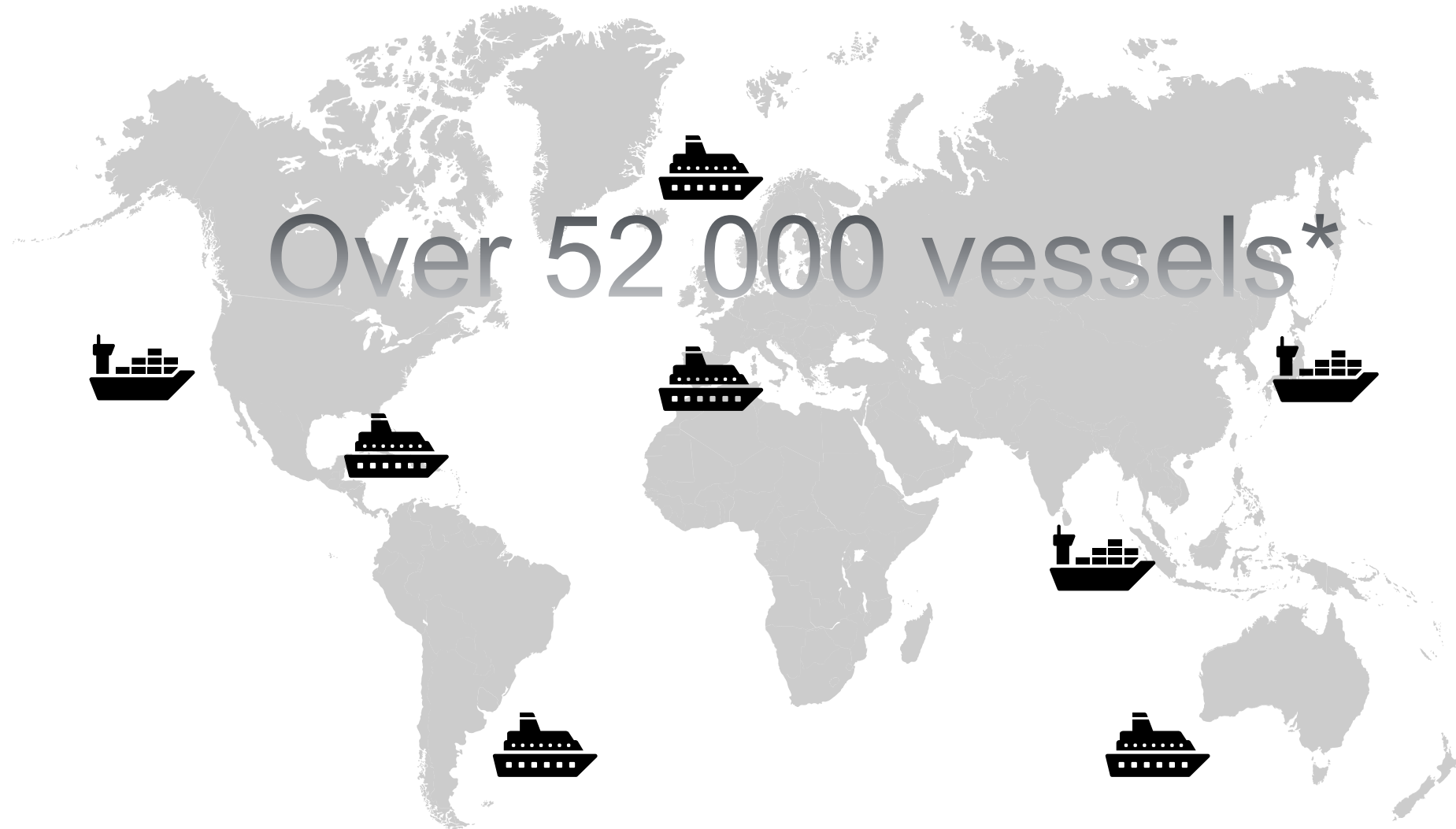


CLEAN MARITIME TRANSPORT: WHAT ROLE FOR LNG?

WÄRTSILÄ VIEWPOINTS ON FUTURE FUELS
KARI HIETANEN, EXECUTIVE VICE PRESIDENT
WEDNESDAY 1 DECEMBER 2021

Shipping is truly a global business sector



Source: UNCTAD calculations, based on data from Clarksons Research. Notes: Propelled seagoing vessels of 1,000 gross tons and above, as at 1 January 2020.

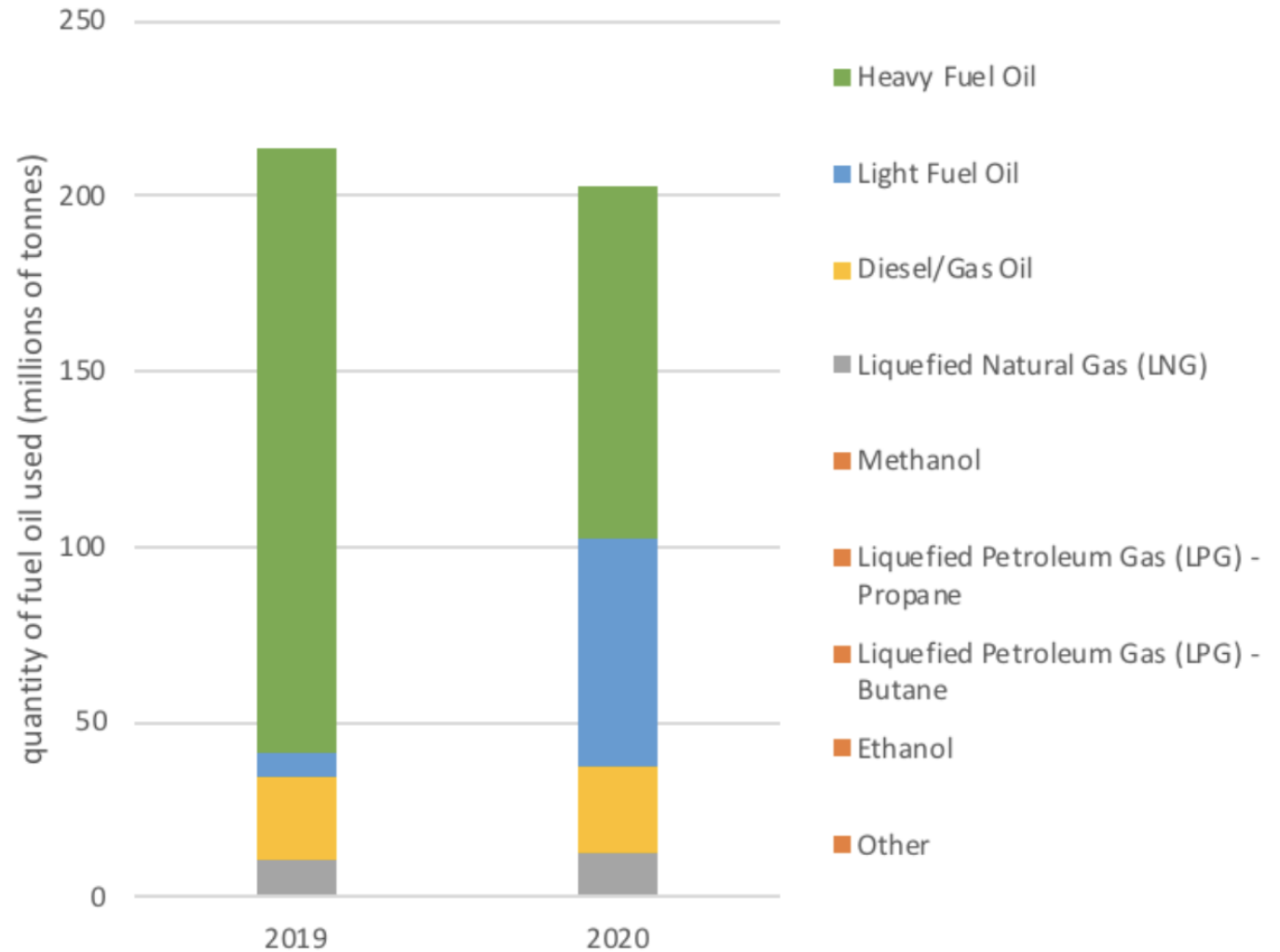
Global Shipping

Figure: The aggregated annual amount of each type of fuel oil consumed by all ships of 5,000 GT and above

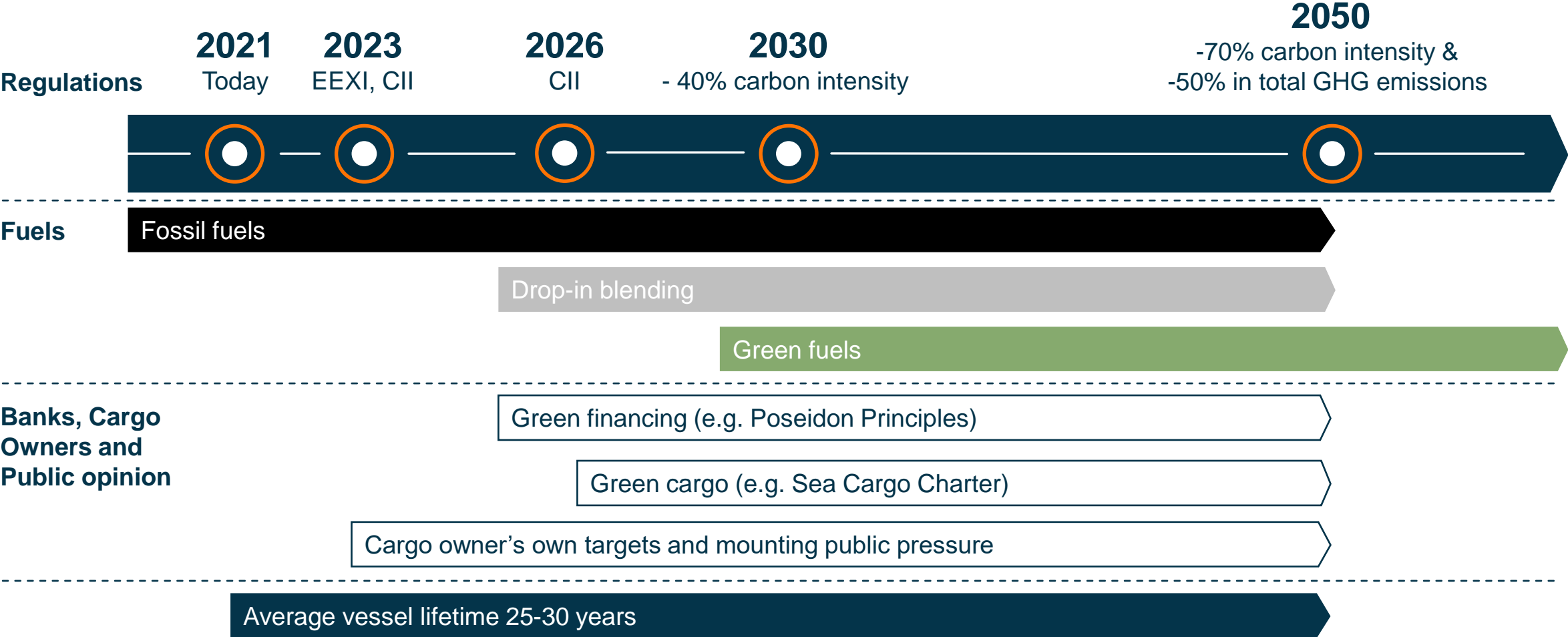
MEPC 77-6-1 Report of fuel oil consumption data submitted.

Relying strongly on liquid fossil fuels

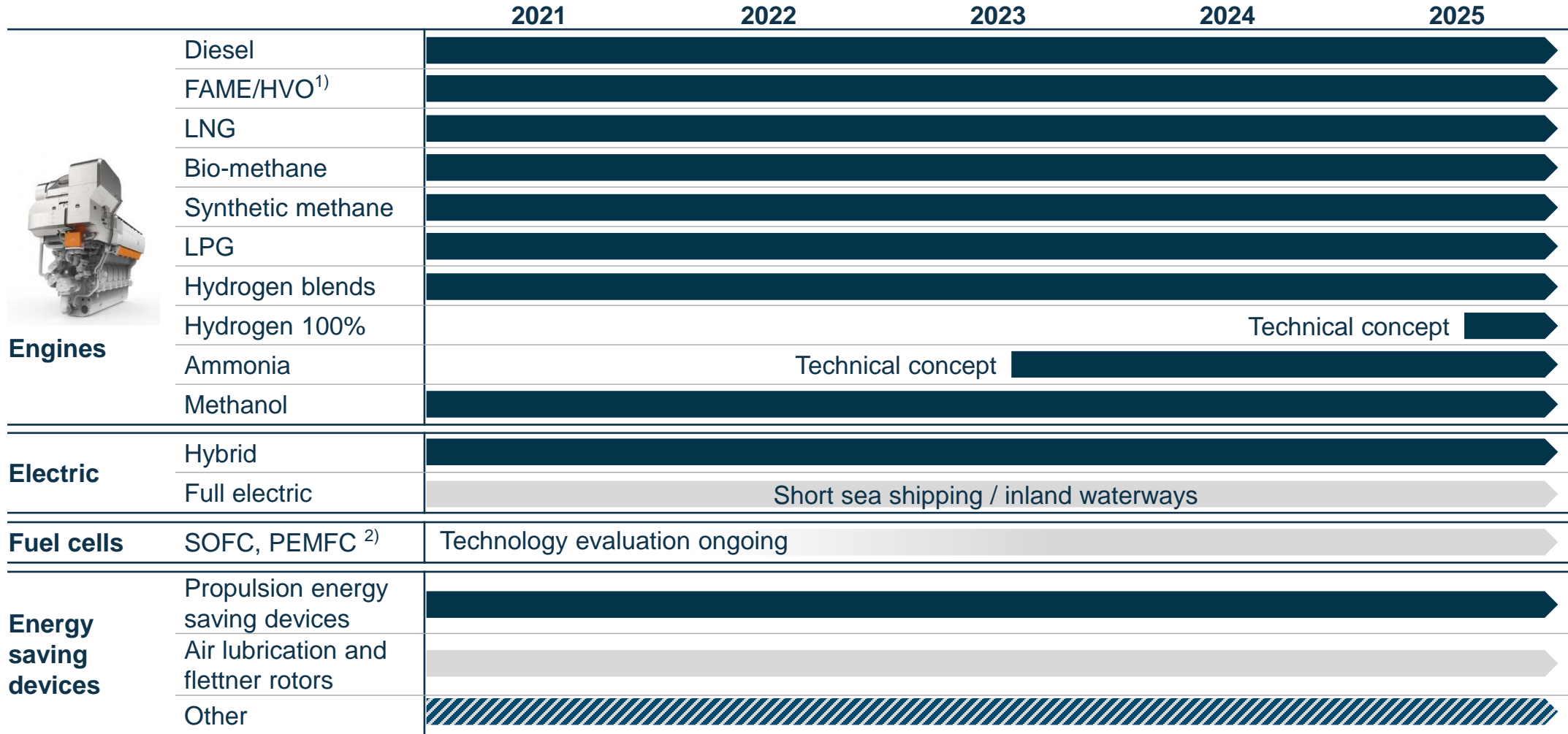
LNG provides means to lower emissions until decarbonised gases available



Decarbonisation targets are shaping the future of our industry. Banks, cargo owners and public opinion have increasing influence in the speed of change




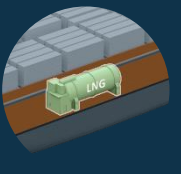

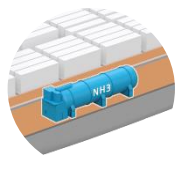
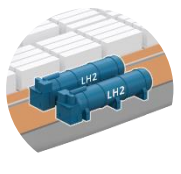
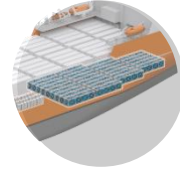

Front-runner in alternative fuel engine technology. Our portfolio goes beyond – we power vessels throughout the path towards decarbonisation



 Own technology
  Through partnering
  Both in house development and partnering

1) FAME, HVO: biodiesel 2) SOFC: solid oxide fuel cell, PEMFC: proton exchange membrane fuel cell

Fuel conversions will play a vital role in the fuel transition for both existing and new vessels built during this and next decade. Fuel selection impacts the vessel structure

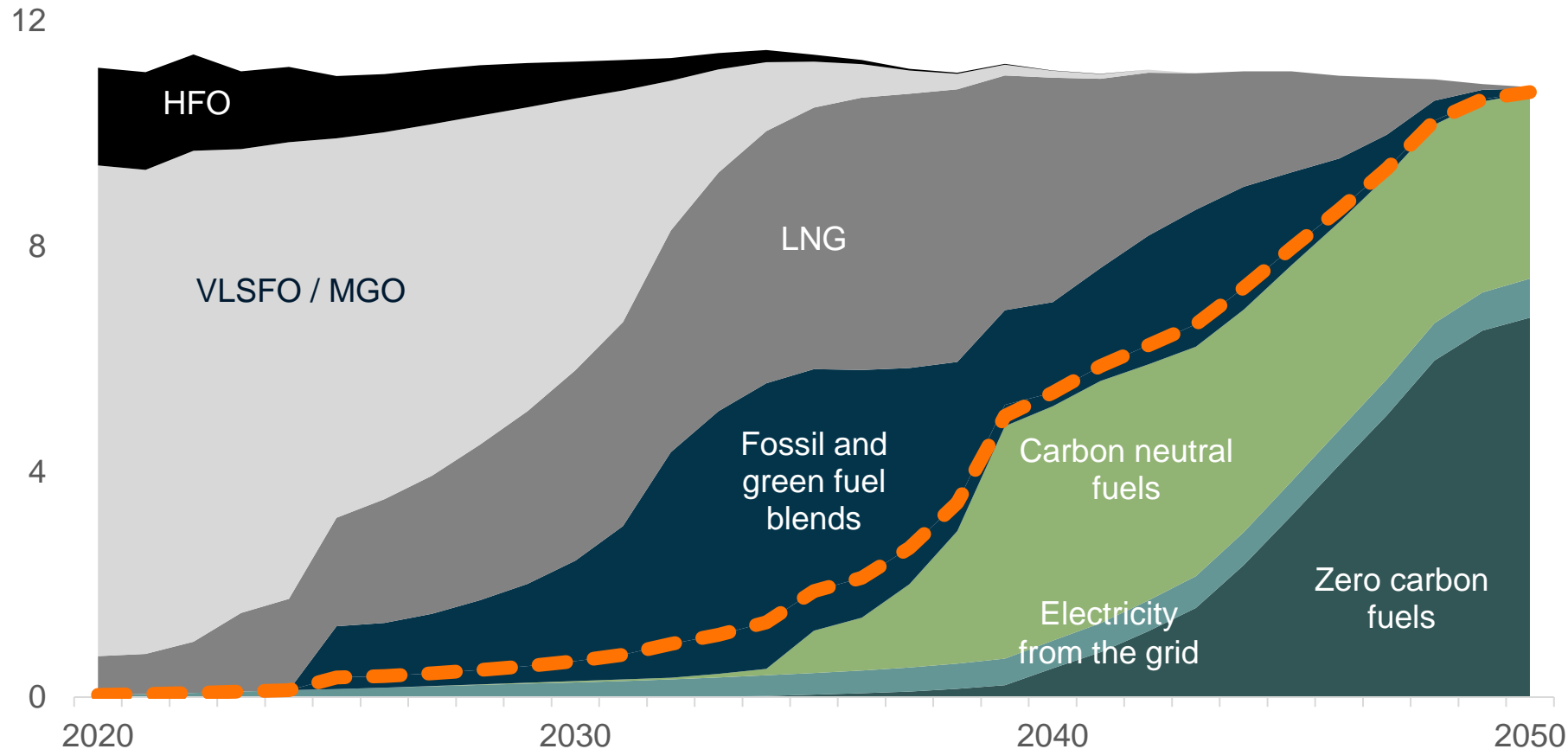
Fuel type	 Heavy Fuel Oil @ 20°C	 Liquified Natural Gas @ -162°C	 Methanol @ 20°C	 Ammonia @ -33°C	 Liquid Hydrogen @ -253°C	 Compressed Hydrogen @ 350bar	 Marine Battery Rack
Key considerations	<ul style="list-style-type: none"> Standard tank arrangement 	<ul style="list-style-type: none"> Cryogenic system 	<ul style="list-style-type: none"> Mildly toxic Flexible tank arrangement 	<ul style="list-style-type: none"> Toxic Corrosive 	<ul style="list-style-type: none"> Highly reactive Cryo system 	<ul style="list-style-type: none"> High pressure Multiple tanks arrangement 	<ul style="list-style-type: none"> Marine adaptation reduces density
Fuel price factor (per GJ)	1X	0.7X ²⁾	2.2X-5.4X ³⁾	2.2X-4.5X ³⁾	2.7X-4.5X ³⁾	1.6X-2.6X ³⁾	1.3X-2.3X
<i>Production cost estimate 2025 ¹⁾</i>							
Gross tank size factor	1X ⁴⁾	2.4X	1.7X	3.9X	7.3X	19.5X	~40X (future potential ~20X)

1) Sources: Maersk Mc-Kinney Møller Center for Zero Carbon Shipping – Industry transition strategy 2021, Wärtsilä-DNV collaboration; 2) fuel price for e-methane is expected to be in a range similar to e-methanol; 3) fuel price range spans across blue, bio and green-electro equivalent; 4) gross tank estimations based on Wärtsilä experience

Transition to green fuels will be slow yet relentless. 2050 is a single vessel's lifespan away – customers need to invest in fuel flexibility to avoid risk of stranded assets


Move from a single-fuel industry to a multi-fuel one

Distribution of fuel types for Decarbonisation 2050 (1.5°C scenario), EJ



Owners will decide on technology partners now:

- Vessel life is 25-30 years
- Critical decision criteria:
 - i) Multifuel capabilities for blending with green fuels
 - ii) Conversion capabilities for future fuels

 Carbon neutral and zero carbon fuels in maritime





WÄRTSILÄ