

# Northern Lights

A European CO<sub>2</sub> transport and storage network

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Marine CleanTech  
NL Shipping – Frank Ollerhead

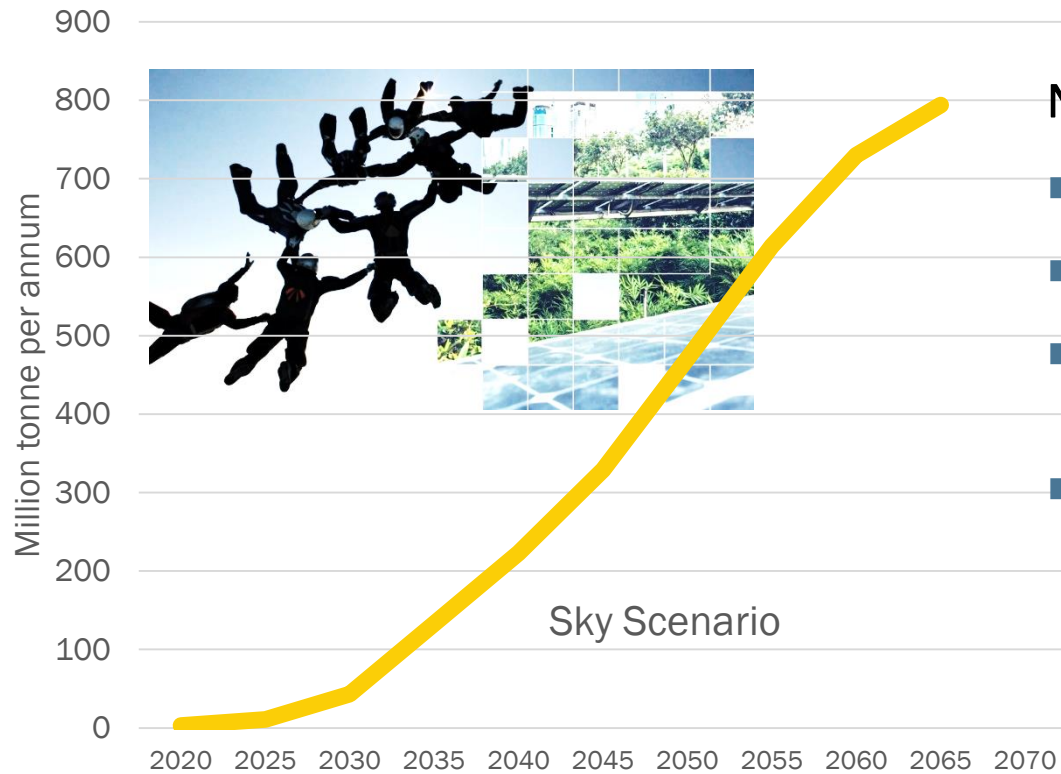


**TOTAL**

# Decarbonising industry !

## - Fundamental to meet Paris Agreement targets

800mtpa CO<sub>2</sub> from industry to be stored in CCS  
in Europe alone



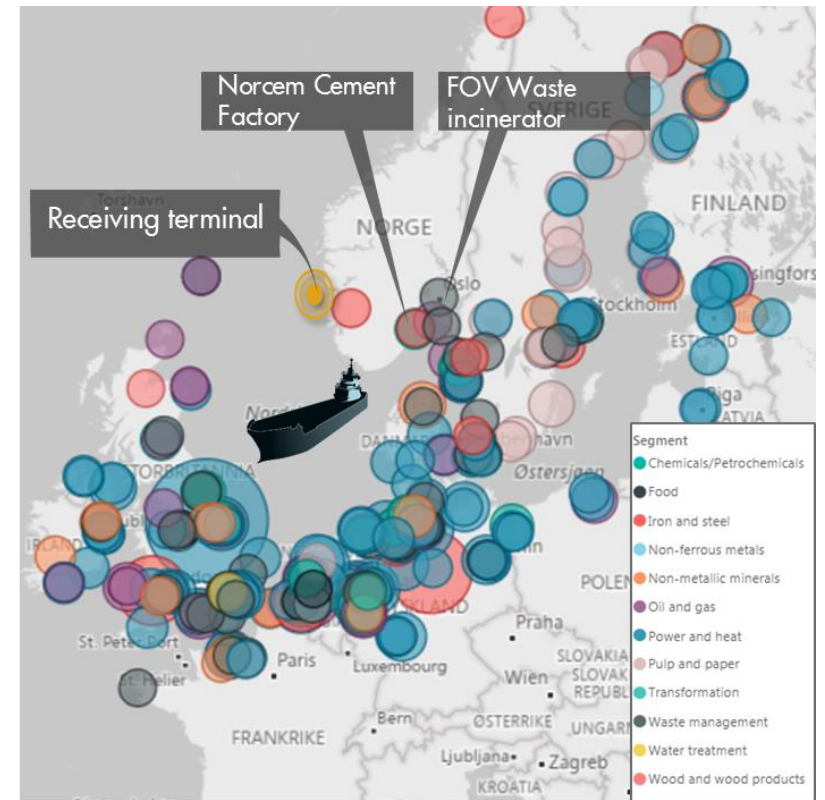
**Northern Lights uniquely develops a number of key concepts:**

- The project breaks the link between source and sink
- The project targets industry that is hard to decarbonise
- Northern Lights uses CO<sub>2</sub> shipping which offers a flexible CCS solution, for emitters without nearby storage
- Project expansion tests cross-border transportation and storage of CO<sub>2</sub>

*In order to achieve these growth rates,  
governments will need to make CCS investable  
for commercial players.*

# Future for CCS - key in the climate toolbox

- Need to establish this market – to drive commerciality
- Future iterations likely to need a lower pressure solution - means operating nearer to CO<sub>2</sub> triple point ... but is manageable
- future market – shipping could unlock it, and be the differentiator!
- Floating storage direct injection could open up even more projects
- Scaling up, so cost will come down –

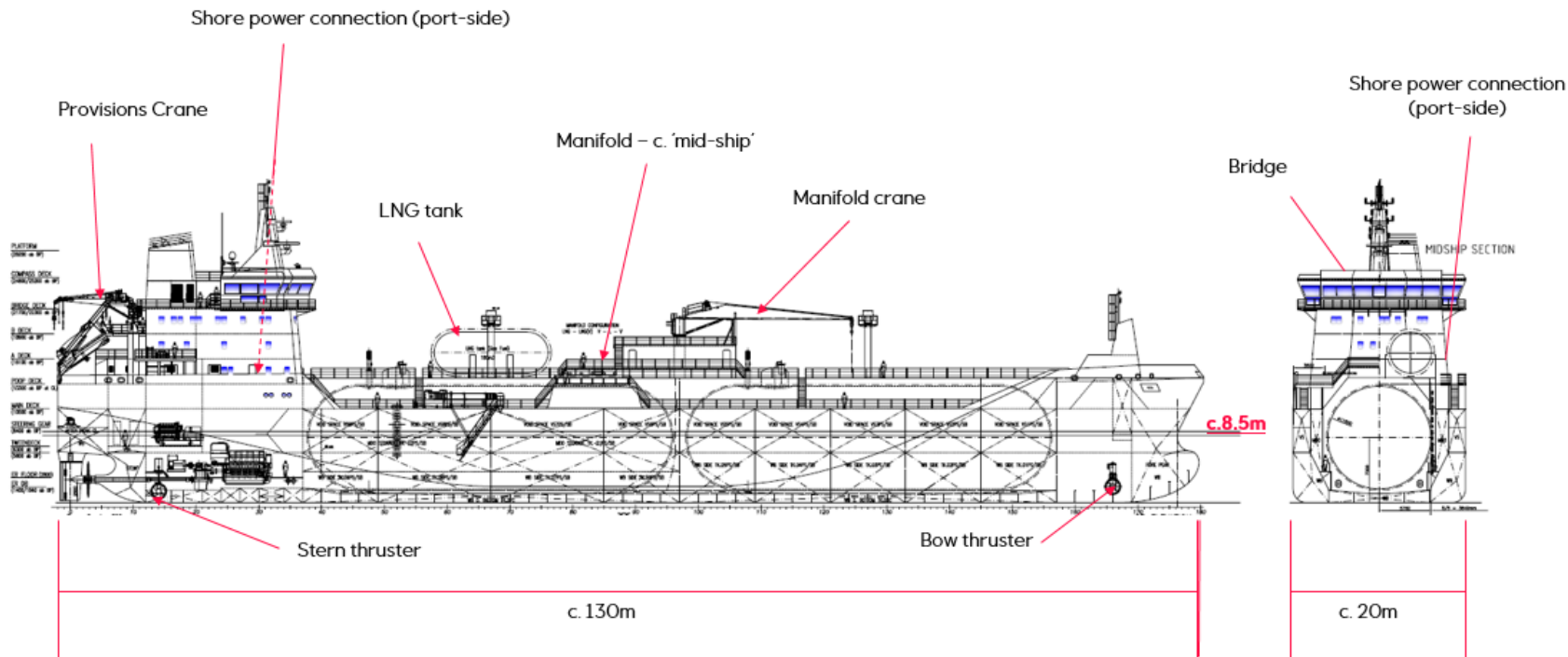


Large emitters (> 0.5 mtpa), near a port, within 1500 km of receiving terminal



# Ship Highlights – Basic – But first of a kind

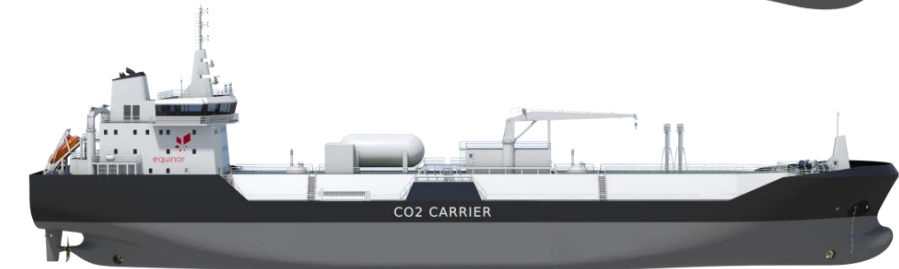
- Currently tendering
- Strategy ‘keep it simple’ – ‘standard’ design & size
- Proven concept (scale-up food industry vessels)
- Norwegian flagged - crewed by approx. 13-16 crew
- Shore power supply
- Interface developed with Acorn CCS in the UK and others (Ervia)





# Cargo Systems for CO<sub>2</sub>

- 2 ships x 7,500 m<sup>3</sup> cargo capacity 2 x type-C cargo tanks
- Operating Condition: 15 to 18 barg, c.-26°C (design 19barg, c.-35°C)
- Offloading via loading arms @ max 800m<sup>3</sup>/hr
- Pump delivery c.25barg at the manifold
- High tensile t50mm steel to enable larger tank diameter to be verified by DNVGL and Norwegian Authorities
  - ❑ Approval in Principle (AiP) complete
  - ❑ General Approval for Ship Application (GASA) Complete



# Challenges – turning the gas business on its head!

Bad image for CCS Public Perceptions – Won't it leak?

Misinformation – Energy companies want to sell more Fossil fuel!

London protocol – prevents waste from crossing borders (close to resolution) – *NEW agreed a legal amendment to allow govts to trade between each other before full ratification*

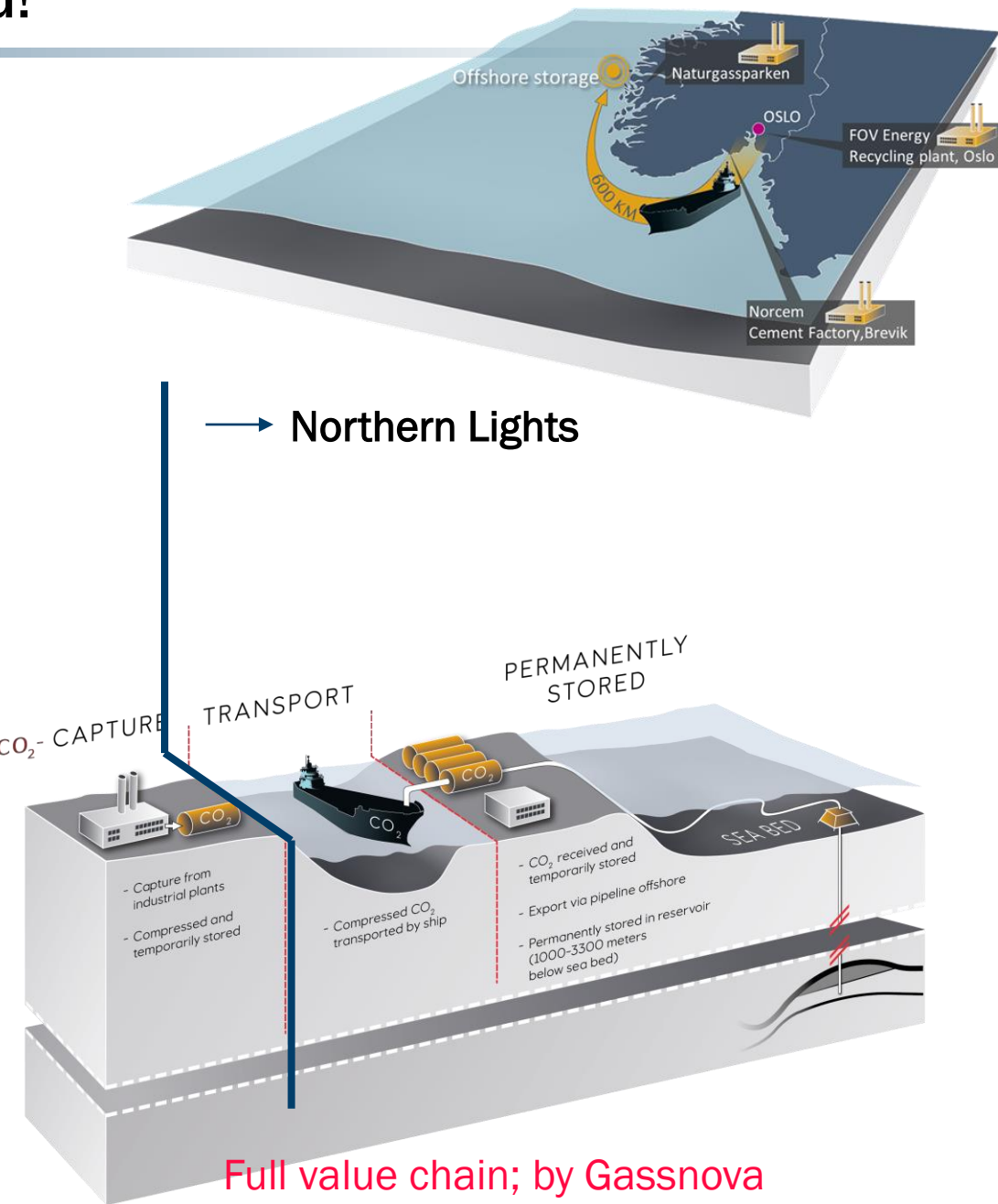
Multi-layered: world needs renewables businesses, low carbon energy and focus on carbon capture and storage (CCS).

Ship Technology is lagging - volumes are small for the food industry – NL scales up concept using proven carriage conditions,

Counter-parts aren't shipping or O&G People !

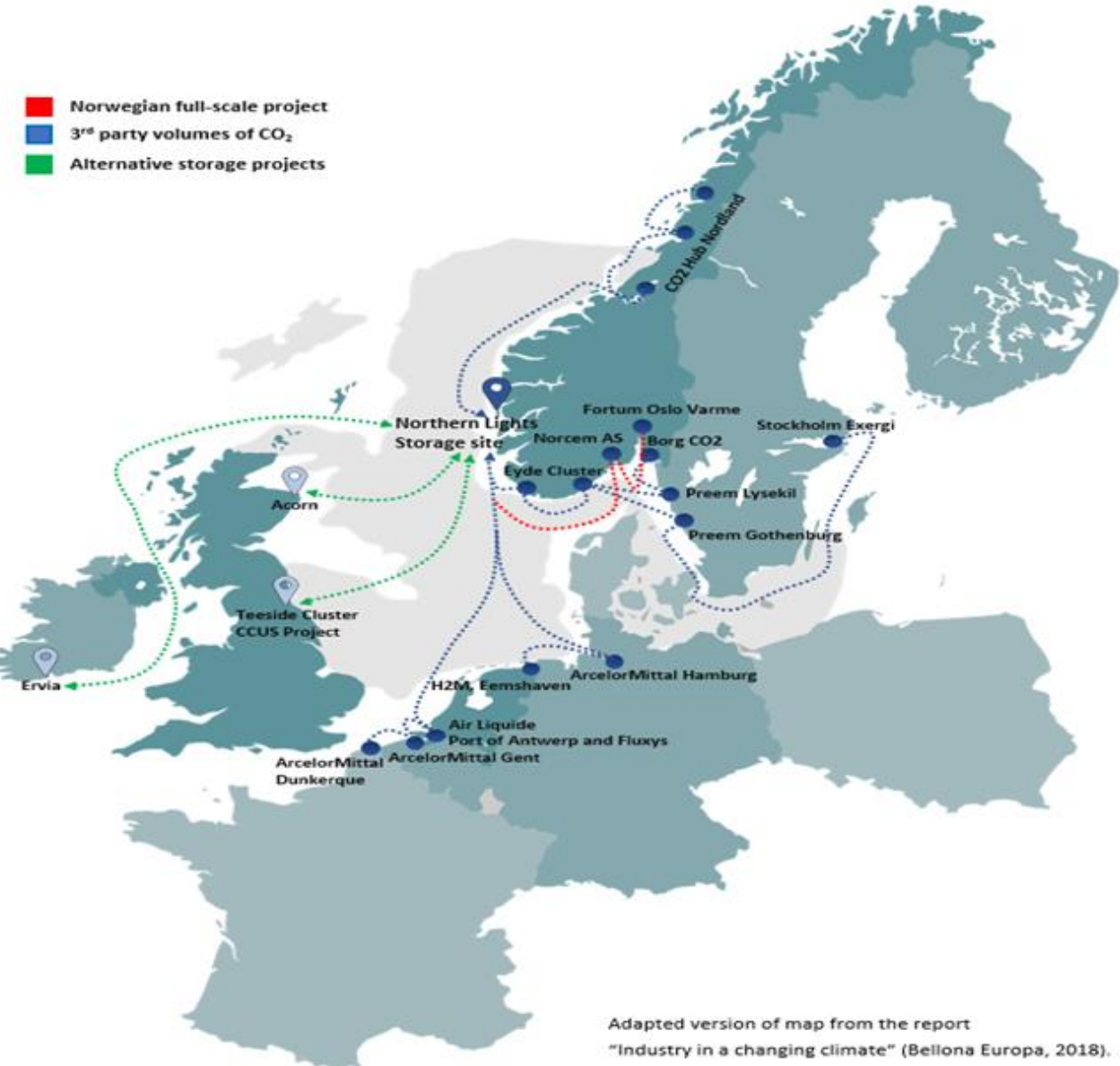
Needs to be scaled up further with R&D –

We look like a FP LPG ship with some insulation – future ships likely similar to SR LPG ships



# Scale-up – future hubs?

- 2 ships on milking route ‘works’ for all ports from Kollsnes to Malmo (2 capture plants)
- Each ship completes trip in ~ 5/6 Days or less

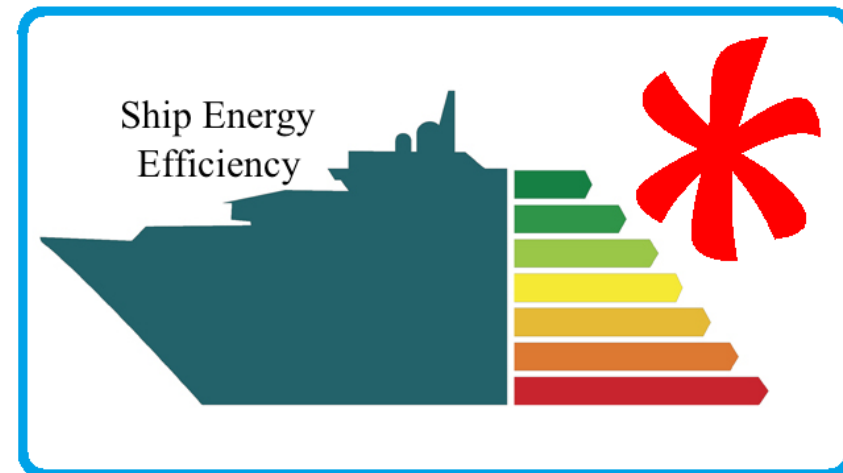


Adapted version of map from the report  
"Industry in a changing climate" (Bellona Europa, 2018).



# Greener focus

- Current goal is to prove trade and market
  - but CO<sub>2</sub> footprint will come into focus
- Energy Efficiency Design Index (EEDI) Phase 3
  - 30% higher efficiency
  - Air-cushion options/rotor sails? (other tech likely required)
- Basic Studies CO<sub>2</sub> Capture technology development
- c.8KT/CO<sub>2</sub> per year emission c.1.5% captured vol
- Develop LP shipping systems – start c.10-20Km3 & Develop floating storage and direct injection
- Future - look at Ammonia, H<sub>2</sub> and LPG as fuels – also trying to use 2 stoke as preference to reduce slip and be ready to repeat



# Onshore Facilities





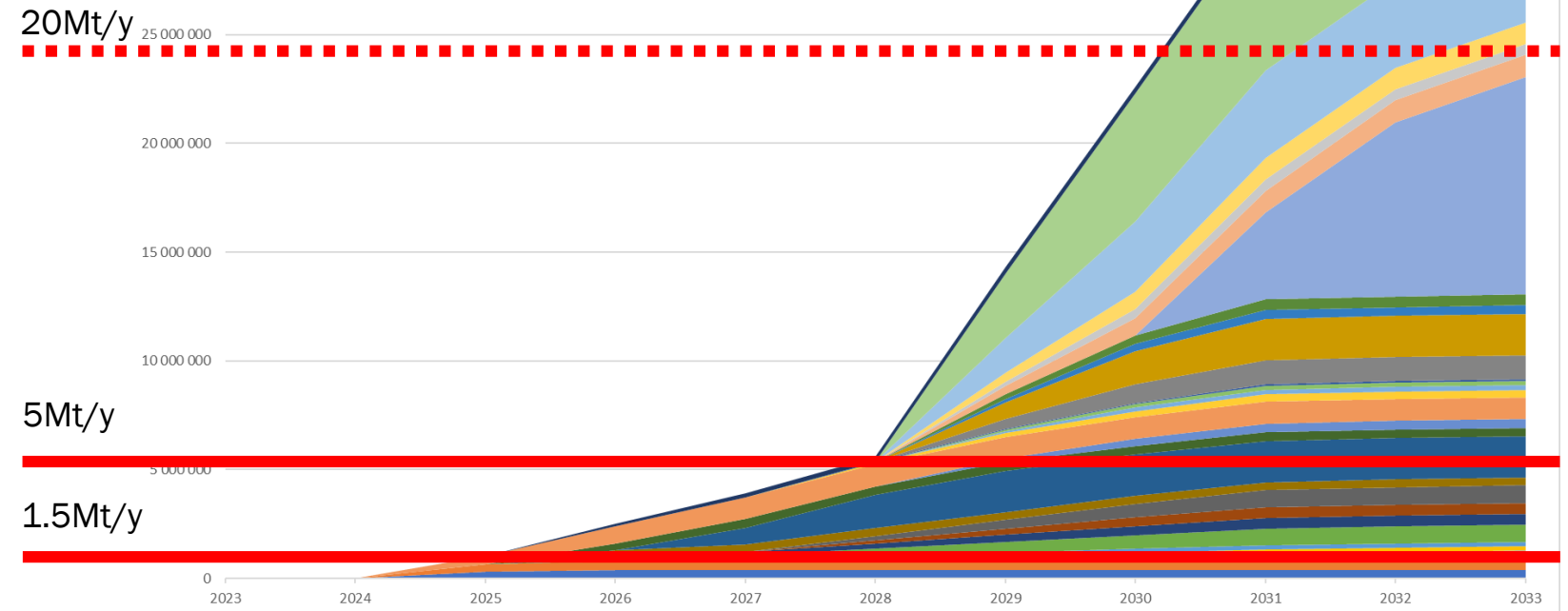
An aerial photograph of a large fleet of cargo ships on the ocean during sunset. The water is a deep blue on the left and transitions to a shimmering golden yellow on the right, where the sun is low on the horizon. Numerous cargo ships of various sizes are scattered across the water, some appearing as small specks and others as larger, more detailed vessels. A large, semi-transparent blue rectangular box is centered horizontally across the middle of the image, containing the text "What does success look like?" in white, bold, sans-serif font.

What does success look like?



# Indictative scale-up - phased

- Phase 1 [ ~8 years from feasibility to start injection ]
- Debottlenecking of Phase 1
- Phase 2 expansion of facilities to fill pipeline capacity of approximately 5 Mt/y [ ~ 5 - 7 years from study start ]
- Phase 3 expansion or new facilities for a capacity of ~20 Mt/y [ ~7 - 10 years from study start ]





# Ship Transport - How do we look?

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