Maritime Bunkering Options for Decarbonisation

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Building a better working world

Low-carbon fuels are entering the market

A change in bunker requirements for lines and ports?

- The International Maritime Organisation (IMO) has targeted emission reductions of 40% on a per vessel basis by 2030, with a goal of net-zero by 2050.
- Regulations and taxes on marine emissions are coming; e.g. the revised EU Emissions Trading Scheme(ETS) will include maritime transport emissions from 1 January 2024
- The majority of the shipping lines have 2050 NetZero targets versus 2040 for Maersk
- Maersk have not considered LNG an option due to its relatively high lifecycle emissions and instead begun developing methanol fuel ships
- LNG is the preferred alternative fuel choice amongst other major shipping lines – particularly for MSC who expressed major interest in using bio-LNG (bio-methane)
- However, more lines are now ordering Methanol fuel ships, notably CMA and in June 2023 COSCO ordered methanol fuel supply system for four 16,000-TEU containerships with COSCO Shipping Heavy Industry (Yangzhou).
- Note that vessels are “duel-fuel” - can also run on fuel oil

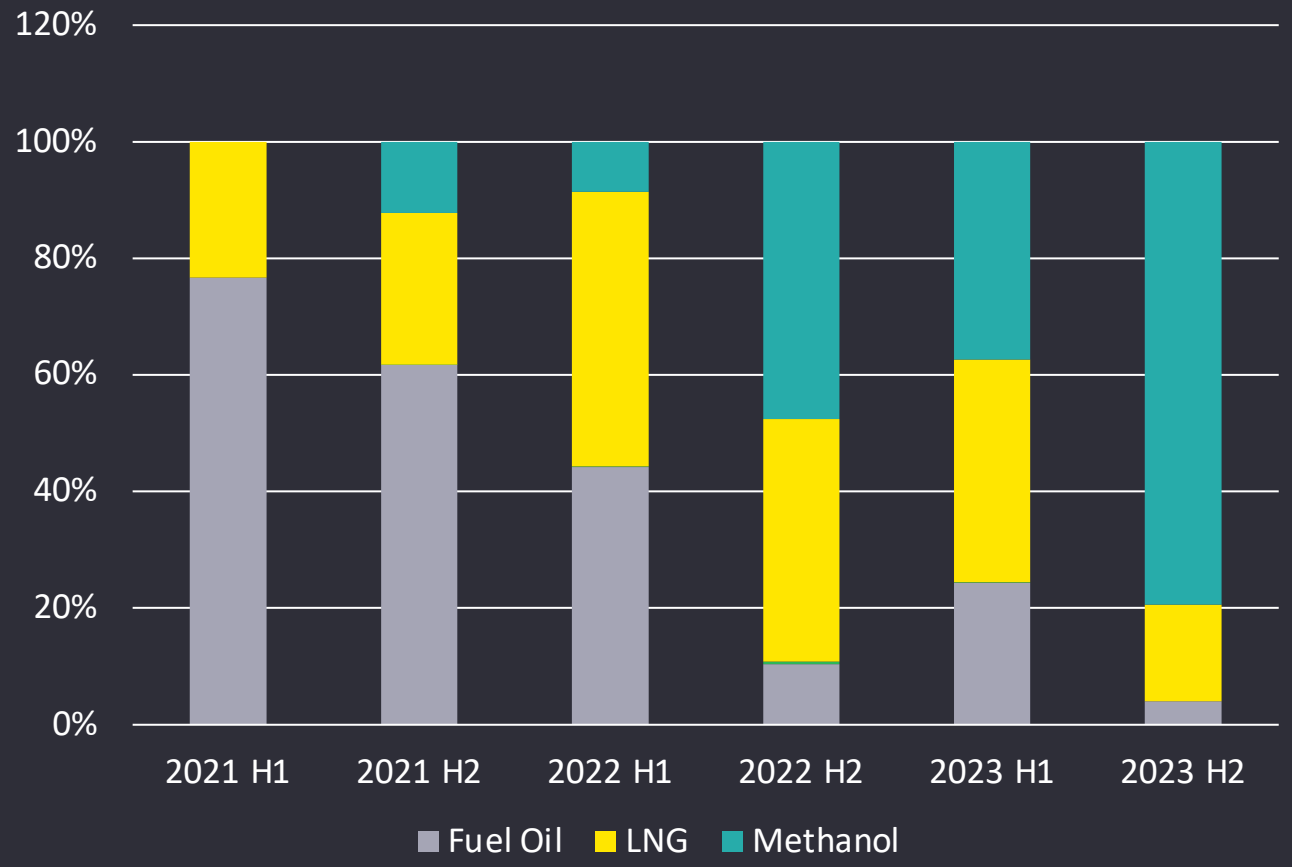
Source: MPA

- The first of Maersk’s orderbook of methanol dual fuel vessels, 2,100-TEU feeder to be deployed in Baltic Sea.
- Summer 2023, maiden voyage from South Korea to North Europe via Suez canal, **including pilot bunkering with green methanol at Singapore & Rotterdam**
- OCI Global provided green methanol (from North America) to Singapore

Low-carbon fuels are entering the market

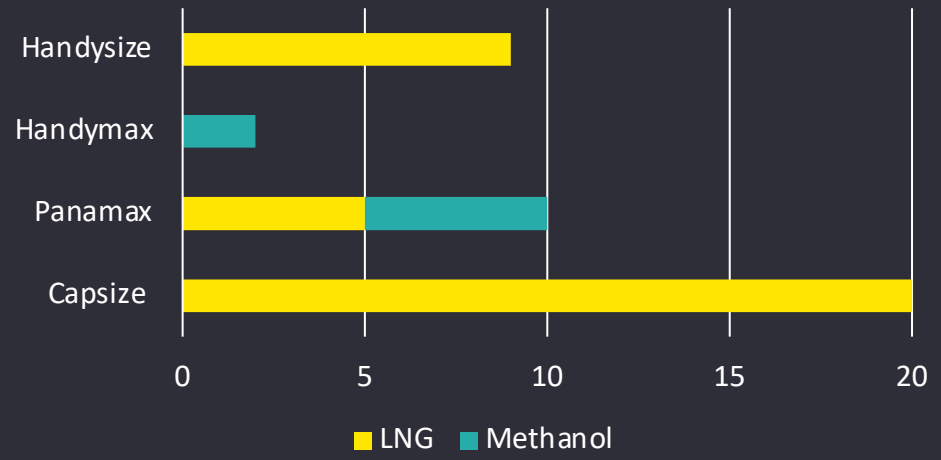
Methanol is the current fuel in favour

Container vessel orders by order date (TEU capacity)



Source: Alphaliner

Bulk carriers on order – alternative fuels

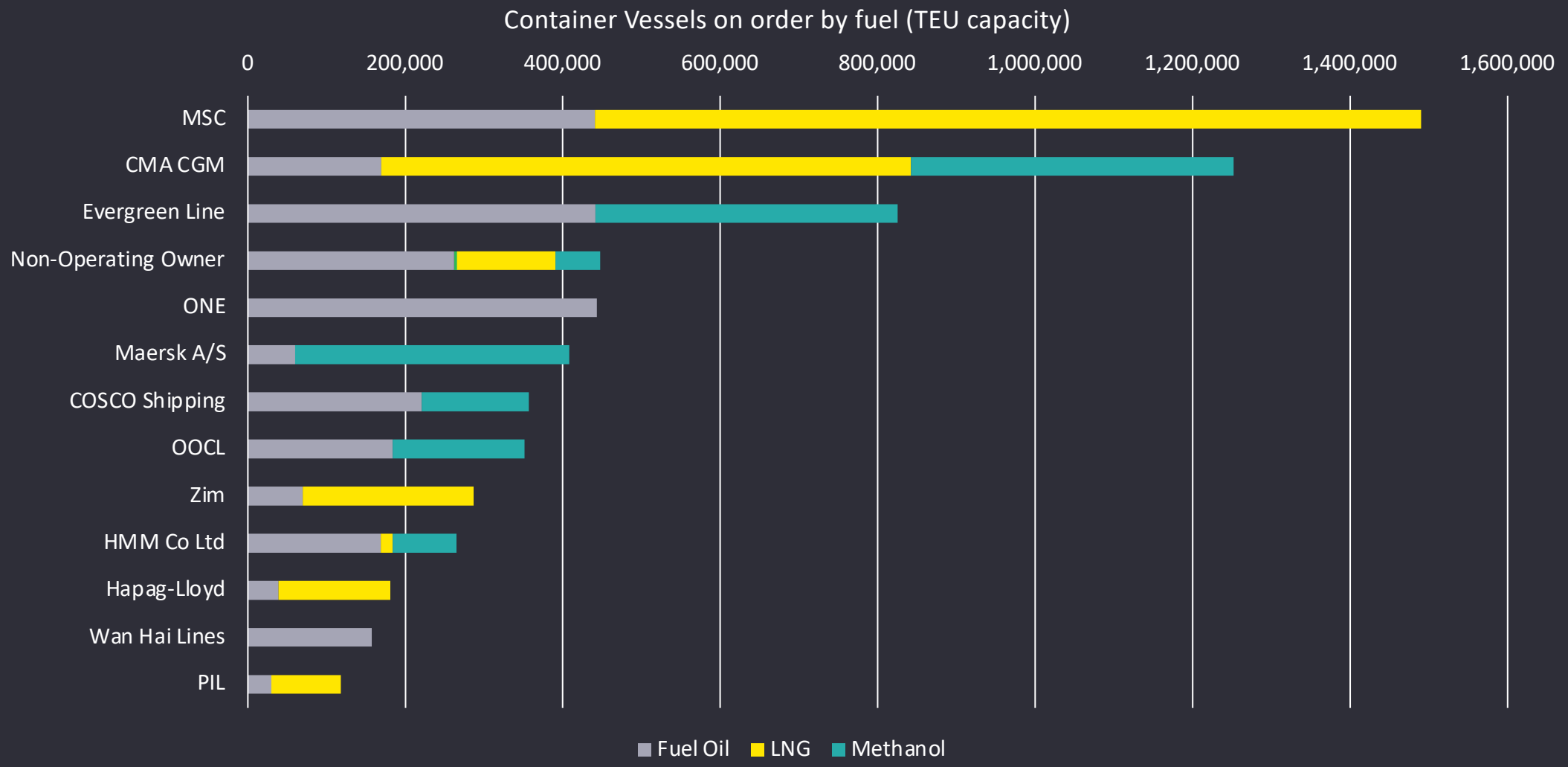


Source: Clarkson's

- Other methanol vessel types on order:
  - Oil/chemical tanker 3 (& 23 in operation)
  - Tug 1
  - Cruise 1
  - RoPax (1 in operation)
  - Other offshore vessels 4

Low-carbon fuels are entering the market

Vessels on order by owner



Source: Alphaliner

Notes: "LNG" and "Methanol" designates dual-fuel vessels that can also run on fuel oil

Alternative Fuels - Summary

LNG and Methanol as Near-term Bunkering Options

LNG

- Continued **demand** for new **LNG vessels**, albeit growth may be slowing
- Well established **supply chains/infrastructure**
- Some pushback against LNG as a bunker fuel due to its **high lifecycle greenhouse gas emissions.**
- Bio/ e-LNG can be dropped in to **further reduce emissions**
- **Flammable** and requires vapor handling systems
- **Requires specialist tanks** pressure & low temperature (expensive to build, maintain and operate)

Methanol

- Consistent growth in orderbooks from **most major shipping lines**
- Bio/e methanol is **ultra low carbon**
- **4.7 mil tonnes of green methanol planned / committed globally**
- Toxic but **water soluble and biodegradable**
- **Many ports have existing methanol storage** - possible to store in modified fuel oil tanks at ambient temperature
- Bunker barges and procedures for **simultaneous bunkering and cargo operations** being trialed
- Likely to be higher cost than Ammonia at maturity

Ammonia

- 3-5 years away from ammonia ready engines / vessels
- viability of use in the shipping industry currently uncertain.

Hydrogen

- Technical challenges - need to handle & store at high pressures, low temperatures

Bio/e-diesel

- “Drop in” fuel that burns in existing engines, can provide 50-90% decarbonization compared with M/HFO, etc. (depending on feedstock & production);
- faces bio-feedstock constraints; & limited cost-reduction potential (mature production processes).
- e-diesel has potential to significantly reduce emissions with existing engine designs, but early in its tech. cycle

Nuclear

- Closest to current zero-carbon shipping (navies and ice-breaking vessels), but still needs to overcome environmental, regulatory, economic, and societal acceptance issues

Sources: Partnerships for Infrastructure (P4I); EY

Alternative Fuels - Summary

Alternative fuel price estimates

		Fuel properties					
		Low Heating Value (LHV) (MJ/kg)	Volumetric Energy density (GJ/M3)	Current Price per GJ	Estimated Price per tonne (2030)	Estimated price per GJ (2030)	Estimated price per GJ (2030) + $100/tonne CO2 price
FO	HFO	39.5	39.2	$15	$500-800 /tonne	$12-20	$21-28
LNG	LNG	48.6	20.8	$18	$700-1,000/tonne	$14-20	$20-26
Methanol	Bio-methanol	19.9	15.8	$29	$500-800 /tonne	$25-40	$25-40
	E-methanol			n/a	$600-1,070 /tonne	$30-54	$30-54
Ammonia	Green ammonia (pressurised)	18.6	12.7	$40	$475-$950/tonne	$26-51	$26-51

Top 10 bunkering ports globally - Singapore is by some margin the largest

Strategically located for ocean trade, but does not have close / direct access to green fuels

2021 Annual bunker sales of selected ports

(M tonnes)

Notes: *Zhoushan will likely move to 3rd place for 2023

Sources: Partnerships for Infrastructure (P4I); EY

Decarbonisation Priorities for Countries

In the excitement over e-fuels are we picking the highest hanging ‘decarbonation’ fruits first?

- Many countries have committed to net-zero carbon emissions by 2050, with interim targets requiring immediate action.
- With a finite amount of new green electricity generation coming online each year, countries have an option between turning off coal (or gas) fired power stations, or using the green energy to produce green fuels.

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CLEAN ENERGY

Germany has shut down its last three nuclear power plants, and some climate scientists are aghast

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KEY POINTS

- On April 15, Germany stopped producing any electricity from nuclear power plants.
- The move was expected, but is nonetheless seen as a blow to climate advocates who support nuclear energy as a clean, zero-carbon source of electricity.

- **E-fuels production is extremely energy intensive,** add to this the inefficiencies in fuel combustion to turn the fuel back into power. Using the e-methanol pathway you need between 4.3kwh* of green electricity to produce 1kwh of engine power in a ship.
- If Green Electricity is used for e-methanol production when it could have displaced coal electricity on the grid, you would emit **6.1 tonnes* of CO2 from coal generation for every 1 tonne of CO2** of marine fuel oil emissions prevented.
- Therefore, at a country level it may be best to completely decarbonize the electricity grid, electrify all systems which can be done simply and reasonably cheaply (EV cars, heating/cooling) and only then use excess green electricity to produce green fuels.
- The same logic applies to converting electricity to hydrogen/methanol/ammonia then burning it for electricity generation: **~75-85% net energy loss**, excluding transportation.
- Due to the energy loss the electricity produced on the receiving end would be **at least 4-5x higher** than the original electricity production cost.

Notes: *represents e-methanol where CO2 captured from industrial point source

Summary & Key Takeaways

A rapidly evolving landscape with major uncertainties over fuel supply, demand and price

1. Variety of fuel types under consideration to deliver maritime decarbonisation
2. Landscape is evolving rapidly - uncertainty about ultimate/ optimal 'solution'
3. However, over short to medium term key lines have opted for LNG (as a transitional fuel) and methanol, and are making investments accordingly
4. Other fuels, notably Ammonia, hydrogen and possibly nuclear are at an earlier stage of development (and / or acceptance), but may emerge as key solutions over the medium to longer-term
5. **Supply side maturity is not adequate** – must be a substantial ramp up in capacity to meet demand. In addition, other potential fuels (e.g. ammonia) have yet to develop the appropriate regulatory framework (HSE, etc.).
6. The green fuels will **raise costs for supply chains -** prices may fall as supply matures, but which supply chain parties will bear the costs?
7. Will the new vessels lead to a **re-configuration of networks & hubs**, due to shorter vessel ranges (plus break-up of alliances, specifically the 2M)?
8. Or do established hubs, e.g. Rotterdam & Singapore retain their position?
9. For example, Singapore's economies of scale, established cluster of expertise and excellence, and ability to leverage a 'whole of government' approach for decarbonisation (beyond just maritime) are key advantages…
10. …but does not have **ready access to green fuels – other locations do and those located close to key trade lanes may target the bunkering market**

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23 Jun 2023 Share

PTP and Port of Melbourne join a P4I panel discussion on 'Green Fuel Bunkering and Maritime Decarbonisation: Insights from Malaysian Ports' during the Green Shipping Conference on 22 June, part of Malaysia Maritime Week

Australia and Malaysia have shared the findings of a study into the potential for Port of Tanjung Pelepas (PTP) ... regional green shipping hub at Malaysia Maritime Week in Kuala Lumpur.

The Australian Government through Partnerships for Infrastructure (P4I) supported a session on 'Green Fuel Bu... Maritime Decarbonisation: Insights from Australian and Malaysian Ports' during the Green Shipping Conferenc...

Opened by Deputy Australian High Commissioner to Malaysia Ms Clare Gatehouse, the session discussed how ... supporting the decarbonisation of the maritime industry in partnership with Malaysia and the region.

"The shipping industry has a critical role in the global path to net zero. There is great demand and need for A...

Thank you

Dr Jonathan Beard

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