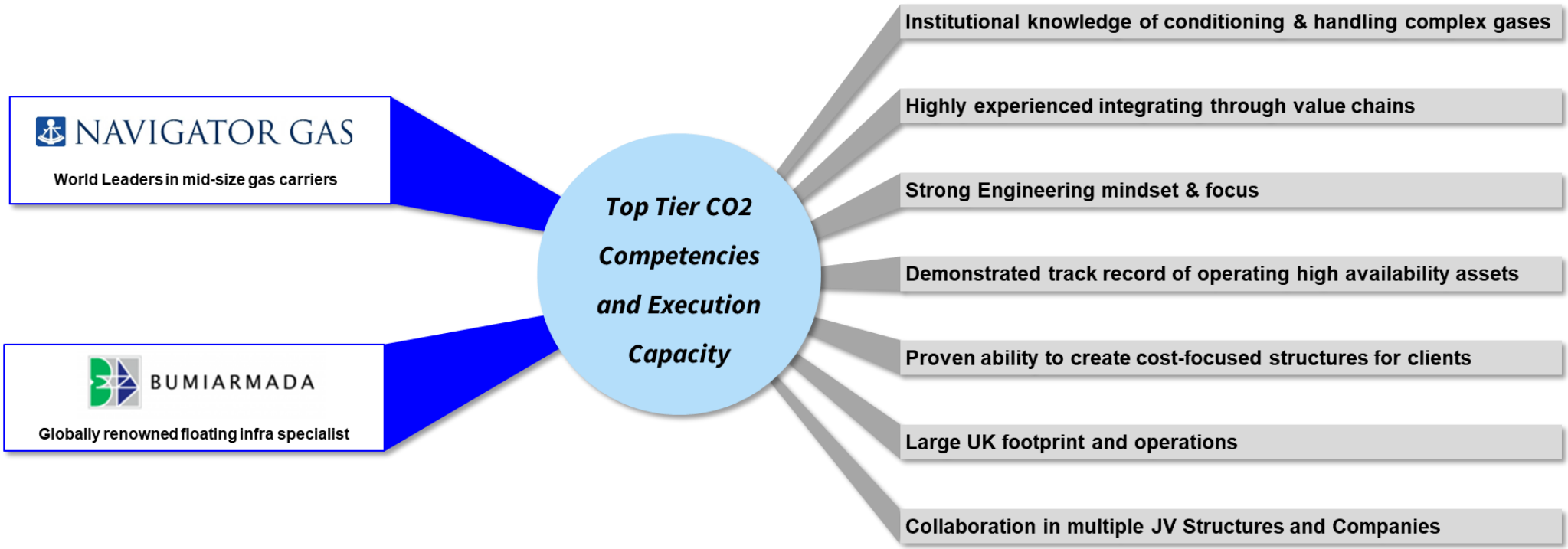
WHY BLUESTREAK?



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NAVIGATOR GAS CAPABILITIES

LPG

Liquefied Petroleum Gas (LPG) is a portable, clean and efficient energy source which is readily available to consumers around the world. LPG is primarily obtained from natural gas and oil production but is also produced increasingly from renewable sources; its unique properties make it a versatile energy source which can be used in more than 1,000 different applications.

Petrochemicals

Ethylene is the fundamental plastic building block in the chemical industry and is produced through steam cracking. It has a boiling point of -103ºC. Our ethylene capable vessels are suited to carry this cargo.

Ammonia

Liquid ammonia has a boiling point at -33ºC. 90% of ammonia production globally is used as a key component in the manufacturing of fertilizers to help sustain food production for billions of people around the world.

Ethane

Ethane is produced from gas processing and fractionation of North American shale gas and from liquids rich gas fields. Ethane as feedstock to a petrochemical steam cracker increases its yield of ethylene as a derivative product compared to other inputs such as propane and naphtha. Competitively priced U.S. ethane is available and can be carried on specialized gas carriers capable of loading and maintaining the cargo at its boiling point of -88ºC.

Carbon Dioxide

Maritime transportation of carbon dioxide will play a vital role in enabling the carbon capture & storage value chain for industrial clusters.
CO2 transportation in liquid form is one real and proven avenue to reduce green house gas emissions to the atmosphere, and is driven by legislation for carbon tax.

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NAVIGATOR GAS FLEET

Vessel Type			Existing Number of Vessels	Order Book		Navigator Fleet
				Vessels on Order	% of Fleet (# vessels)	
Very Large Gas Carrier >60,000 cbm	Fully-Refrigerated		330	66	20%	
Large Gas Carrier 40,000 - 59,999 cbm	Fully-Refrigerated		21	-	-	
Medium Gas Carrier 25,000 - 39,999 cbm	Fully-Refrigerated Ethylene & Ethane		107 15	32 -	26%	5
Handysize Gas Carrier 15,000 - 24,999 cbm	Fully-Refrigerated Semi-Refrigerated Ethylene		24 59 36	2 - 2	4%	42*
Small Gas Carrier 5,000 - 14,999 cbm	Ethylene Semi-Refrigerated Pressure		363	27	7%	9
Small Gas Carrier <4,999 cbm	Semi-Refrigerated Pressure		254	3	1%	

Steem1960, 2022

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WHAT ARE THE TECHNICAL CHALLENGES OF SHIPPING CO2?

Shipping as part of a CO2 supply chain

- Ship & cargo system design depending on an overall financial approach for the whole chain
- Size/condition of onshore storage tanks, pipes and logistics
- CO2 capture efficiency on shore *&* CO2 composition/impurities at delivery to vessel
- Sailing distance and needed speed
- Price of CO2 & introduced levy?
- Exporting “waste” crossing national borders
- Pipelines vs shipping?

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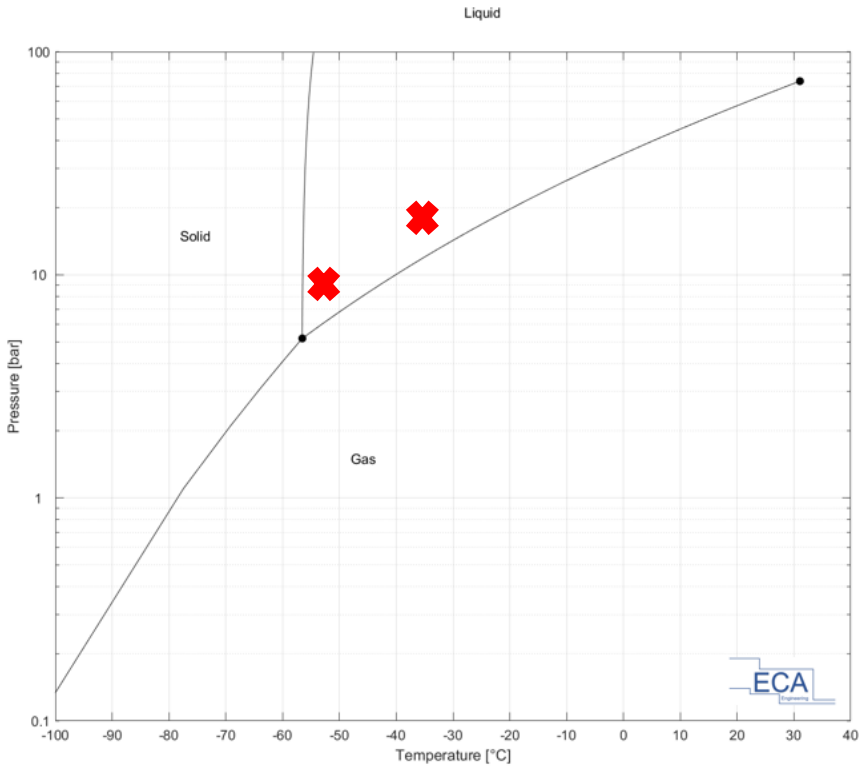
WHAT ARE THE TECHNICAL CHALLENGES OF SHIPPING CO2?

Low pressure or medium pressure? In between? Which to choose?

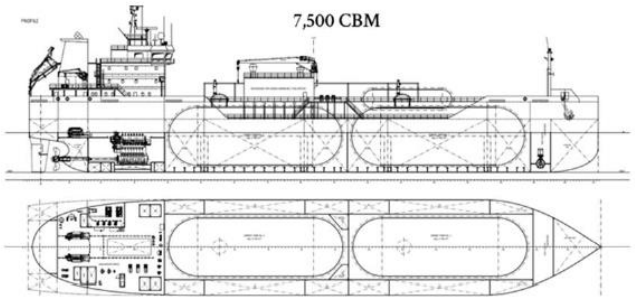


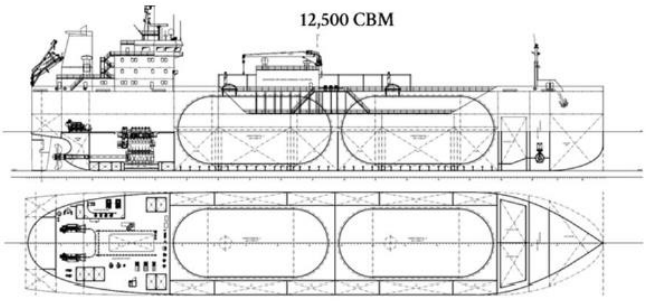
- Limitation of tank sizes based on current rules
- Higher density of CO2 (approx. twice the density of LPG)
- Vessel design – changed from a “volume” design to “deadweight” => impact on type of cargo tanks
- CO2 composition & purity => may affecting the triple point. Different sources of CO2 in same cargo tank?
- Holding time and need for re-liquefaction?
- Cargo tank material: type, fatigue, construction details, max plate thickness, material testing temperature and availability
- High weight on saddles
- Cargo handling – pressure relief systems
- Crew training & safety/HAZID & HAZOPS
- Combination carrier (+ LPG, ethylene, VCM)?

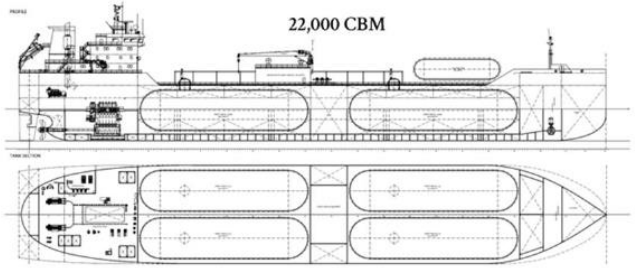
THE SHIPS

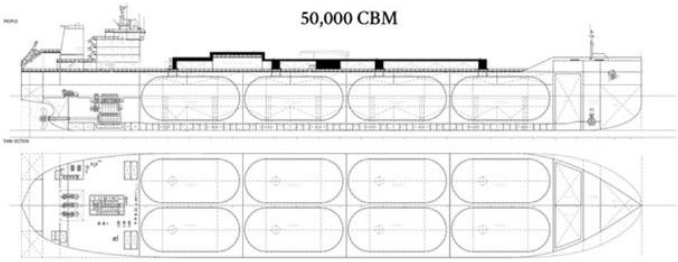
Low Pressure

- 7,500 m³
- 12,500 m³
- 14,000 m³
- 21,000 m³
- 22,000 m³
- 50,000 m³









Mid Pressure

- 16,000 m³
- 24,000 m³

Advantages of LP over MP:

- Greater capacity due to density differences between LP and MP, and therefore better for long-haul voyages and/or larger vessels
- Less capital intensive (could be up to 30% cheaper)

Advantages of MP over LP:

- Infrastructure in other parts of CCUS chain appear to be most compatible with MP

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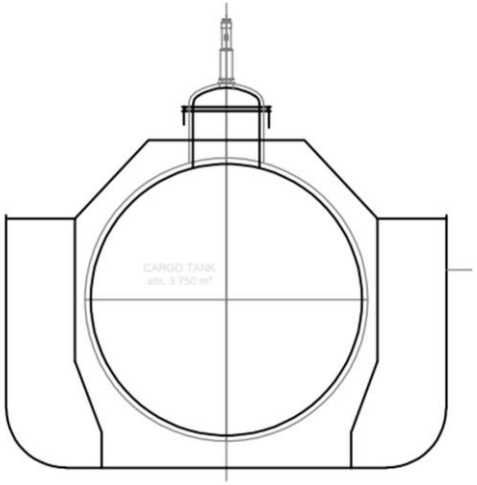
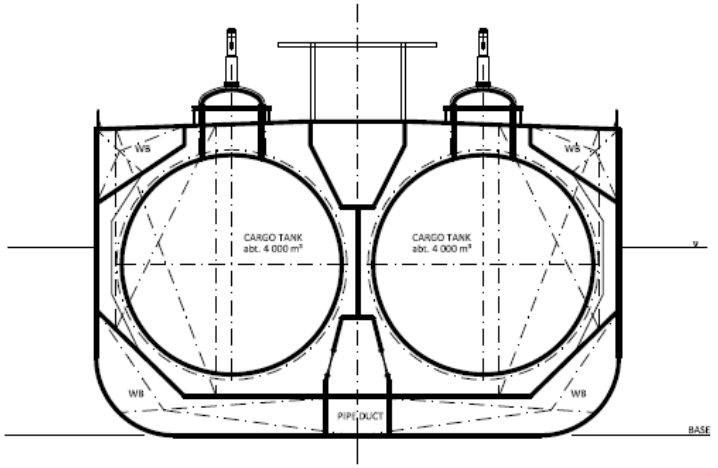
THE SHIPS – CARGO COMPARTMENTS

Cargo tank design, 12k, low pressure



Tank Data	
Main Material	5.0% Ni
Cargo, Design Density	CO2, 1172 kg/m^3
Tank Type	Cylindrical
Total Gross Volume	2 x 6250 m^3 = 12,500 m^3
Total Installation Weight	1580 t
Min. Design Pressure (IGC Code)	6.6 bar(g)
Design Pressure	8.3 bar(g)
Design Temperature	-55 / +45 ^{o}C
Max. Plate Thickness	50 mm

Cargo tank design, 16k, mid pressure



Tank Data	
Main Material	2.5% Ni
Cargo, Design Density	CO2, 1100 kg/m^3
Tank Type	Cylindrical
Total Gross Volume	4 x 4000 m^3 = 16,000 m^3
Total Installation Weight	653 t per tank
Min. Design Pressure (IGC Code)	TBA (in design stage)
Design Pressure	TBA (in design stage)
Design Temperature	-35 / +45 ^{o}C
Max. Plate Thickness	50 mm

THE SHIPS – INDICATIVE PARTICULARS

12,500 CBM Specifications	
LOA:	abt 136.40m
Length btw perpendiculars:	133.95m
Breadth moulded	24.00m
Depth to maindeck:	13.60m
Cargo tank capacity (100%):	abt 12,500m³
Draught (design)	abt 9.30m
Corresp. Deadweight all told:	16,200 ton
Draught (scantl.):	abt 9.40m
Corresp. Deadweight all told:	16,600 ton
Service speed at design draught:	13.50 knt

22,000 CBM Specifications	
LOA:	abt 179.40m
Length btw perpendiculars:	176.30m
Breadth moulded	29.80m
Depth to maindeck:	16.80m
Cargo tank capacity (100%):	abt 22,000m³
Draught (design)	abt 9.60m
Corresp. Deadweight all told:	28,200 ton
Draught (scantl.):	abt 9.70m
Corresp. Deadweight all told:	28,800 ton
Service speed at design draught:	15.50 knt

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APPENDIX - WHAT ARE THE TECHNICAL CHALLENGES OF SHIPPING CO2?

3. Bi-lobe or cylindrical CO2 cargo tanks?

- LP CO2 may approach triple point in a bi-lobe tank
- Considerations for offsetting draft and weight of vessel due to high density of CO2 plus heavier bi-lobe tanks
- Cylindrical tanks could be more flexible for designs

Source: TGE Marine

Floating Carbon Storage Injection Unit

September 2023

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Floating Production Offloading Global Presence

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BUMI ARMADA KEY CLIENTS

"We set an ambitious delivery target and it is a credit to all involved that this has been achieved ahead of schedule."
- Pharos Energy (ex-Soco International)

"We are beginning production of the East Hub … 5 months ahead of schedule"
- Eni Angola

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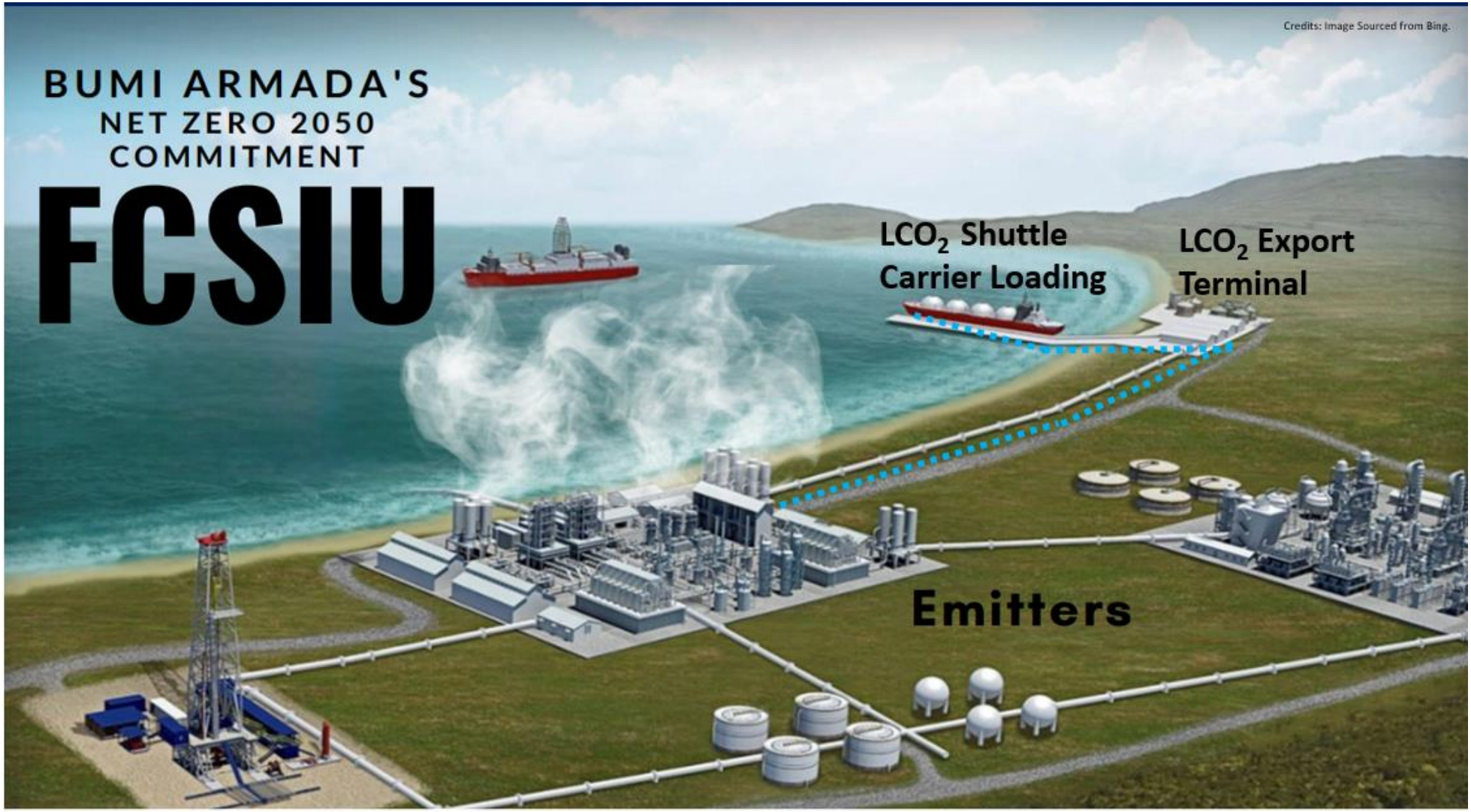
FROM EMISSION TO SEQUESTRATION



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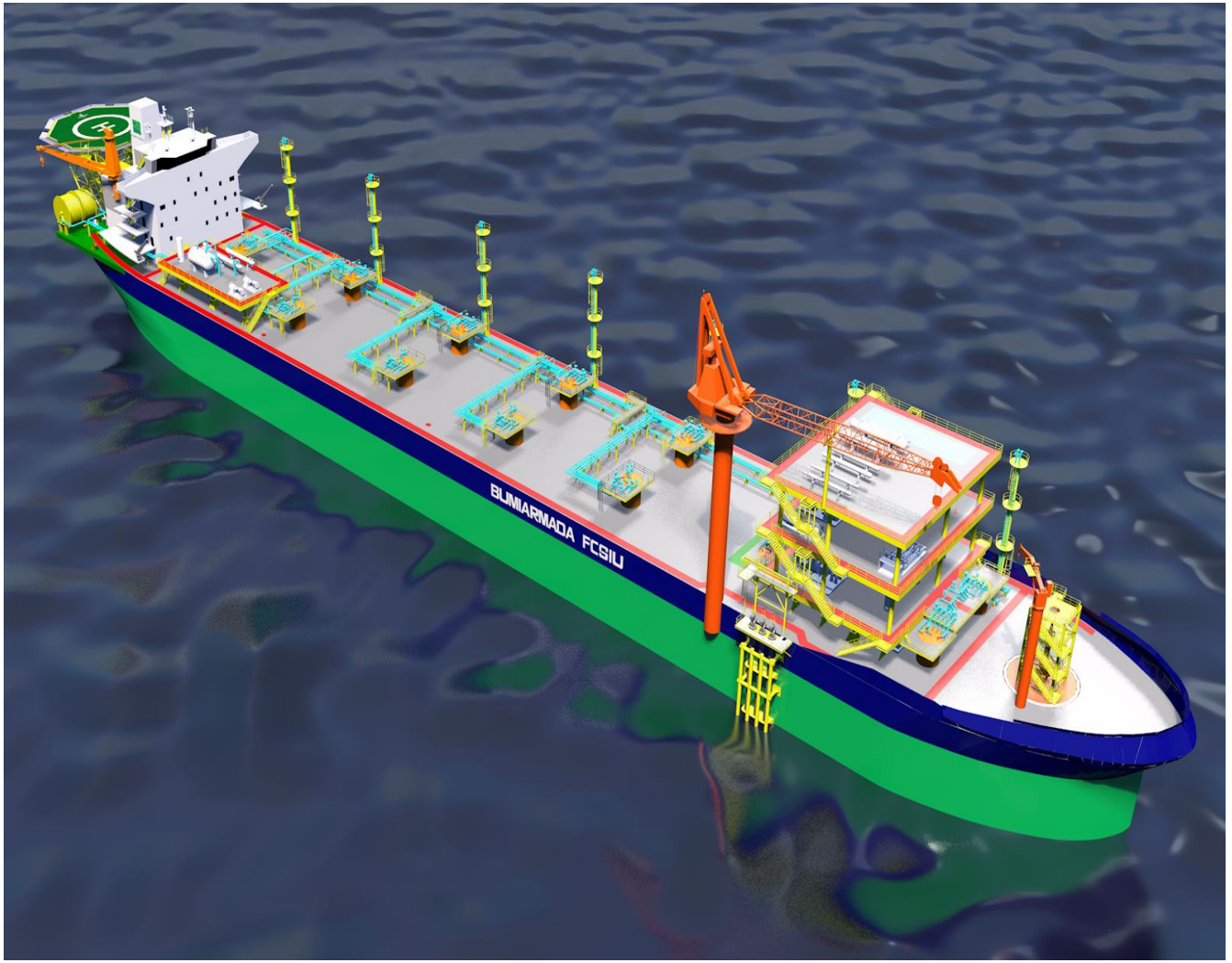
FLOATING CARBON STORAGE AND INJECTION UNIT (FCSIU)



- The ability to receive LCO_2 parcels in an offshore environment;
- Can receive LCO_2 at:
  - i. Low pressure (7 bar and -50°C)
  - ii. Medium pressure (15 bar and -26°C)
- The availability of offshore LCO_2 buffer storage;
- The capability to condition LCO_2 prior to injection into depleted wells and/or aquifers.

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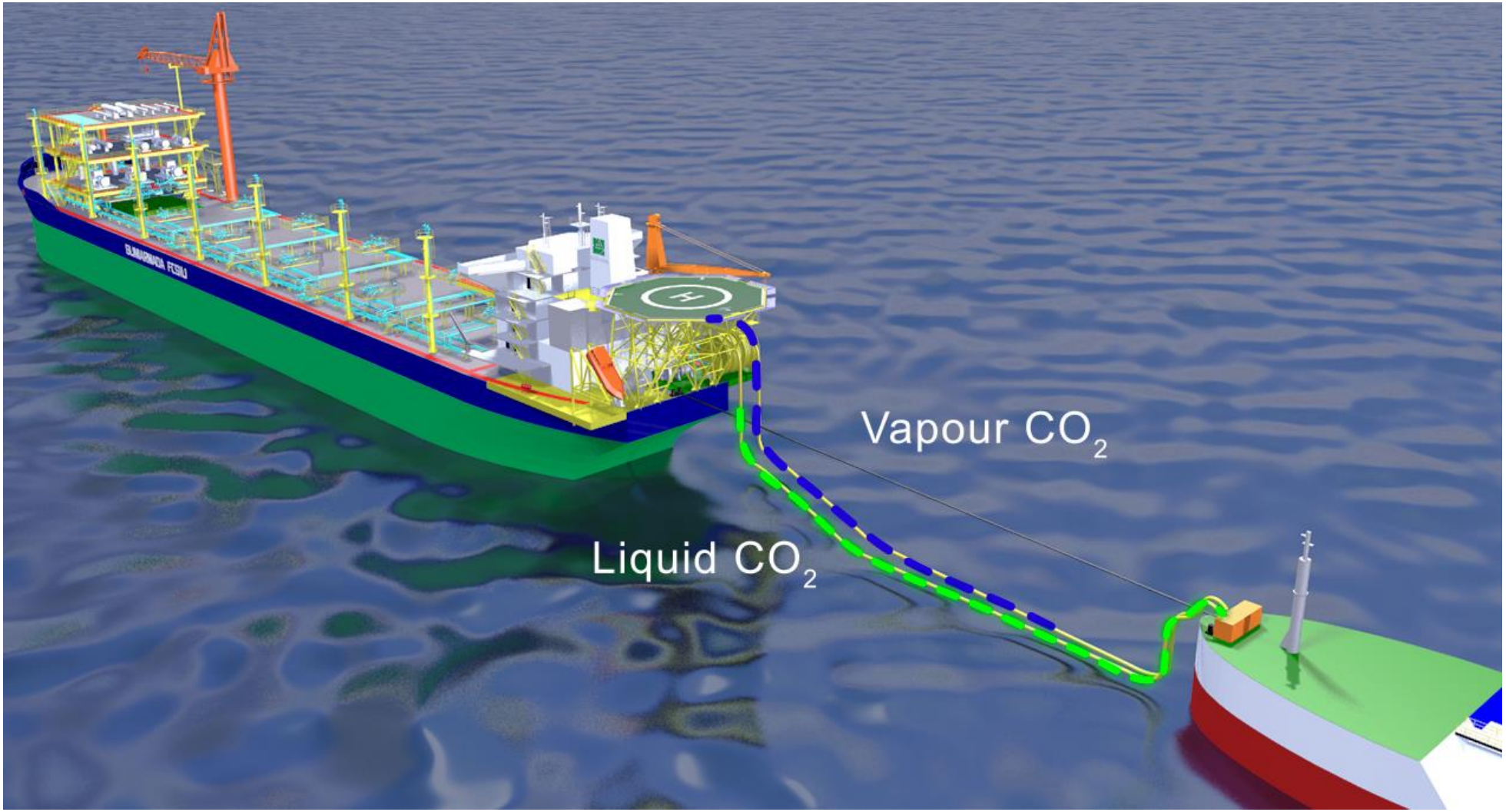
OFFSHORE LCO_2 CARGO TRANSFER SYSTEM



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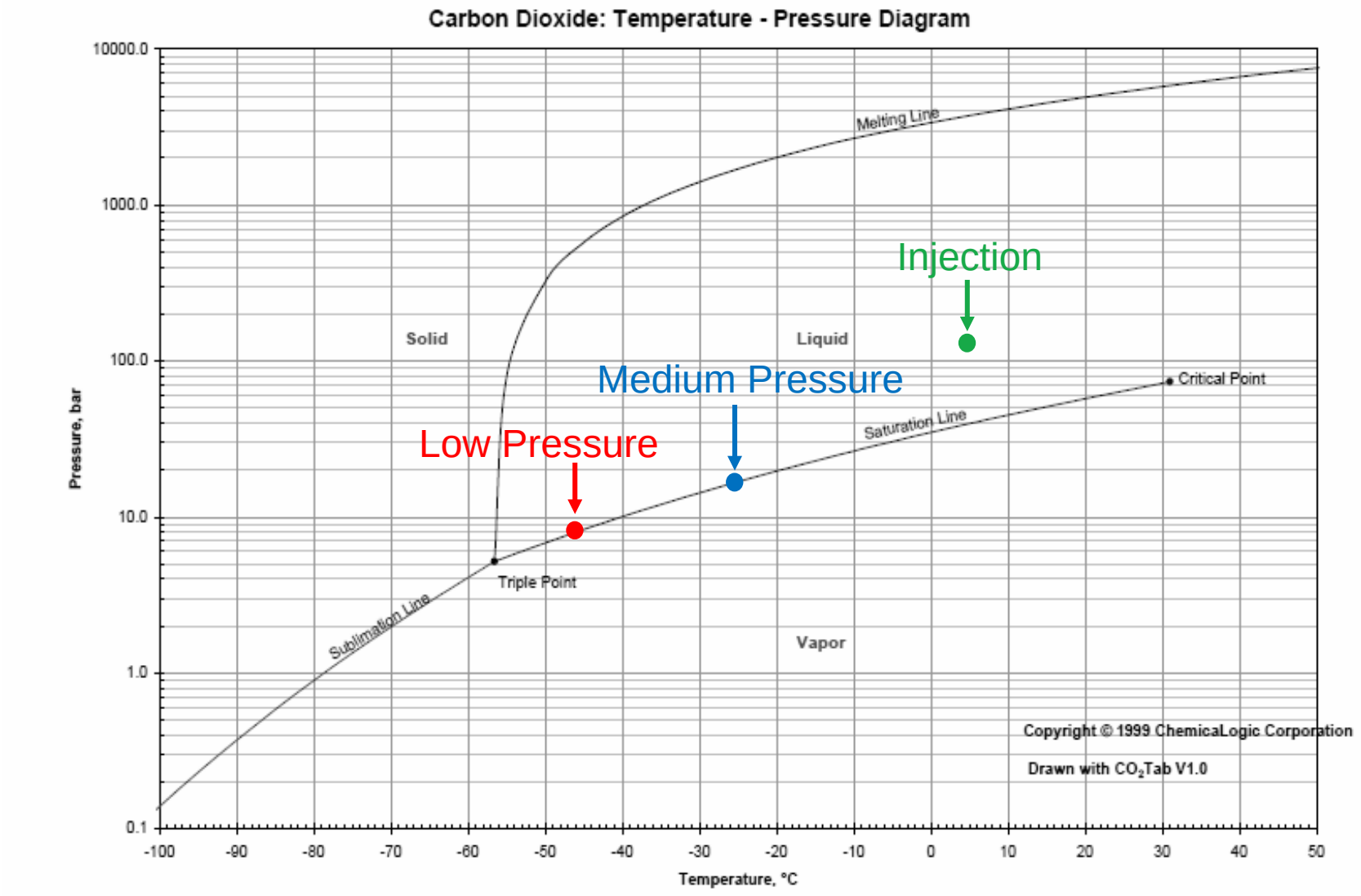
LCO_2 CONDITIONING AND INJECTION



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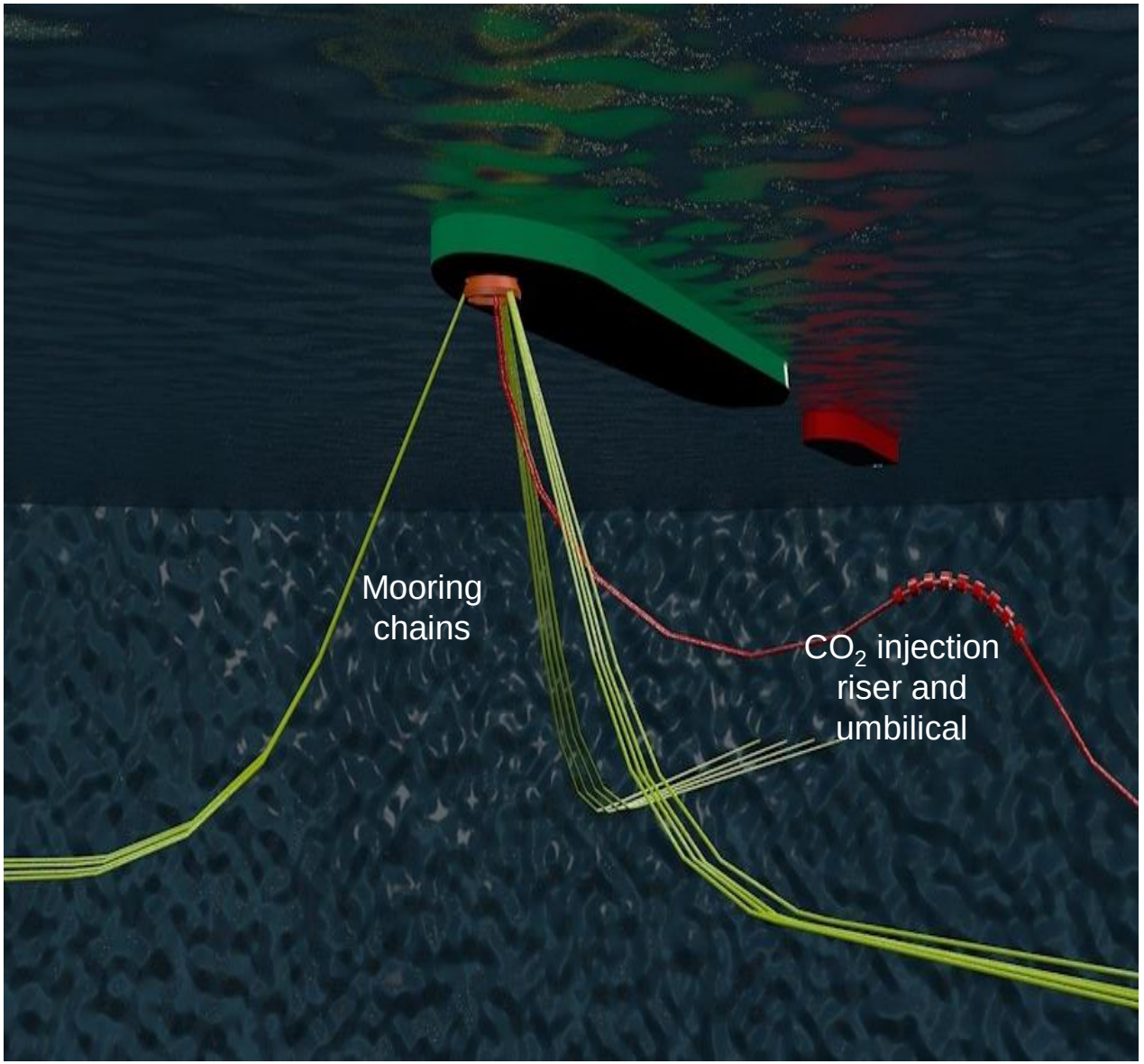
TURRET MOORING SYSTEM FOR NORTH SEA



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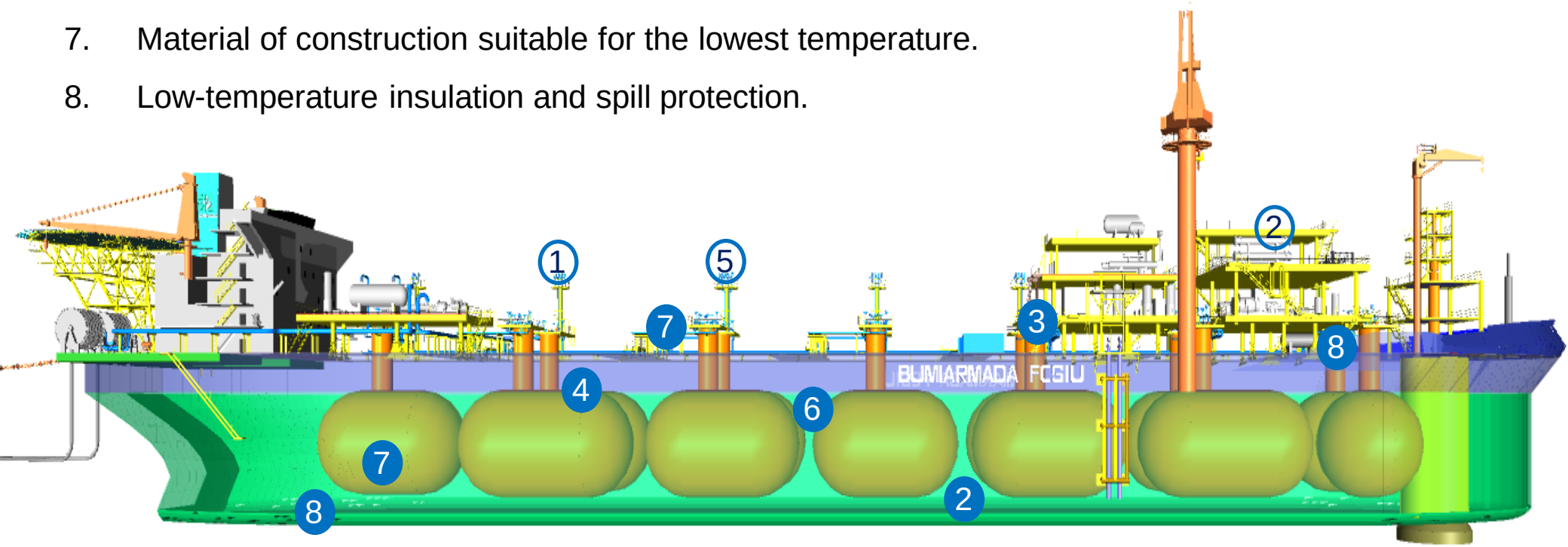
SAFETY IN DESIGN FOR LCO_2 HANDLING FACILITIES

1. PSVs for individual LCO_2 buffer storage tanks provides over pressure protection.
2. Cargo hold spaces and modules provided with CO_2 gas detection and monitoring system.
3. Gap between decks to promote natural ventilation and dilution of any CO_2 leakage.
4. Storage tank dome housed in caissons to minimize CO_2 leak potential into cargo hold space.
5. CO_2 dispersion study will verify vent mast height and overboard orientation of discharge tip.
6. Cargo hold spaces provided with portable ventilation system connection for safe entry.
7. Material of construction suitable for the lowest temperature.
8. Low-temperature insulation and spill protection.



BUMI ARMADA FCSIU VIDEO

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NAVIGATOR GAS

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