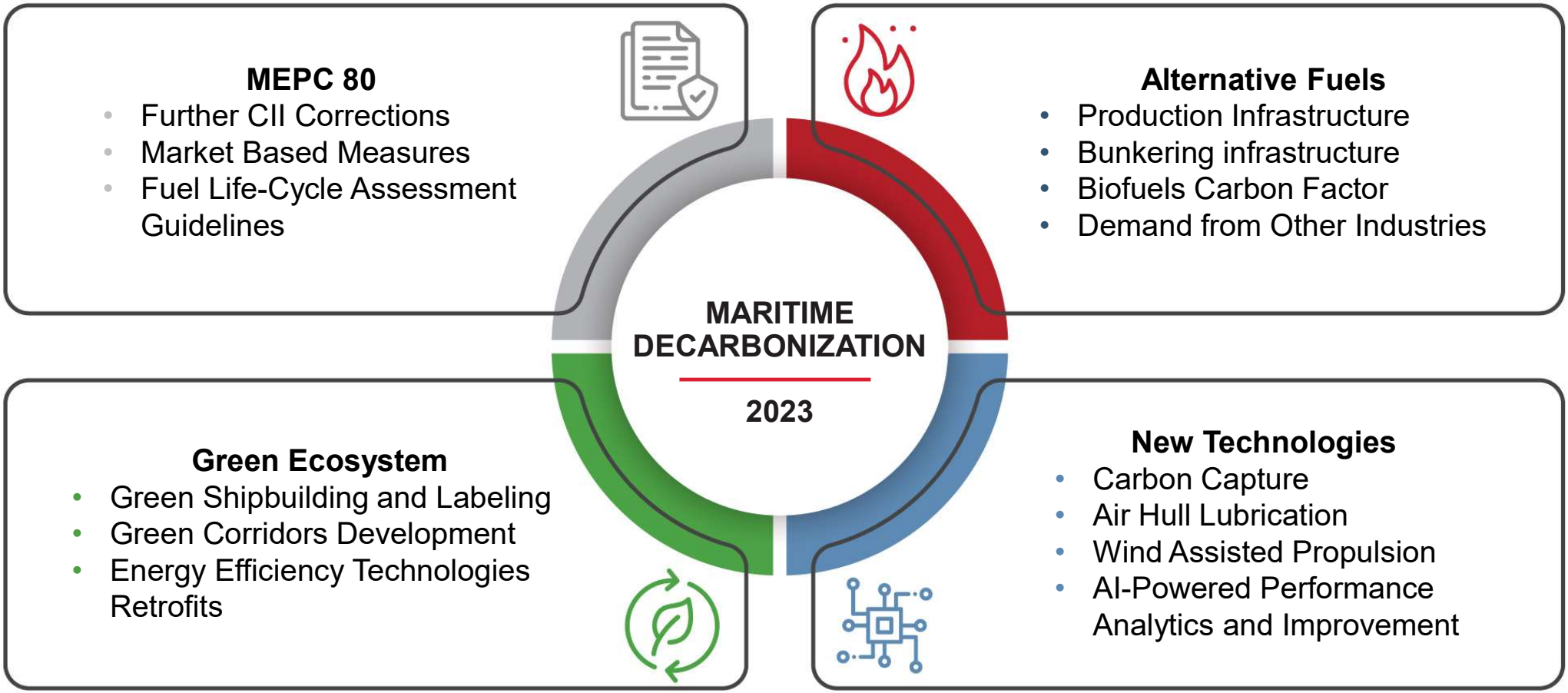
Navigating the Alternative Fuels Landscape – Impact on Fleet Renewal

Vassilios Kroustallis | March 2023

Maritime Decarbonization in 2023: What to Expect



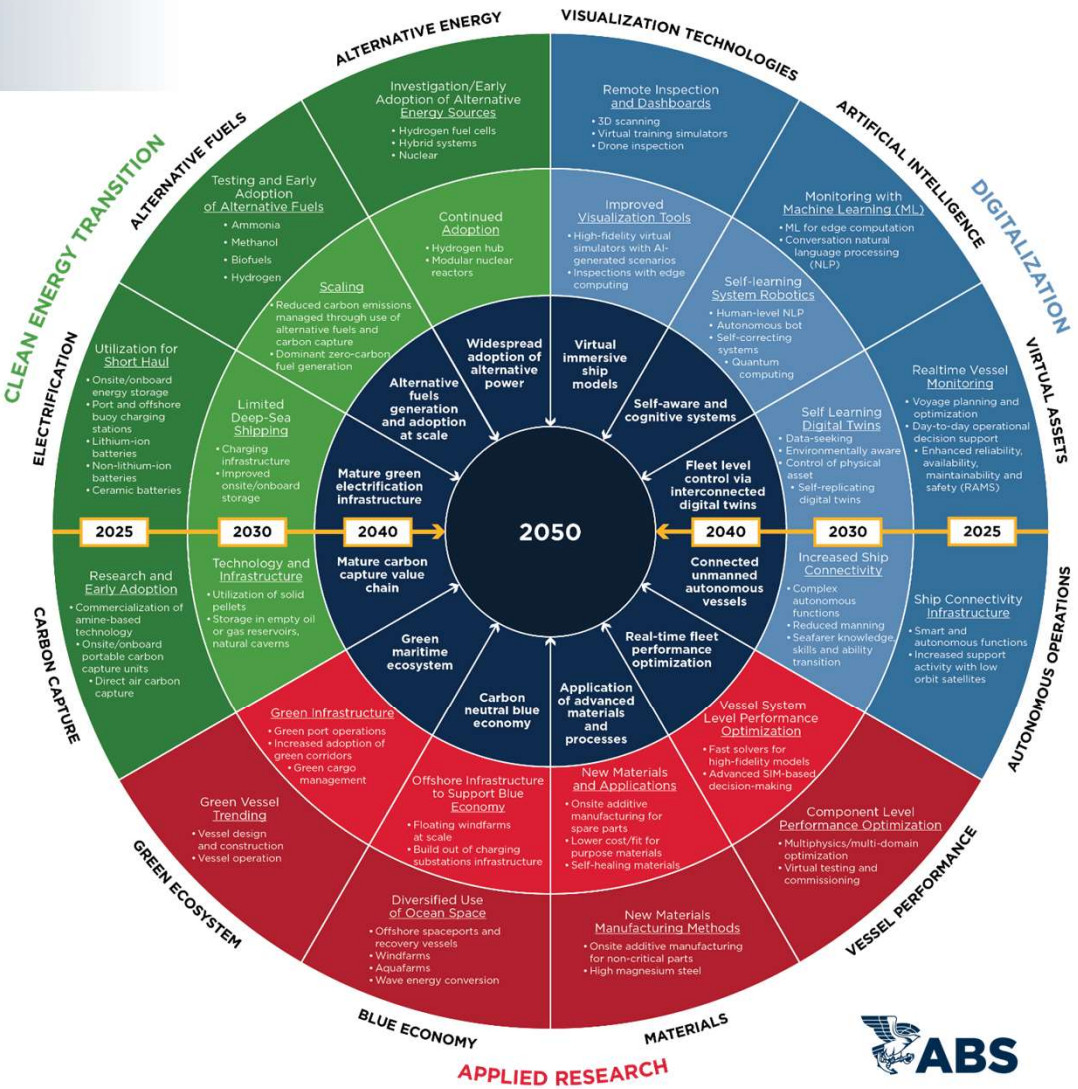
Innovation Outlook

Sustaining innovation for

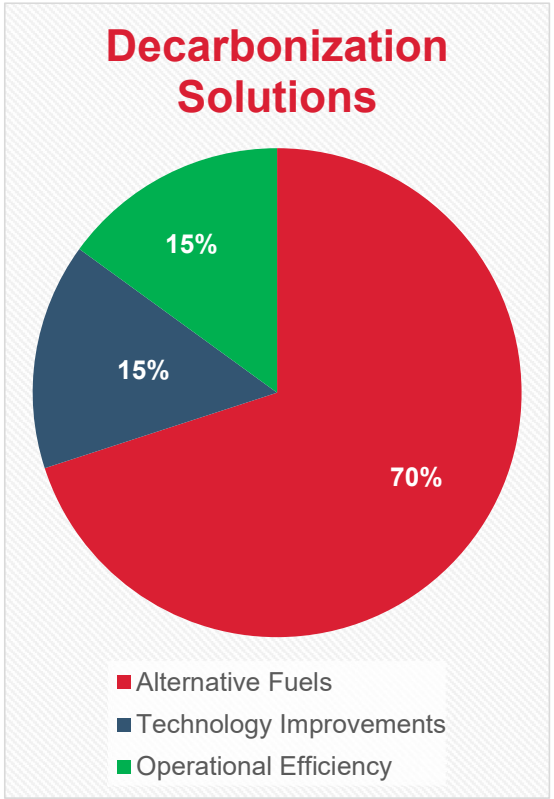
Net-Zero Carbon Environment

enabled by a

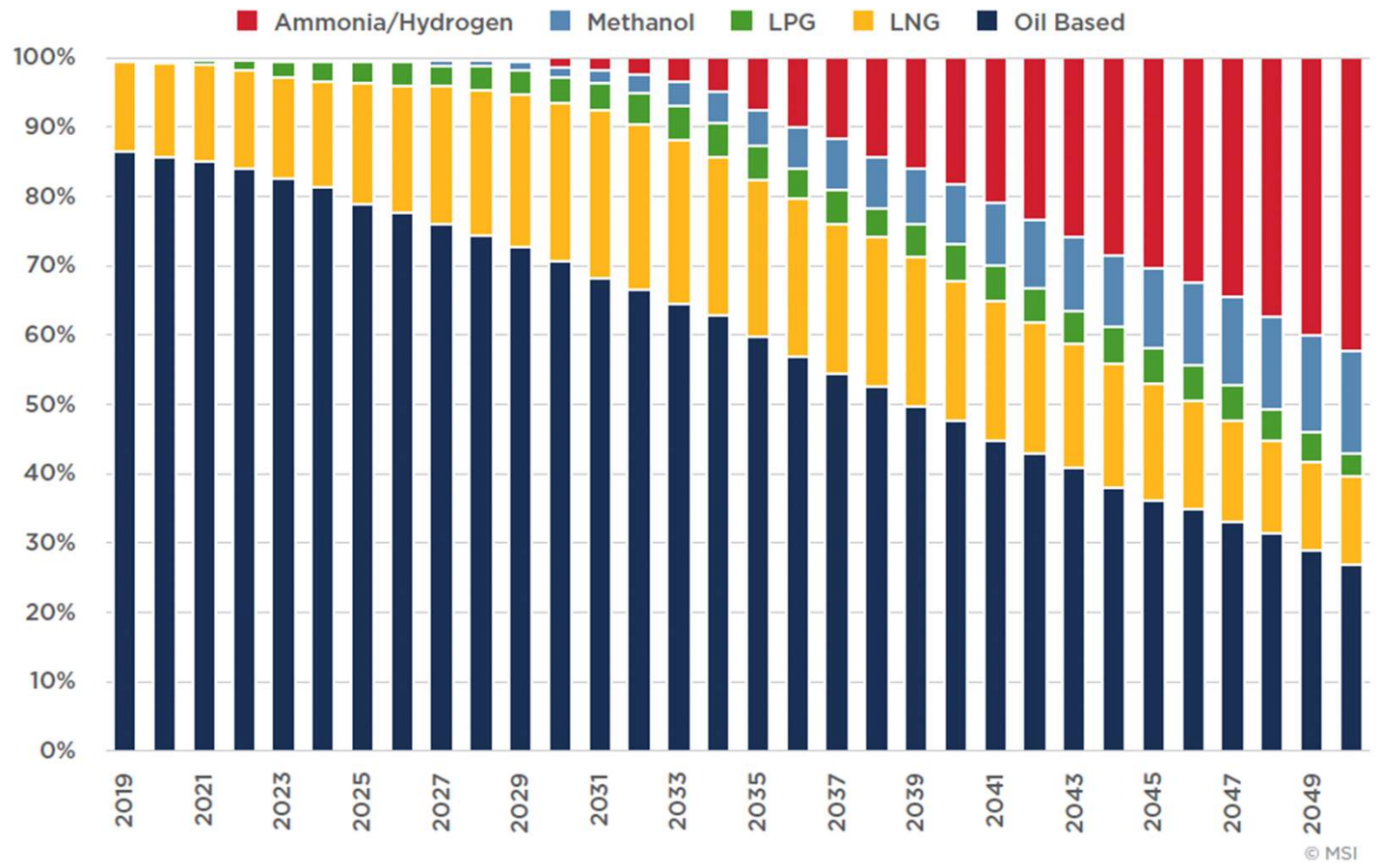
Digital Ecosystem



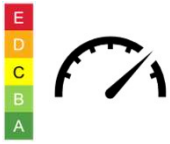
Decarbonization Solutions



The Future Fuel Mix



What is the Expected Impact from CII?



Increased awareness for ship performance (owners, charterers, operations and financial institutions)

Compliance expected **with low OPEX and CAPEX solutions**: speed reduction, scheduling of vessels, energy management

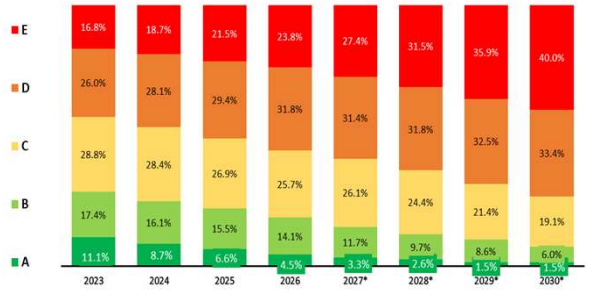
High CAPEX and OPEX solutions are not employed due to regulatory uncertainty and how market will use CII

CII is the current common language for carbon intensity.

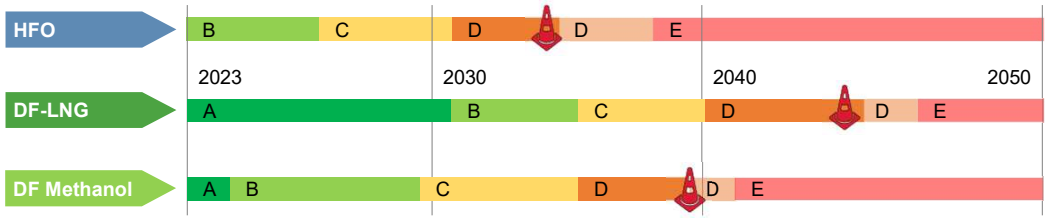
Non-IMO-regulated players impact CII but are not directly regulated by it**:** ports, channels and canals, charterers, brokers and markets in general

CII Impact

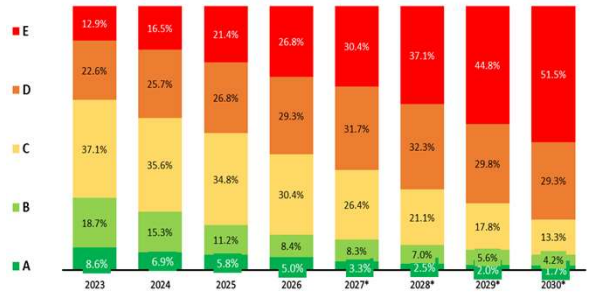
Global Tanker Fleet



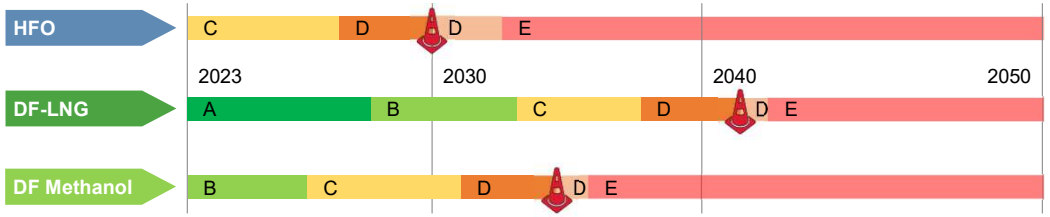
VLCC conventional vs. DF options



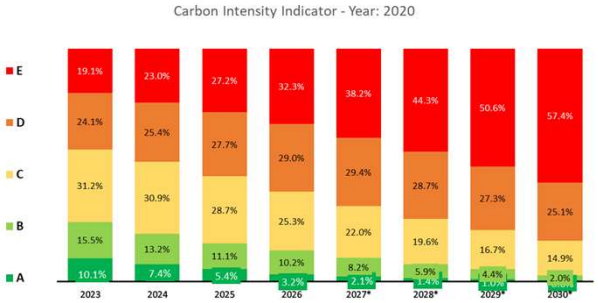
Global Containership Fleet



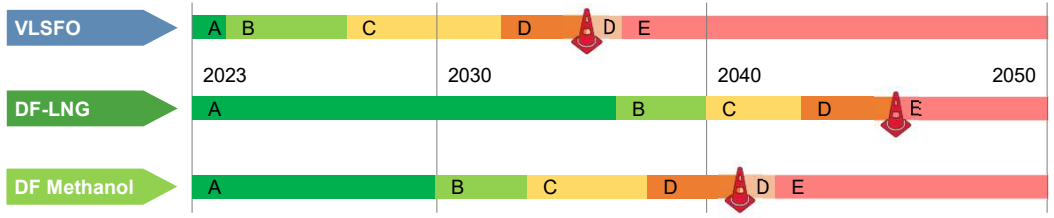
14k TEU conventional vs. DF options



Global Bulk Carrier Fleet



Kamsarmax Bulker conventional vs. DF options

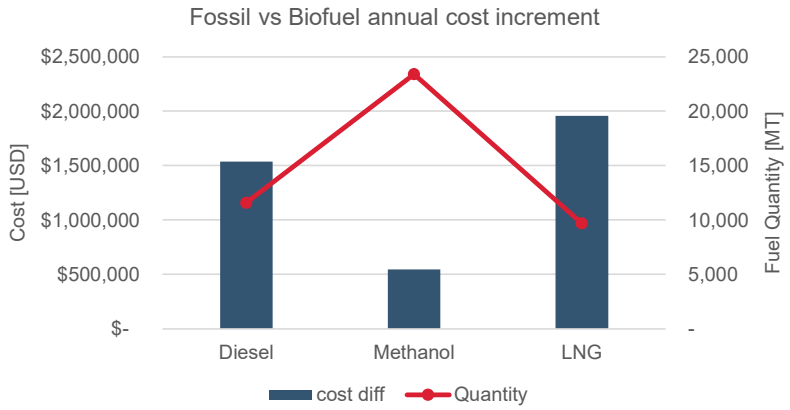


*The current CII regulation covers until 2030; the extension to 2050 is based on assumption

Improvement action required. Additional CAPEX

Biofuel's Effect on CII

- Biofuel blends may reduce the carbon factor for TtW CO_2 calculations for CII
- CII based on TtW emissions
- S_F to be prorated for biofuel blends
- Case Study: VLCC tanker



	MEPC 76 Reduction factor - 2%								Assumed Reduction factor - 2%																			
Vessel	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
HFO	D	D	D	D	D	D	D	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Biodiesel (B30)	A	A	B	B	B	B	B	C	C	C	C	C	C	D	D	D	D	D	D	E	E	E	E	E	E	E	E	E

	MEPC 76 Reduction factor - 2%								Assumed Reduction factor - 2%																			
Vessel	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Methanol	C	C	C	D	D	D	D	D	D	D	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Bio-Methanol (30%)	A	A	A	A	A	A	B	B	B	B	B	C	C	C	C	C	D	D	D	D	D	E	E	E	E	E	E	E

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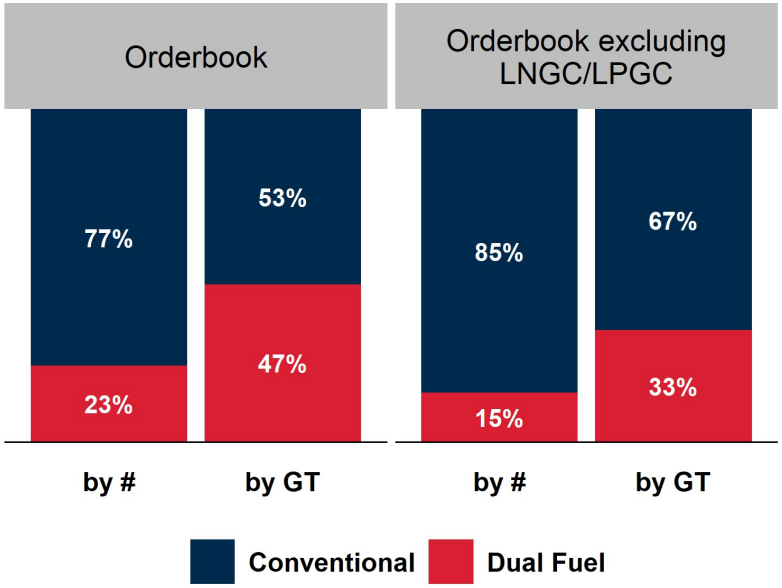
Vessel	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
LNG	B	B	B	B	C	C	C	C	C	C	D	D	D	D	D	D	E	E	E	E	E	E	E	E	E	E	E	E
Bio-Methane (30%)	A	A	A	A	A	A	A	A	A	A	A	A	B	B	B	B	C	C	C	C	D	D	D	D	E	E	E	E

Dual-Fuel Orderbook

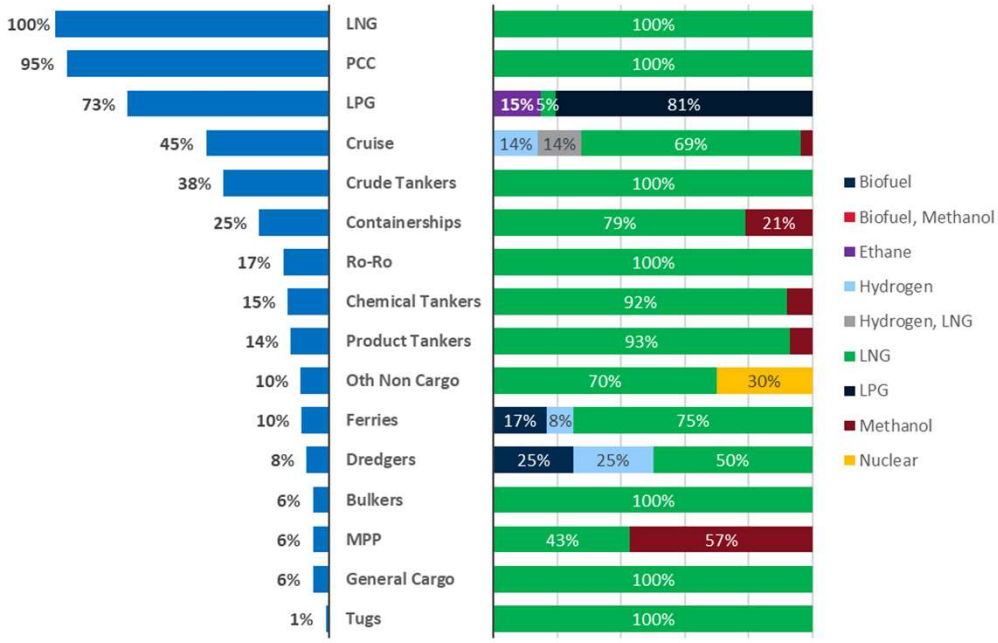
What is the Dual-Fuel share ?



- LNGCs and LPGCs readiness for dual-fuel
- Focus on deep sea larger vessels, Short sea/Coastal vessels and Passenger

What is the Alternative Fuel Mix?

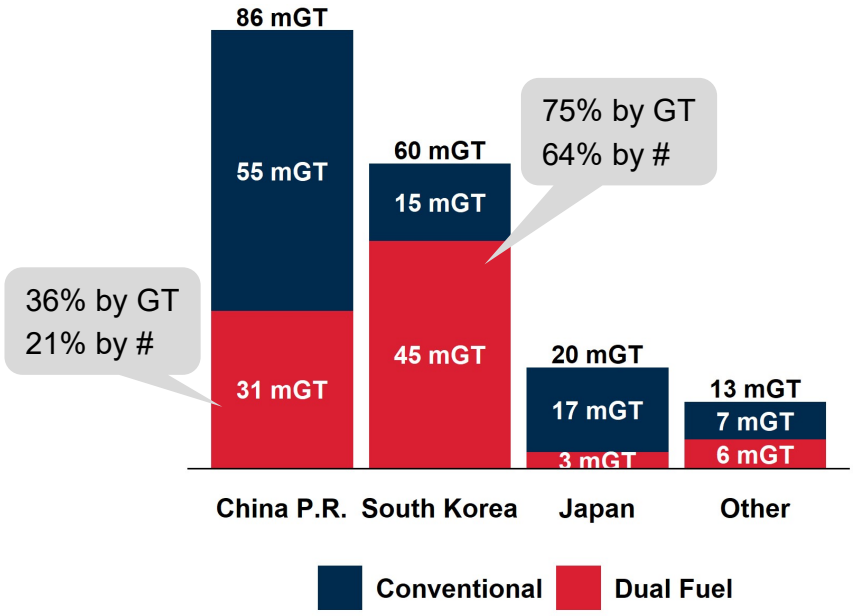
- Mostly LNG … 81% of the orderbook … 86% exc. LNG/LPG
- Followed by Methanol with 6%... 10% exc. LNG/LPG



Data source: ABS, IHS Fairplay, Clarksons January 2023

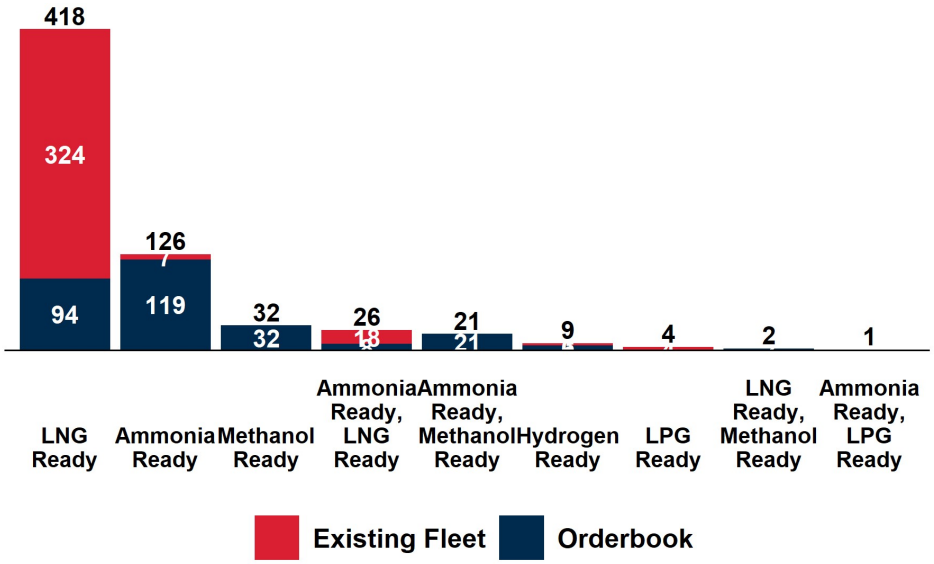
Dual-Fuel Orderbook

Where are Dual-Fuel Vessels built?



- Excluding Gas Carriers, in terms of GT:
  - 53% of Korea orderbook is dual-fuel
  - 29% of China orderbook is dual-fuel

Dual-Fuel Ready… Which alternative fuel?

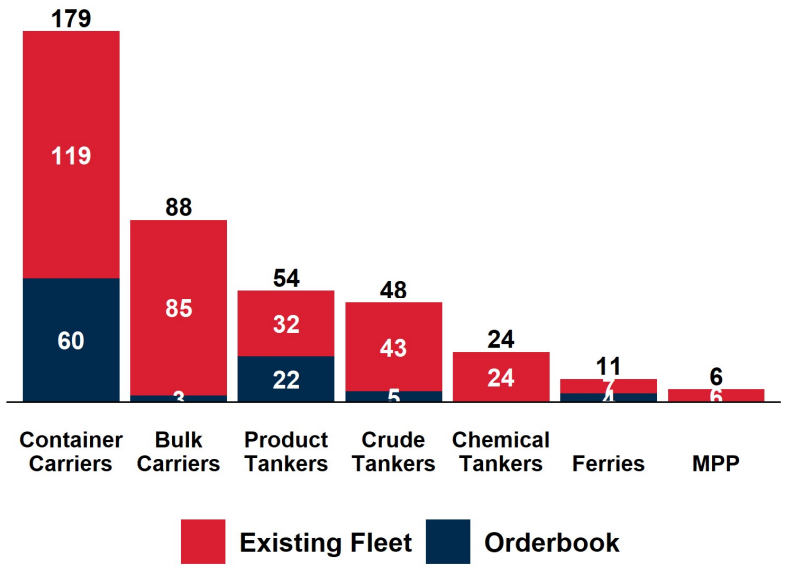


- Dominated by LNG Ready

Data source: ABS, IHS Fairplay, Clarksons January 2023

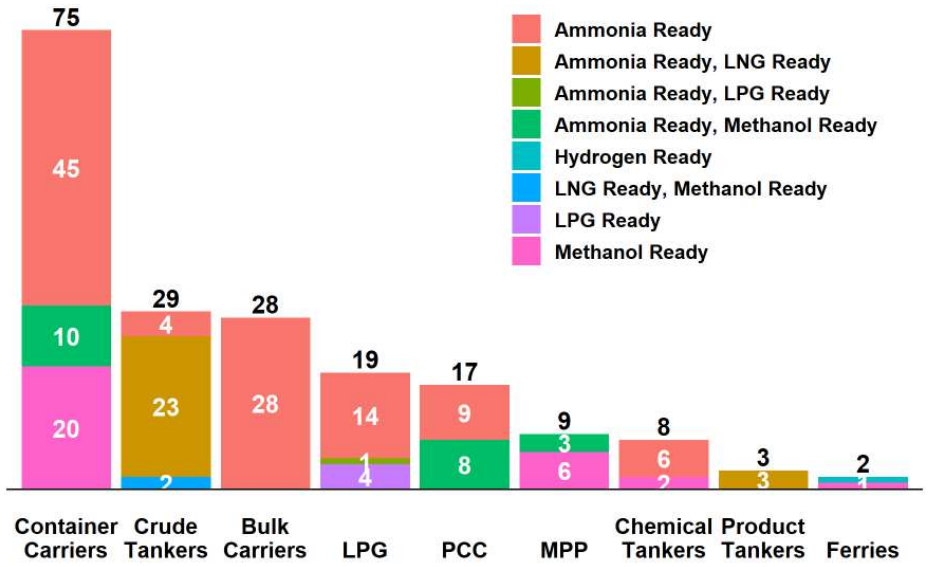
Alternative Fuel Ready

LNG Ready…. Which vessel types?



- Dominated by Container Carriers followed by Bulk Carriers (Chinese built ore carriers).... Crude/Product Tanker rising

Other Alternative Fuel Ready trends….



- Alternative Fuel Ready of choice is LNG… with emerging alternative fuels… Ammonia and Methanol (container carriers)

Data source: ABS, IHS Fairplay, Clarksons January 2023

Carrying Low/Zero Carbon Fuels as Cargo

- Why?
- Large sized carriers
- Challenges
- Big picture

Ammonia

- 29% of the existing fleet of LPGCs capable of carrying ammonia
- 33% of the new orders are ammonia carriers

Existing Fleet

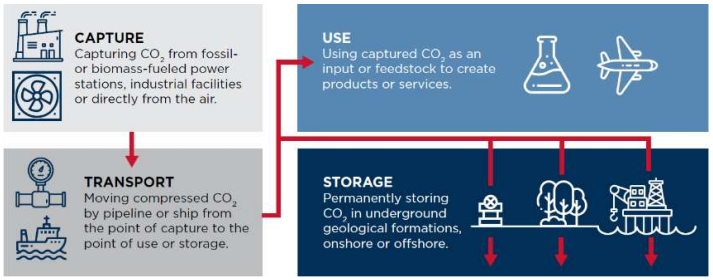
Size	Fleet	Ammonia	%
< 5,000 cbm	597	69	12%
5,000 – 29,999 cbm	474	227	48%
30,000 – 64,999 cbm	133	124	93%
> 65,000 cbm	353	31	9%
Total	**1557**	**451**	**29%**

Hydrogen

- Reaching the required temperature of -253°C is a technical challenge
- Requires high amount of energy for liquefaction
- Any degrading of insulation results in rapid pressure rise, boil-off and required venting
- Trend shifting to cryo-compressed hydrogen
- Cryogenic temperatures required but less so (~ -190°C)
- High pressure (250-350 bar) allowed offers flexibility with handling boil-off

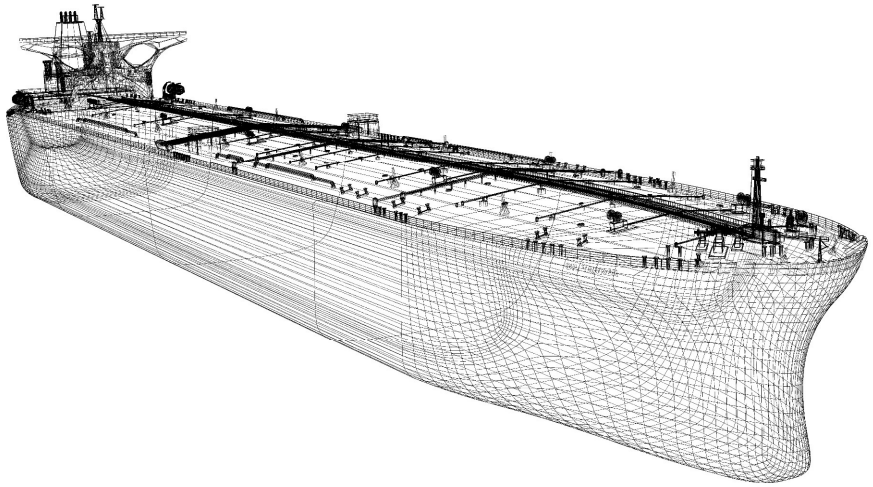
CO_2

- LCO_2 must be carried within a temperature and pressure range that will prevent formation of solid CO_2



Multi-Gas Carriers

A multi-gas options strategy would need to effectively address all the individual risks that might arise from having two or more gases on a vessel.



Potential design of such a carrier will be analyzed taking into consideration:

- Applicability of international regulations and codes and potential conflicts among cargoes
- Material availability and compatibility with all potential cargoes (adequate properties)
- Individual gas characteristics (flammability, toxicity, corrosivity, etc.)
- Constraints due to gas characteristics
- Increase in overall cost due to engineering design constraints (for instance LCO_2 is carried only in Type C tanks)
- Technology development and readiness to handle various cargoes (reliquefaction plants, cargo pumps and compressors)
- Hazardous areas and ventilation requirements

Key Takeaways

1. Asia Leading New Orders
2. China the Major New Construction Area
3. In the Coming Years Expect Increased Number of New Orders with New Technology Ships
4. Which Fuels in the Next Decade?
   - Big Ships:
     - Conversional Fuels
     - LNG
     - Methanol
     - Ammonia
   - Small Ships: All Fuels, Batteries, Fuel Cells Hybrid, Hydrogen
5. Emerging of Carbon Capture and LCO_2 Carriers
6. Emerging of New Fuels as Cargoes (Methanol, Ammonia, Hydrogen and CO_2)
7. Dual-Fuel Ships
   - Almost half of the orderbook is dual-fuel ships and 81% of this is LNG
   - Most of the dual-fuel ships are built in Korea – 53%
8. Not Possible to Replace the Global Fleet Until 2050. Retrofit to Play a Significant Role.
9. Increasing Regulatory and Compliance Risk (Compliance Cost)

Thank You

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