METHANOL INSTITUTE

Methanol as a Maritime Fuel

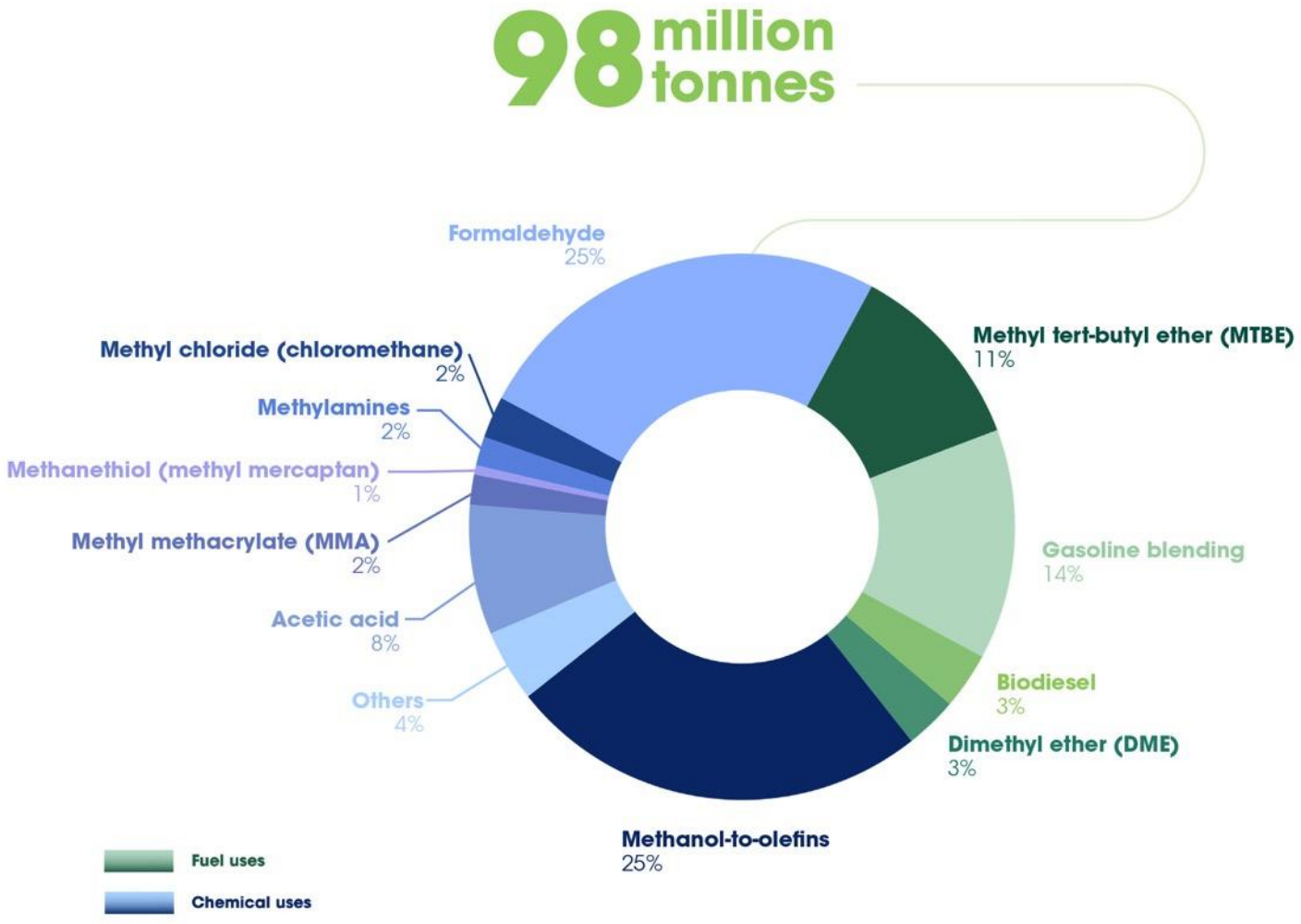
Chris Chatterton, COO

Marintec Innovation Webinar

September 7th, 2023

Singapore | Washington | Brussels | Beijing | New Delhi

Demand



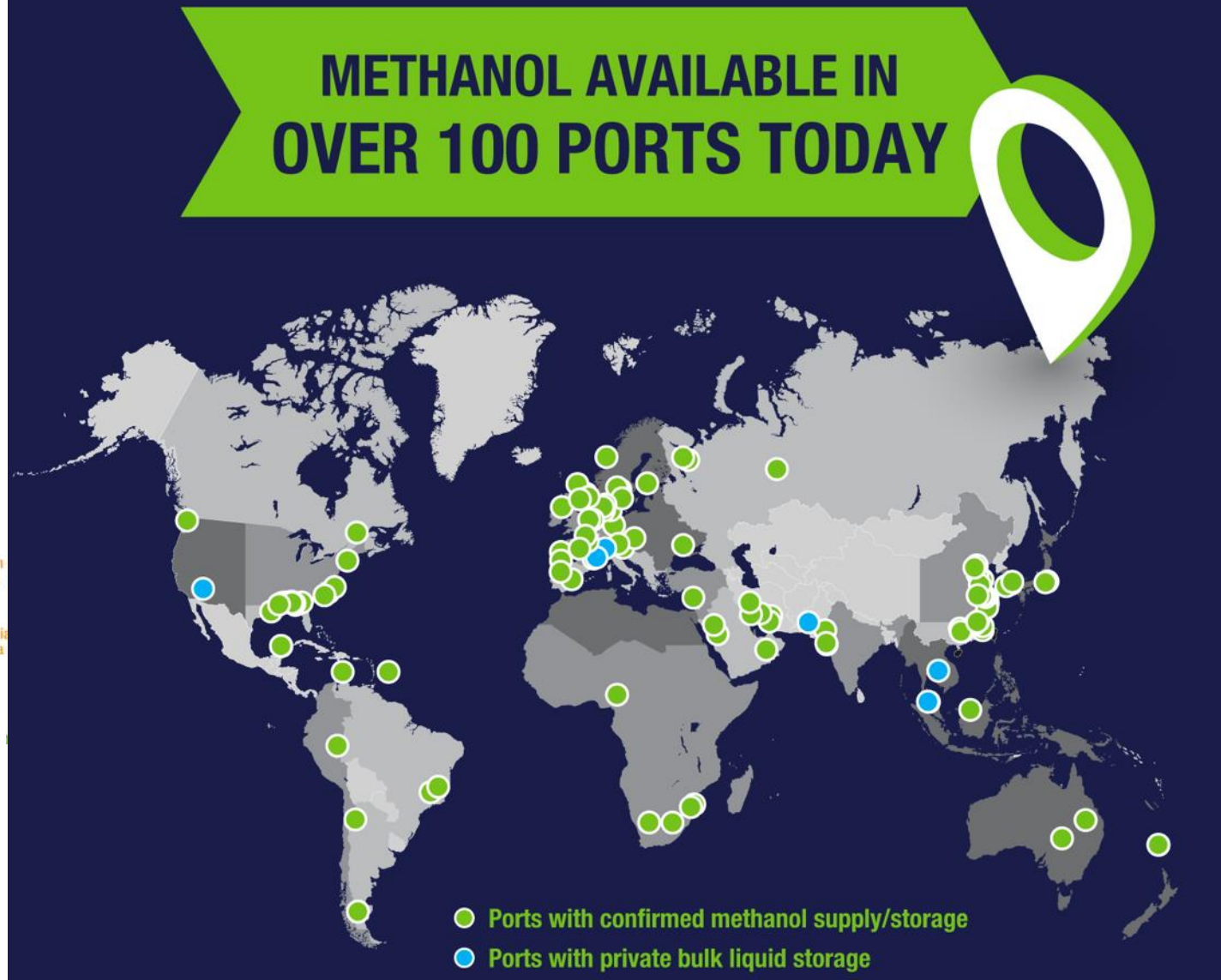
Source: *Based on data from MMSA (2020)*

- Demand and Supply have largely been in balance over the past 20 years
- ~32M mtpa traded internationally
  - China imports >10M mtpa
- Broad sub-vertical markets across both chemicals and fuel applications means
  - Less price volatility
  - Predictable supply
  - Consistent quality - standard

Availability

ESTABLISHED TRADING HUBS

- Efficient break bulking, swaps, blending
- Transparent price assessments
- Standards and safe handling
- Lowers entry costs



Methanol use cases and demand drivers

Looking into the future green methanol will be used in a wide range of applications as a fuel and as a hydrogen carrier - and continue it's role as a chemical building block

Fuels — Raw materials

Maritime

- Used to power ships as a form of cleaner fuel
- Sulphur free and low NOx - suitable fuel to substitute high-carbon conventional ship fuel

Automotive

- Can be used in conventional ICE[1)] vehicles by blending with gasoline or direct
- Can be used in hybrid and fuel cell vehicles – methanol is used to charge fuel cells

Aviation

- Methanol can be the feedstock for sustainable aviation as SAF[2)] via MtJ[3)]
- The source could be bio- or e-MeOH
- So far, no ASTM approval for MtJ process
- MeOH could also be used as a fuel to provide H2 in fuel cell propulsion planes

Power

- Power generation in off-grid solutions as a viable replacement to oil or coal
- Used for fuel cells to generate power and heat with use cases to also include security and surveillance, and remote telecommunication devices

Hydrogen chain

- H2 will be the backbone for a decarbonized economy in industrial sectors
- Long-distance supply chains for green H2 in build-up (e.g., ME => EU)
- MeOH is an option for long-distance transport next to LH2[4)], ammonia (NH3) and LOHC[5)]

Chemicals

- MeOH is a key chemical building block using 60% of all MeOH produced
- Chemical industry will have to decarbonize
- Green MeOH growth driven by balance between
  – higher production cost
  – demand for "green" and willingness-to-pay more

↗ Demand growth of green methanol

1) Internal combustion engine; 2) SAF = Sustainable Aviation Fuel; 3) MtJ = Methanol to jet; 4) LH2 = liquefied H2 at c. -253 °C; 5) LOHC = Liquefied organic hydrogen carrier

Source: IRENA study green methanol, IRENA pathway to decarbonize shipping, EU and national H2 strategies, EU Fit-for-55, Company publications, Auto OEM strategies, Roland Berger

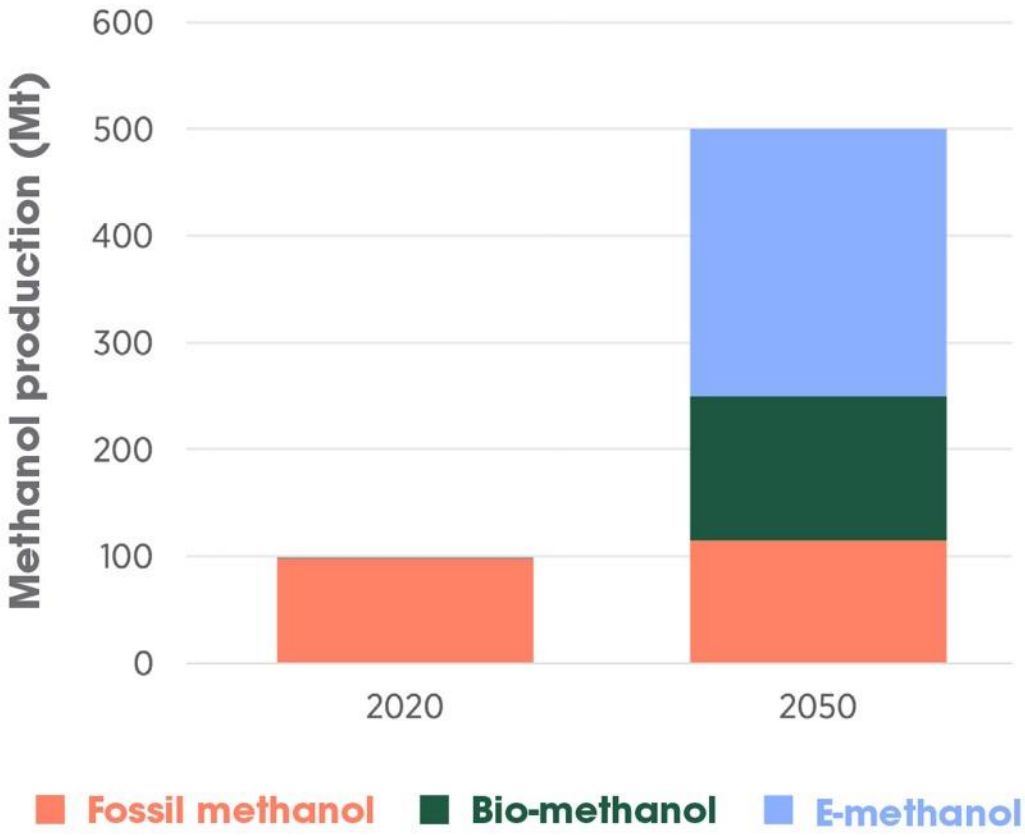
2050: Potential 5-Fold demand increase

Conventional Methanol Emissions Reduction

- According to IRENA, the uptake for both bio and renewable methanol is set to increase substantially, by a factor of 5x compared with conventional methanol, from approximately 1mln mtpa in 2023
    - Existing infrastructure can be repurposed
    - Waste feed and CO_2 streams are readily available, allowing harder to decarbonize sectors to de-leverage
    - Cost effective and supports **transition to carbon neutrality**

https://www.irena.org/publications/2021/Jan/Innovation-Outlook-Renewable-Methanol

Figure 47. Current and future methanol production by source



Order book → Fuel consumption

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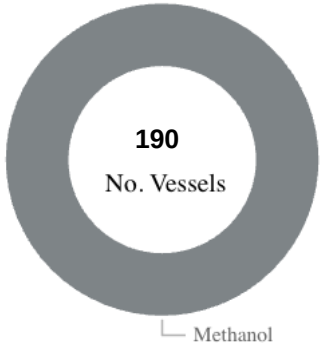
Alternative Fuels Uptake



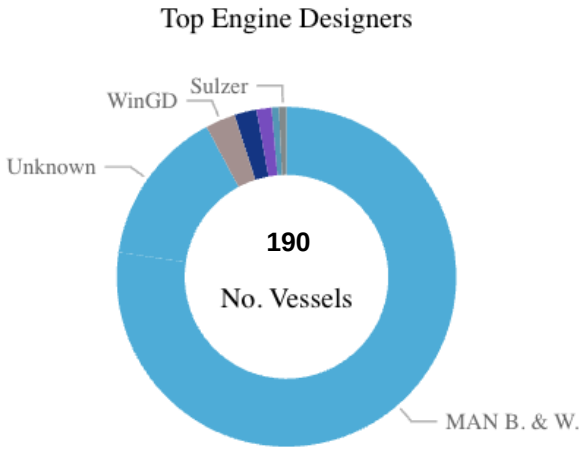
Potential Methanol Demand

190 x 300 = 57,000 mt/day
57,000 x 25 = 1.4M mt/mo
1.4M x 12 mo = **17.1M mtpa**

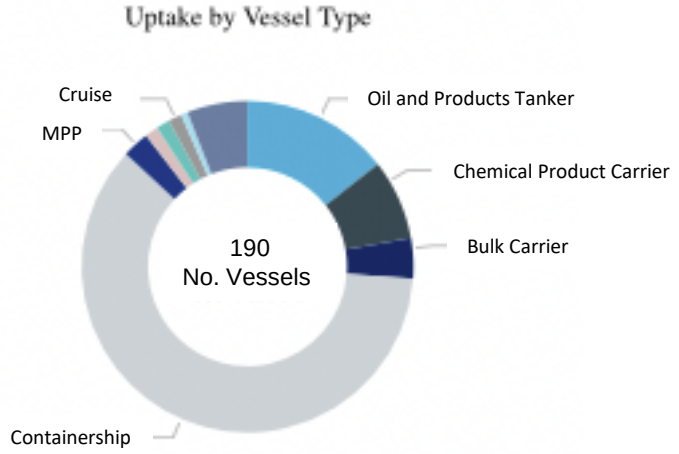
Alt Fuel Uptake by Number of Vessels

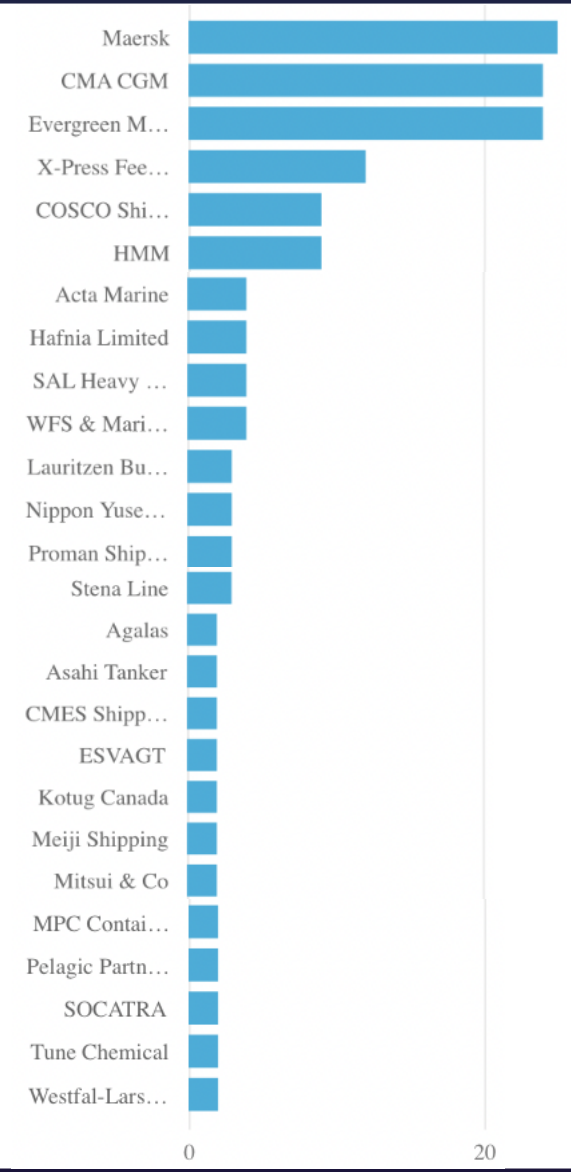
Alt Fuel	Fleet	% Fleet	Order Book	% Order Book
Methanol	25.0	0.0%	165.0	3.1%

Engine Designers



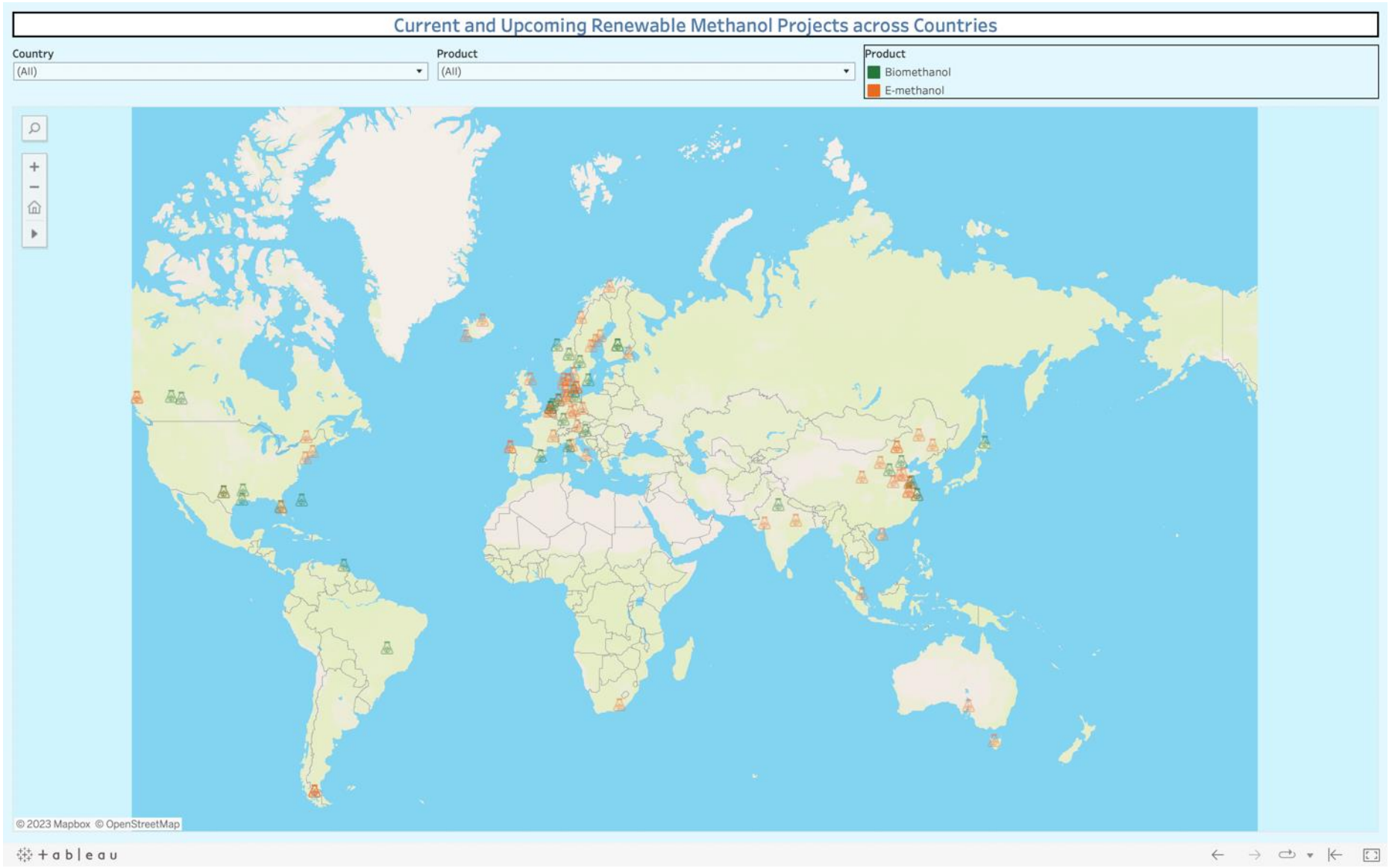
Uptake by Vessel Type





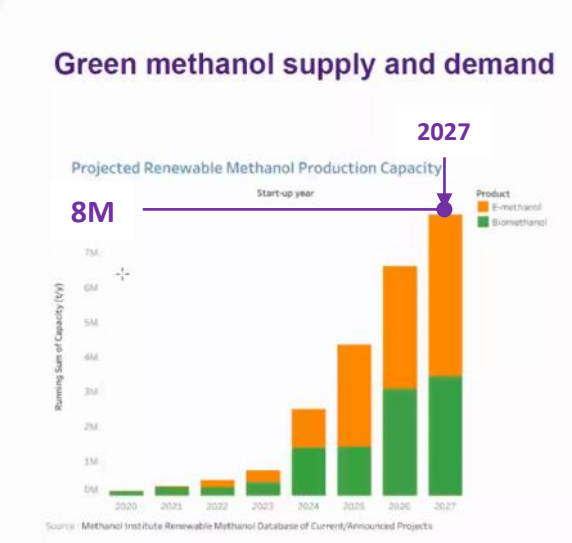
Source: Clarksons

Aggregation of Bio & E-methanol



Can it be optimized?

- Case for consolidation of production capacities
  - Feed
  - Technology
  - EPC
  - Logistics
- Use of existing distribution, storage, S&M
- Digital Trading

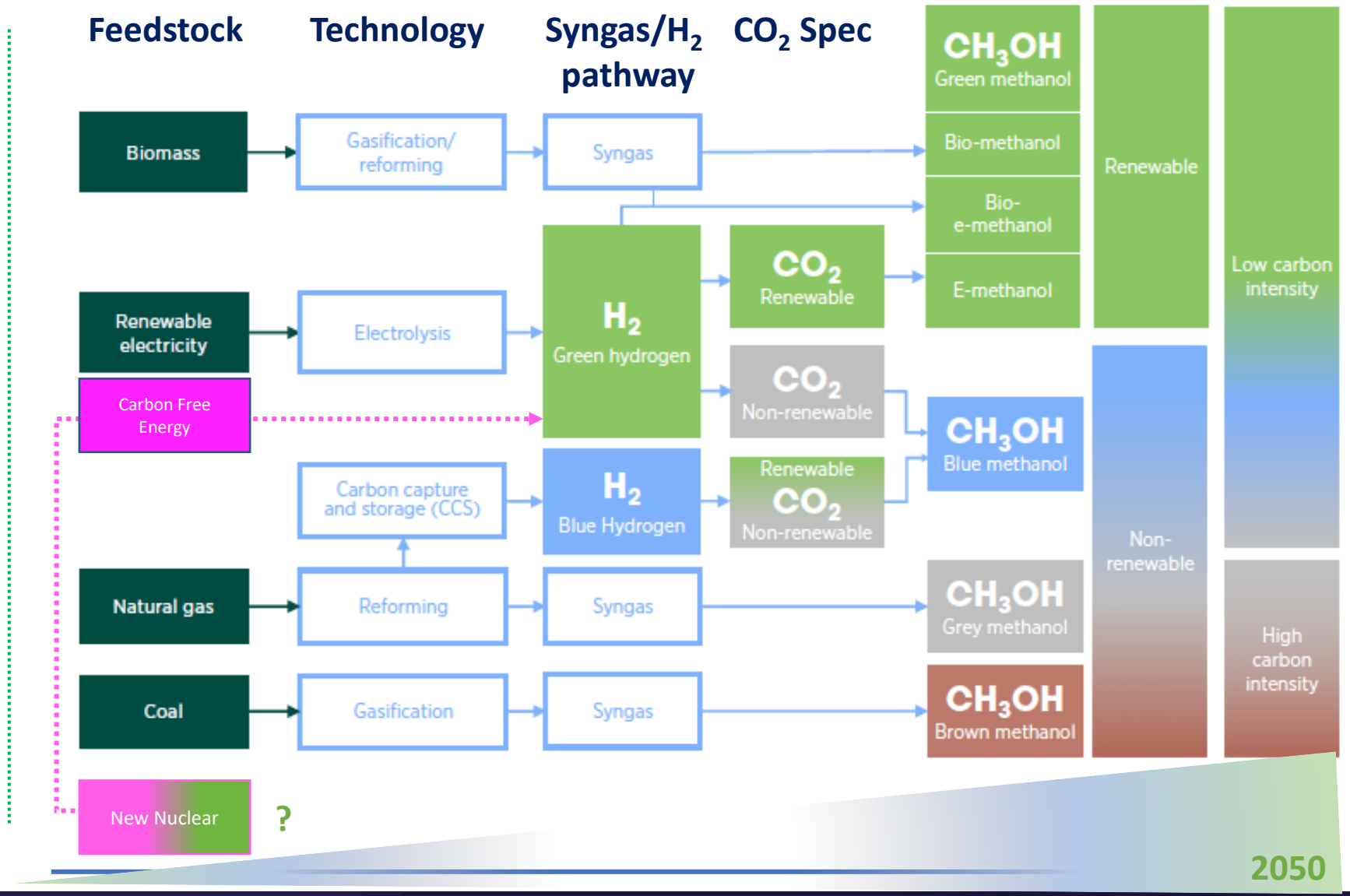


Transitional benchmarking & scaling

Year	IMO Targeted reductions relative to reference year
2020	Reference year
2025	↓ 2%
2030	↓ 6% > 30%
2035	↓ 13%
2040	↓26% > 80%
2045	
2050	↓75% > 100%

"Overall level of ambition to reach net-zero emissions as close to 2050 as possible on an LCA basis"

Sources: IMO, IRENA, MI

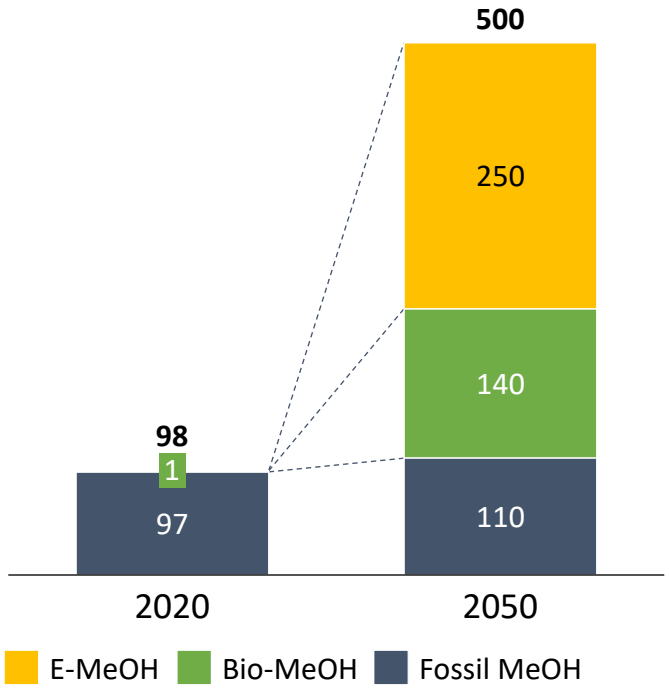


Methanol and green methanol forecast

The outlook for methanol into 2050 is very promising. Strong additional potential in aviation and H2 long-distance transport – but only if key hurdles are mastered

Forecast by IRENA

[million t]



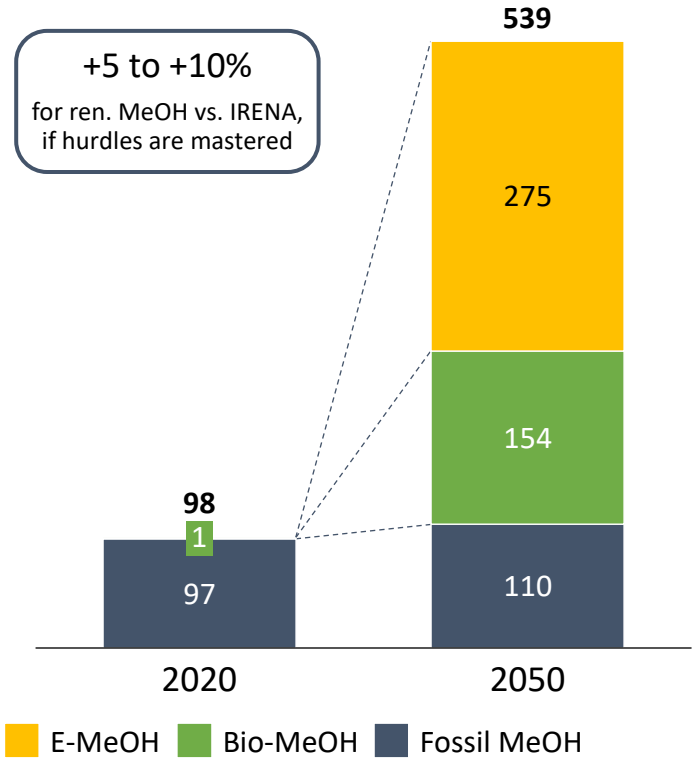
Growth drivers in key segments

Segment	Growth drivers	Outlook (vs. IRENA)
Maritime	• Decarb targets, e.g., IMO • Safe, infrastructure easy handling	↗
Auto	• FC-vehicles in PC limited use, but potential in long-haul HD transport	↗
Aviation	• ASTM approval for MtJ required • Potential for bio- and e-MeOH (PtL)	↗
Power	• Use for off-grid power & heat (direct of via FC solution) • Competes with diesel, LPG, EtOH wind & solar power solutions	→
H2 chain	• Build-up of H2 chains (US, EU, ME) • MeOH robust and safe H2 carrier • MeOH awareness fallen behind NH3	↗
Chemicals	• Chemicals to decarbonize replacing fossil with green MeOH as feed • CCS solutions in MeOH production drive robustness (blue-MeOH)	→

→ well covered by IRENA ↗ strong upside potential, but hurdles

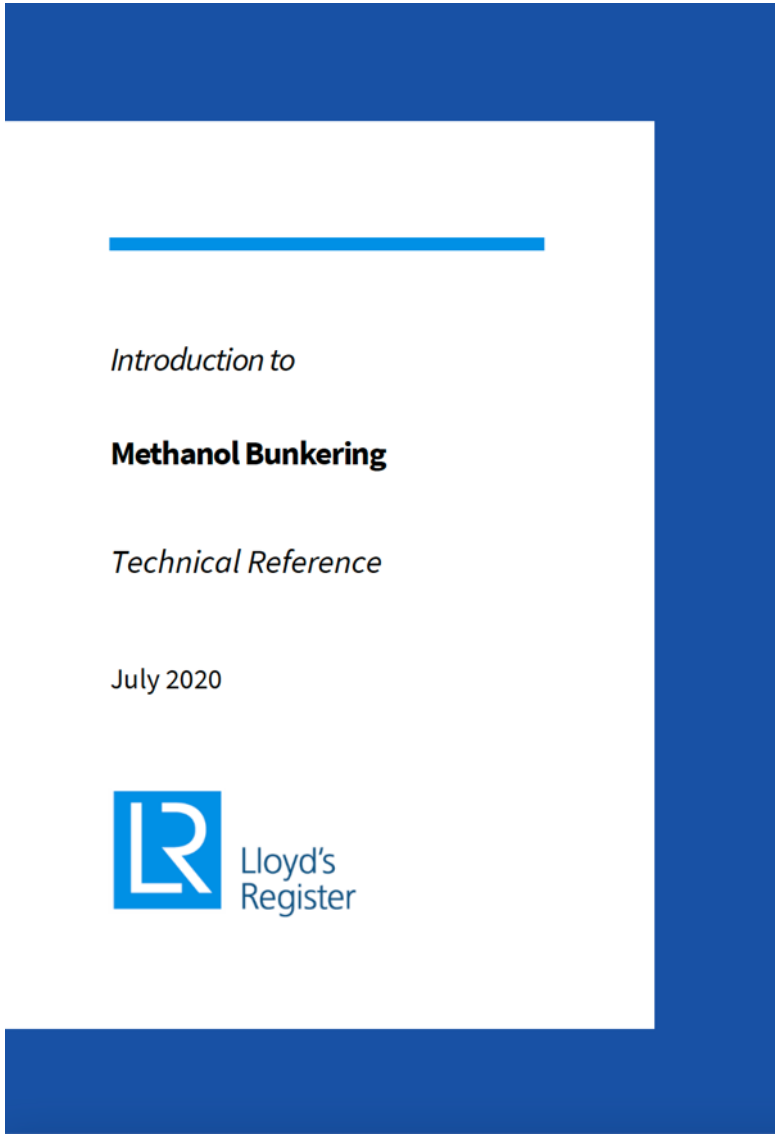
Updated forecast by Roland Berger

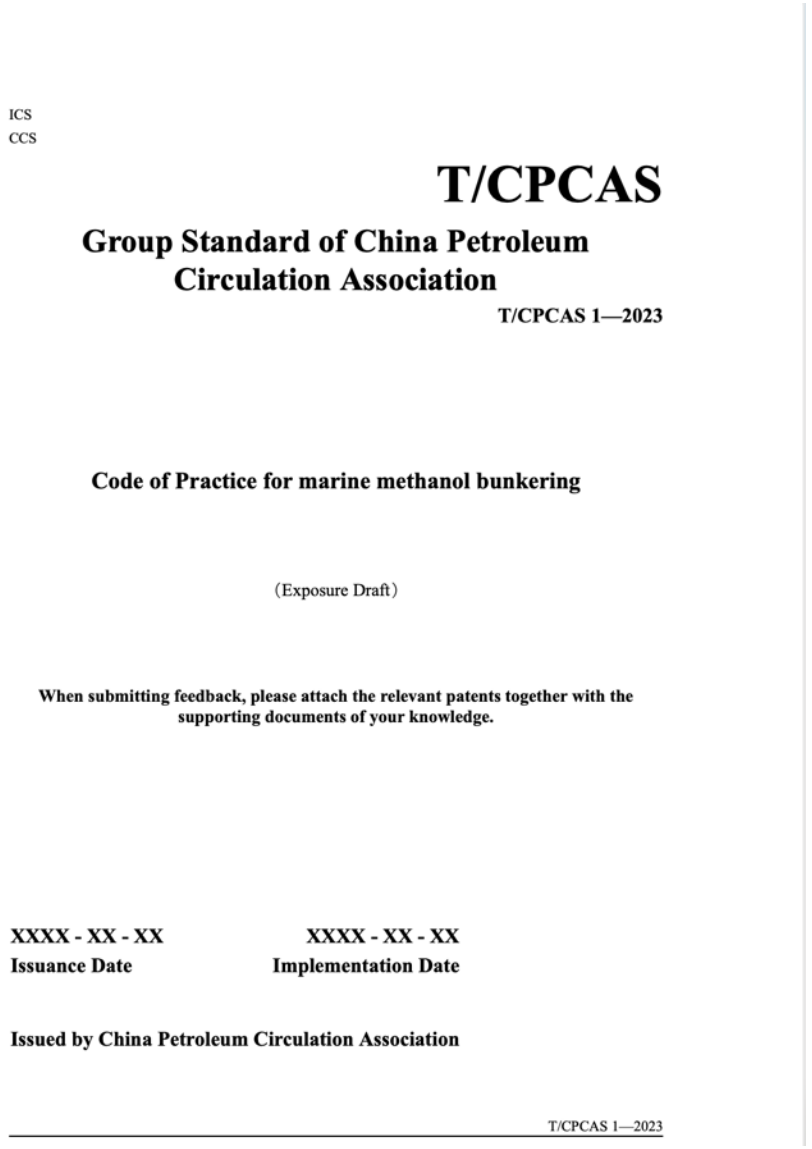
[million t]



Source: IRENA, Roland Berger

Bunkering guidelines





ICS
CCS

T/CPCAS

Group Standard of China Petroleum Circulation Association

T/CPCAS 1—2023

Code of Practice for marine methanol bunkering

(Exposure Draft)

When submitting feedback, please attach the relevant patents together with the supporting documents of your knowledge.

XXXX - XX - XX	**XXXX - XX - XX**
Issuance Date	**Implementation Date**

Issued by China Petroleum Circulation Association

Training & ISO standard

GREEN MARINE

SP Singapore Polytechnic

IBIA

informa corporate learning

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Methanol for Maritime

Live Online Training: 2-Part series | Over 2 days

29 - 30 August 2023 | 13:00 – 16:00 (SGT)

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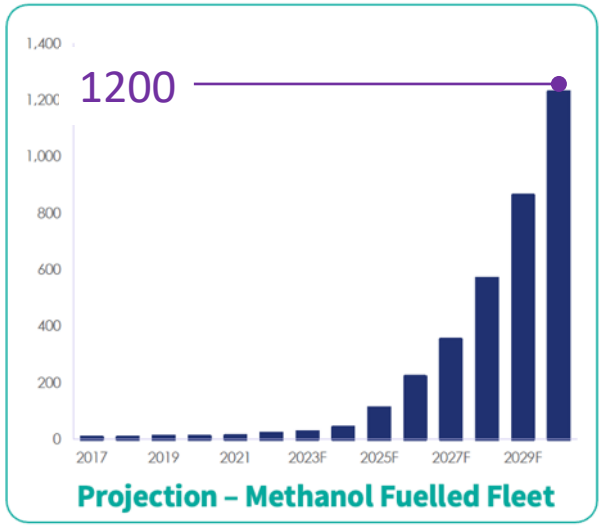
- Green Marine has established training hubs in Asia, with senior trainers, classrooms and onsite facilities as well as appropriate government networks for certification
- Basic SOLAS/IGF/STCE requirement for the Basic and Advanced IGF trainings already in hand, modified to ensure they are methanol specific
- Courses lectures materials have been finalized with courses now on offer: Basic, Advanced, M&O, Bunkering

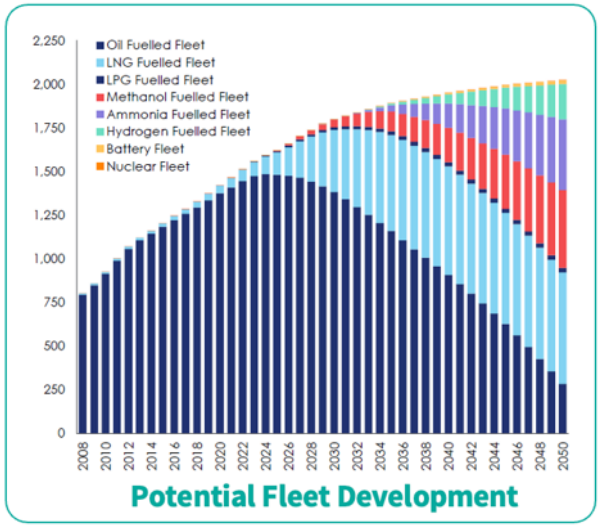
Chemical & Industrial	Motor Vehicle	Conventional Marine Fuel	MAN Engine
Physical Properties Methanol Content, Density, Distillation Range, Water, Appearance, Colour	**Physical Properties** Methanol Content, Density, Distillation Range, Water, Appearance	**Physical Properties** Viscosity, Density, Cetane Number / CCAI, Flash Point, Pour Point, Cloud Point, Water, Appearance, Lubricity	**Physical Properties** Methanol Content, Water, Lower Calorific Value, Appearance
By-Products Ethanol, Acetone, Aldehydes + Ketones, Carbonyl Compounds	**By-Products** Other Alcohol & Ethers, Other Hydrocarbons	**Fuel Stability** Acid Number, Total Sediment, Oxidation Stability, FAME	**By-Products** Ethanol, Acetone
Chemical Properties Carbonizables, Permanganate Time/Content, Non-volatile Matter, Evaporation Residue, Total Acidity/Alkalinity	**Chemical Properties** Gum, Non-volatile Matter, Evaporation Residue, Total Acidity/Alkalinity	**Combustion Residue** Carbon Residue, Ash	**Chemical Properties** Acidity
Contaminants Sulphur, Chloride, Iron	**Contaminants** Sulphur, Chloride, Sodium, Lead, Phosphorous	**Contaminants** Sulphur, Hydrogen Sulphide, Sodium, Vanadium, Al + Si, Used Lubricating Oil, Ca + Zn, Ca + P	**Contaminants** Sulphur, Chloride

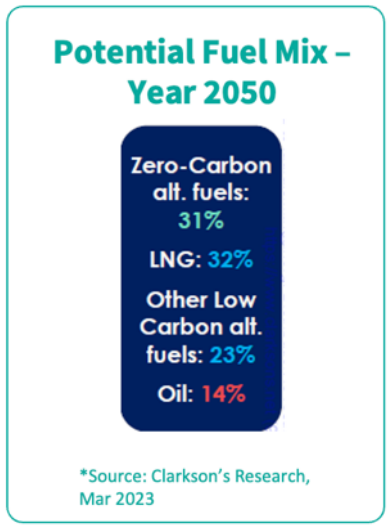
Methanol fueled fleet: No Silver Bullet!

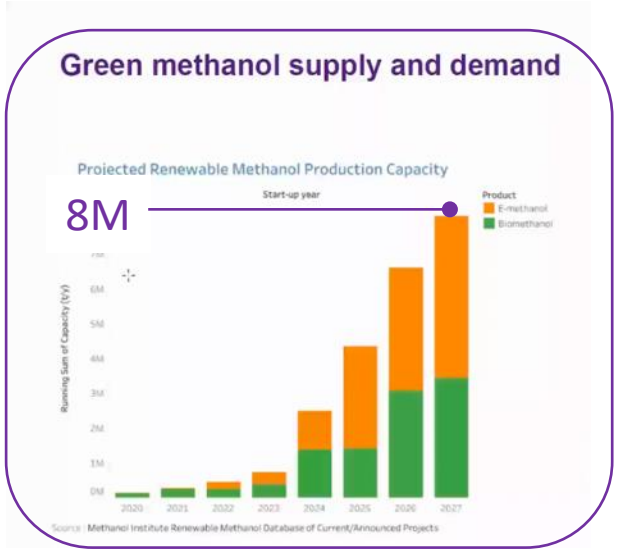
Methanol DF vessels	
25	**165**
In Operation	On Order

- **Ship Types** – Container ships, Bulk carriers, Chemical Tankers, Ferries, harbour craft, dredge, OSV, VLCCs, Car Carriers
- **Retrofits now being launched**









Source: Clarksons, Maersk, MI