Global Centre for GREEN FUELS

Methyl/Ethyl Alcohol Bunkering

Technical Viability, Market Dynamics, and Regulatory Considerations

November 2025

Chris Chatterton
Maritime Advisor, GCGF

Agenda

Introduction

Demand

Supply

Bunkering

About Global Centre for Green Fuels

The **Global Centre for Green Fuels (GCGF)** is a not-for-profit think tank dedicated to empowering policymakers, regulators and industry stakeholders worldwide in developing and charting sustainable energy policies and road maps.

Based in Singapore, GCGF facilitates in-depth research, produces comprehensive reports, and delivers data-driven policy recommendations, helping our stakeholders navigate the complexities of decarbonization and adopt cost-effective, feasible, and sustainable solutions tailored to their unique needs.

By convening global experts, sharing best practices, and offering strategic guidance, GCGF collaborates with governments and industry stakeholders to shape and implement sustainable energy and fuel policies and roadmaps aligned with international goals. This unified approach helps translate decarbonization efforts into tangible benefits for economies, communities and the environment, ensuing a cleaner and more resilient future for generations to come.

Demand

Ethyl Alcohol is Supported by IMO & Class

INTERIM IMO GUIDELINES FOR THE SAFETY OF SHIPS: USING METHYL/ETHYL ALCOHOL AS FUEL

"These guidelines are provided primarily concerning methanol as fuel but may also be applied to ships using ethanol as fuel with changes as applicable."


IMO INTERNATIONAL MARITIME ORGANIZATION

E

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MSC.1/Circ.1621
7 December 2020

INTERIM GUIDELINES FOR THE SAFETY OF SHIPS USING METHYL/ETHYL ALCOHOL AS FUEL

1 The Maritime Safety Committee, at its ninety-fifth session, adopted, by resolution MSC.392(95), inter alia, amendments to chapters II-1, II-2 and the appendix to the annex of the International Convention for the Safety of Life at Sea (SOLAS), 1974, to make the provisions of the International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code) (resolution MSC.391(95)) mandatory under the Convention.


ClassNK

Annex 1

Alternative Fuel Ready


ABS

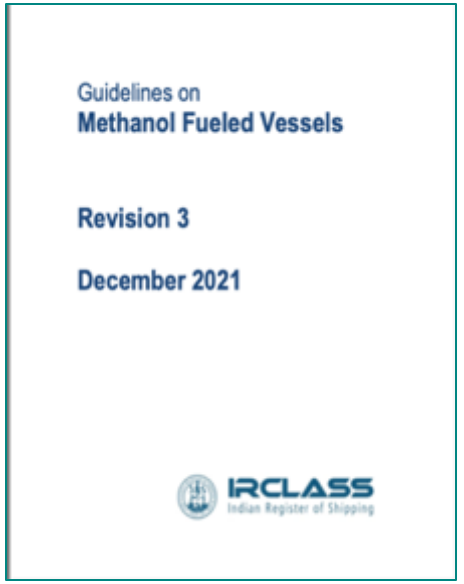
REQUIREMENTS FOR
METHANOL AND ETHANOL FUELED VESSELS
JULY 2024


CR 財團法人驗船中心
CR CLASSIFICATION SOCIETY

GUIDELINES FOR SHIPS USING METHANOL(METHYL ALCOHOL) AND ETHANOL(ETHYL ALCOHOL) FUELS

CR CLASSIFICATION SOCIETY

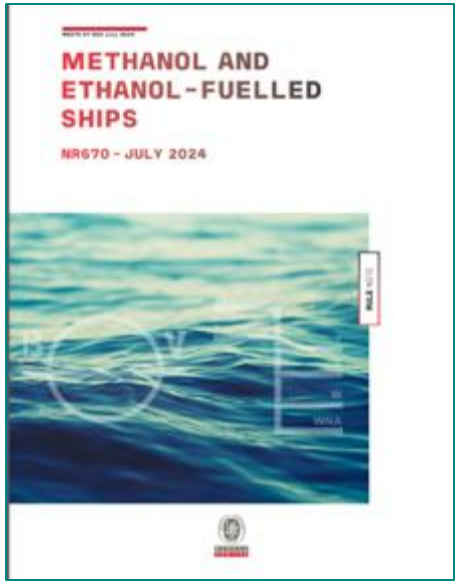
July 2022


Guidelines on
Methanol Fueled Vessels

Revision 3

December 2021

IRCLASS
Indian Register of Shipping


METHANOL AND ETHANOL-FUELLED SHIPS

NR670 - JULY 2024

Sources: IMO, ABS, CLASS NK, IR CLASS, BV, CR CLASS, GCGF

IMO submission for SME (Sustainable Marine Ethanol)

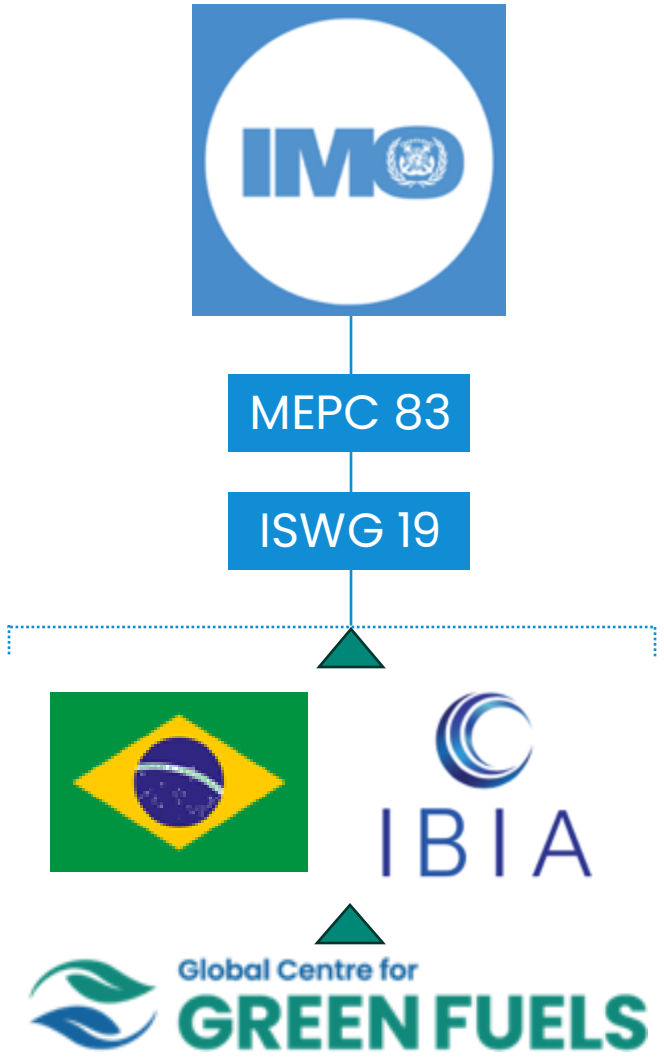
- GCGF joined **IBIA** (**International Bunker Industry Association**) as a member in November 2024

- With support from GCGF, **IBIA and the Flag State of Brazil made a joint submission at IMO's ISWG 19 ahead of MEPC 83 for the purpose of:**

  1. Ensuring inclusion of Ethanol in the GESAMP LCA WG

  2. Request IMO to invite ISO to develop a standard for Ethanol as a Marine Fuel

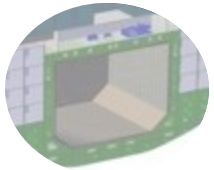
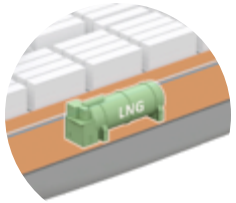
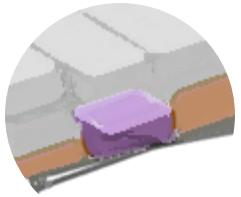
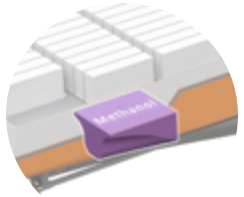
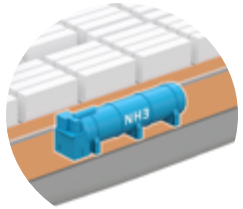
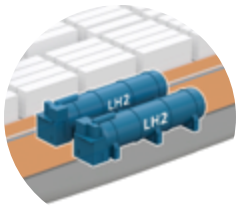
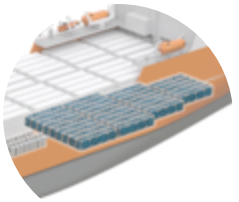
  3. Revise IGF Code to highlight the differences between Methanol and Ethanol with an additional submission for MSC 110



Sources: GCGF

Marine Fuels Today and in the Future

Fuel selection will impact vessel design, CAPEX, OPEX and revenue generation potential of individual vessels

Fuel type	 **Low Sulphur Fuel Oil** @ 20°C	 **Liquified Natural Gas** @ -162°C	 **Ethanol** @ 20°C	 **Methanol** @ 20°C	 **Ammonia** @ -33°C	 **Liquid Hydrogen** @ -253°C	 **Compressed Hydrogen** @350bar
Key considerations	▪ Standard tank arrangement	▪ Cryogenic system	▪ Lower toxicity compared to methanol ▪ Flexible tank arrangement	▪ Mildly toxic ▪ Flexible tank arrangement	▪ Toxic ▪ Corrosive	▪ Highly flammable ▪ Cryogenic system	▪ High pressure ▪ Multiple tanks arrangement ▪ Highly flammable
Regulation readiness	✓	✓	✓	✓	✗	✗	✗
Volumetric energy equivalent	1x	1,6x	1.7x	2.3x	2,9x	4.3x	11.7x
Tank hold space compartment volume	1x	1.7x – 2.4x *)	1.3x	1.7x 1)	3.9x 1)	7.3x 1)	19.5X

Gross tank estimations based on Wärtsilä experience considering inspection spaces needed around the tanks. Cylindrical tanks only considered for LNG, if stored in prismatic tank then LNG gross tank size factor is better for LNG than for methanol.

*) 1.7x membrane tanks, 2.4x type C tanks

Source: Wartsila

Methanol Fleet & Future Fuel Mix

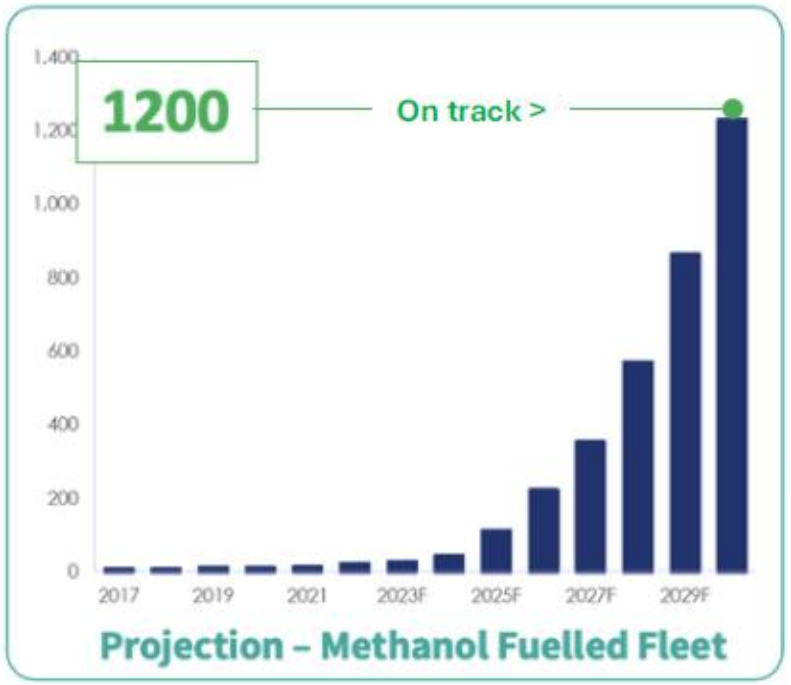
A diversified fuel mix is required. Ethanol offers a complementary pathway alongside methanol, ammonia, e-fuels, and biofuels.

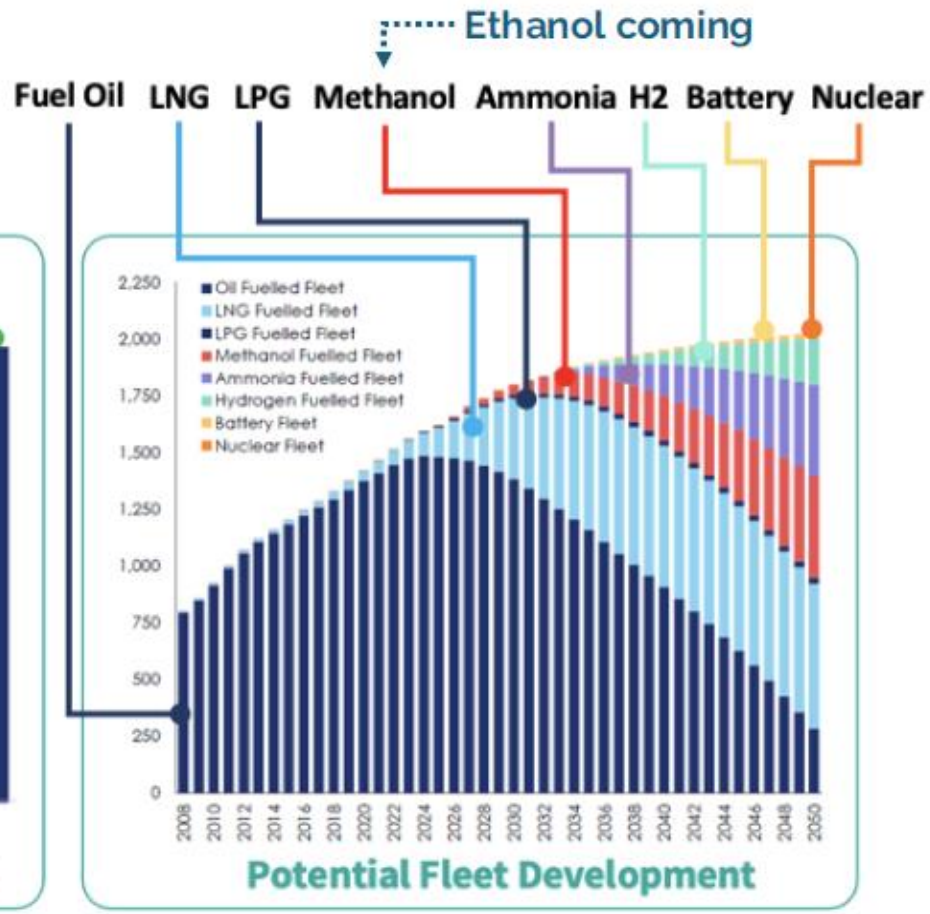
Methanol DF Main Engines

Fuels

Methanol DF Auxiliary engines

300 est	2000+
In Operation	On Order





- **Ship Types**
  - Containers
  - Bulk carriers
  - Chemical Tankers
  - VLCC
  - Cruise, Ferries
  - Dredge
  - OSV
  - Harbour craft, tugs
  - Pure Car Carriers

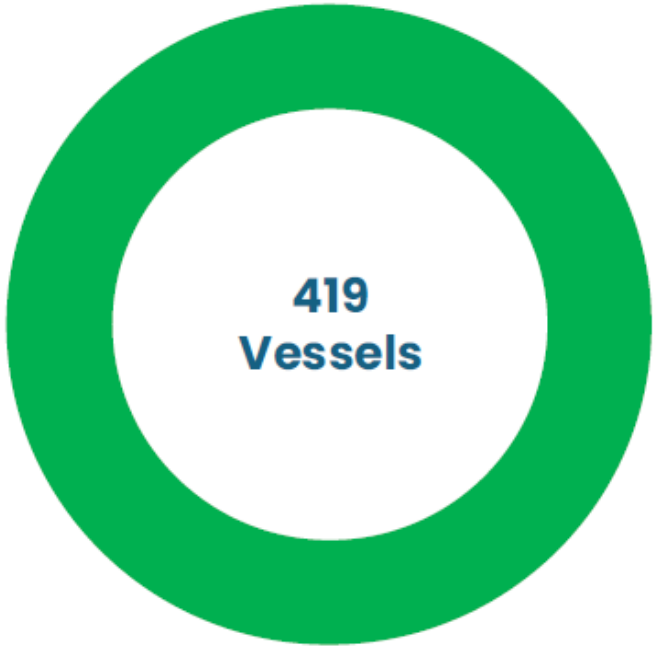
Every fuel has its unique development pathway

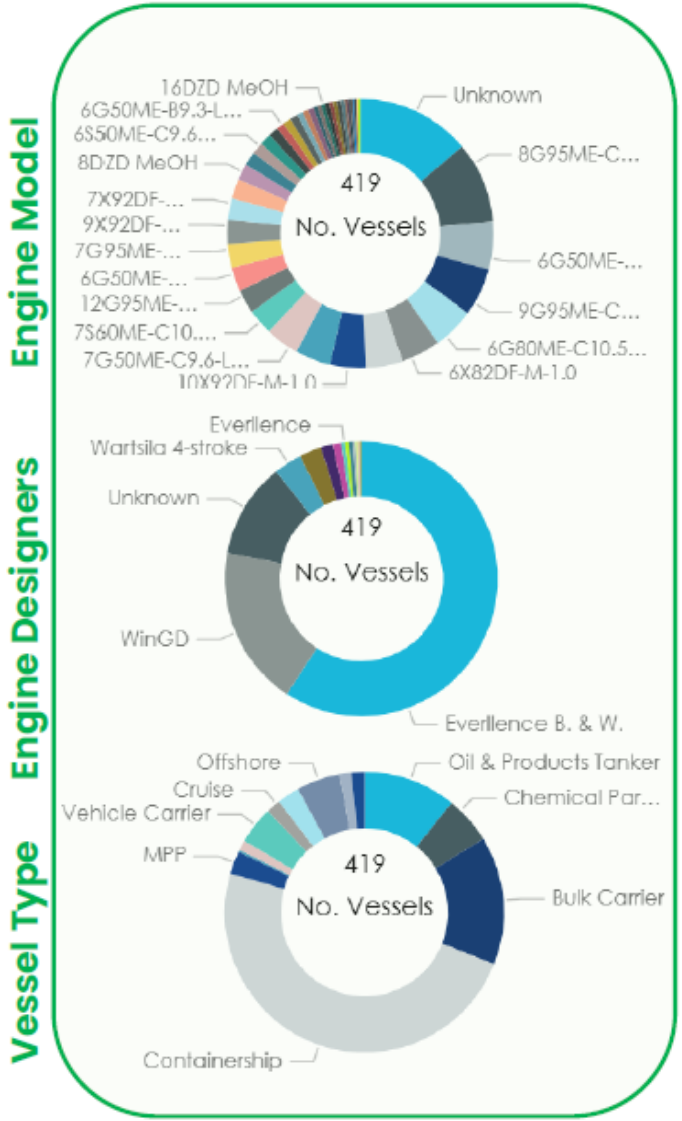
Source: LR, Clarksons, GCGF

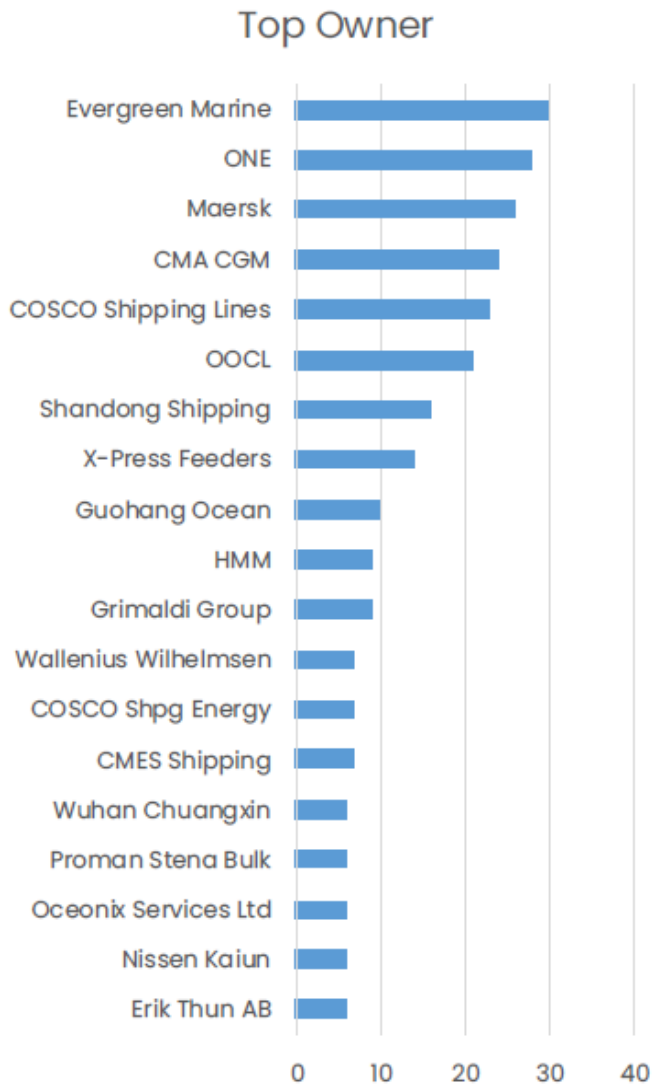
Methanol Fleet NB Order Book

New Build Order Book
Oct 2025

Alt Fuel Uptake by Number of Vessels				
Alt Fuel	Fleet	% Fleet	Order Book	% Order Book
Methanol New Build	81.0	0.1%	338.0	4.6%





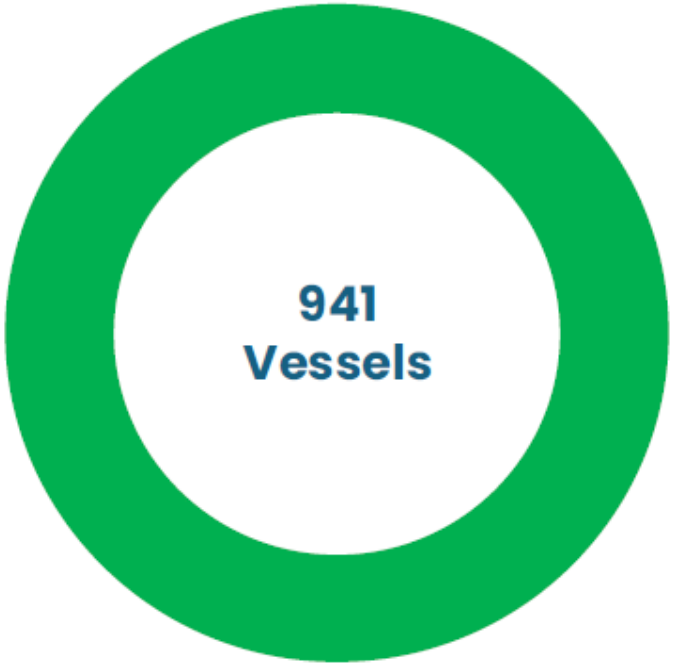


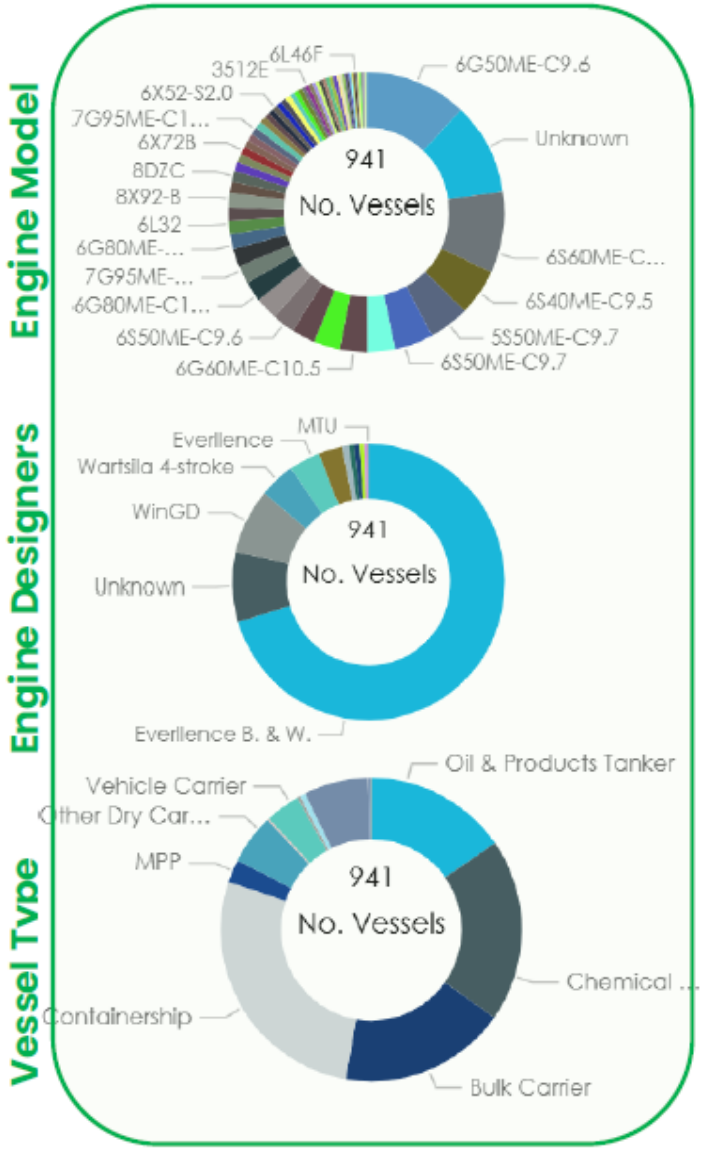
Source: Clarksons, GCGF

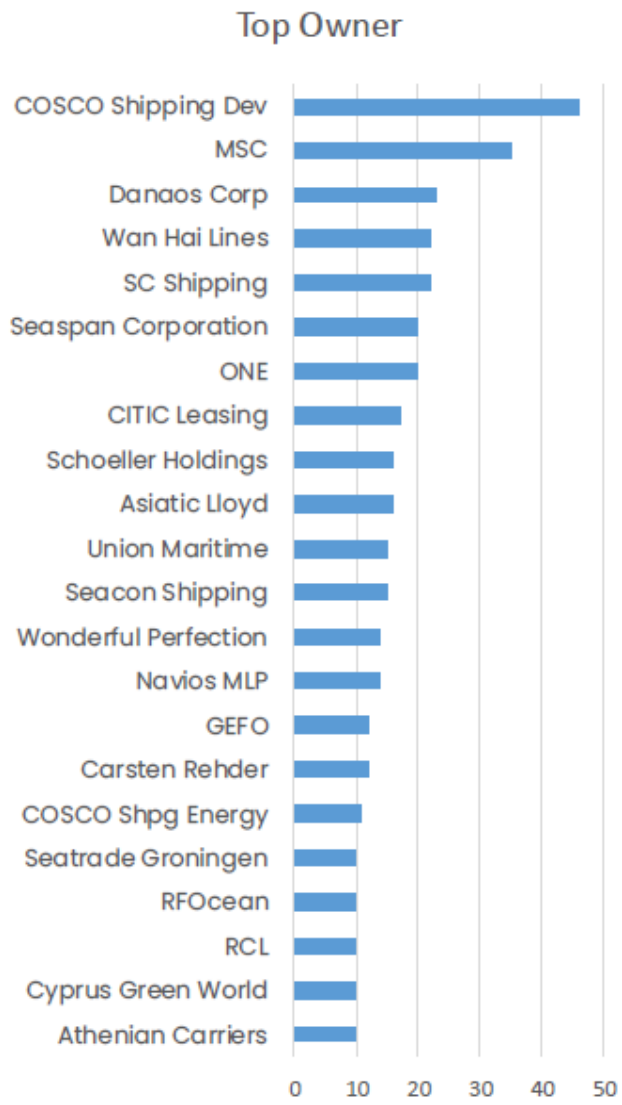
Methanol Fleet – Retrofits

Retrofit | MeOH-EtOH Ready
Oct 2025

Alt Fuel Uptake by Number of Vessels				
Alt Fuel	Fleet	% Fleet	Order Book	% Order Book
MeOH | EtOH Ready	240	0.2%	701.0	9.5%

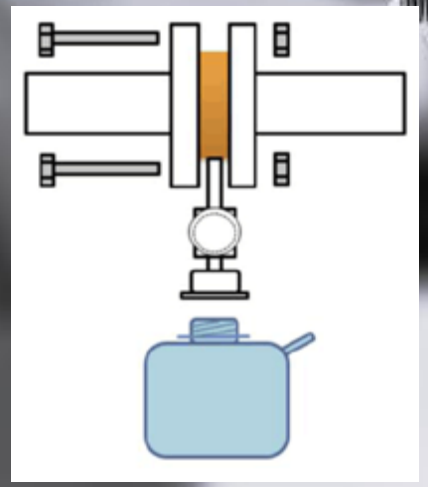


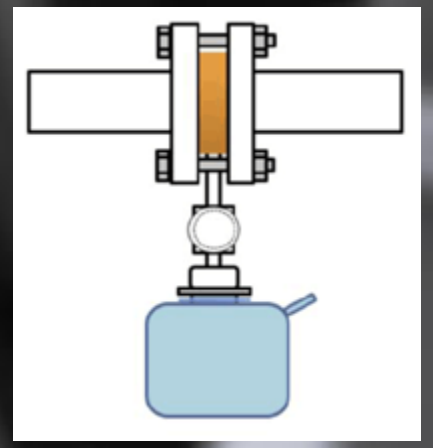




Source: Clarksons, GCGF

Supply





Bunkering Ports

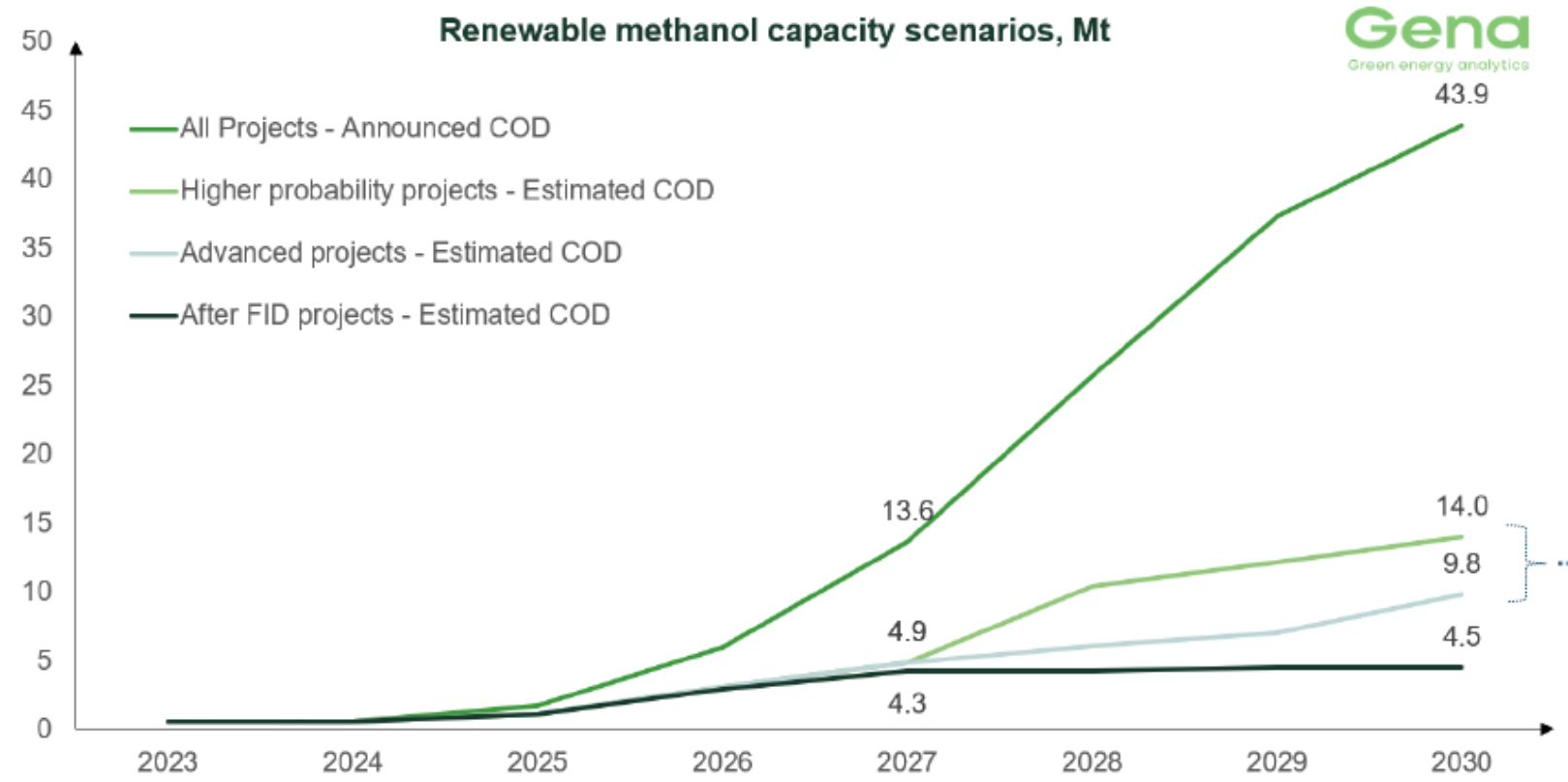
- Over **125 ports** identified globally which store methanol at volumes of at least 25,000 – 50,000mt and where ethanol can also be stored

- **Same bunkering** infrastructure can be used for ethanol (*This has been verified with leading tankage companies*)

MeOH | EtOH Storage & Bunkering Infrastructure: **100% Compatibility**

Source: https://public.tableau.com/app/profile/kelionel.mak/viz/MethanolInstituteRM-Ports/PortsDashboard, OOCL, GCGF

Renewable Methanol Supply



Source: GENA Solutions, www.genasolutions.com. Note: As of September 2025. Advanced projects - operational facilities, projects under construction and in engineering. After FID projects - operational facilities and projects under construction. Higher probability projects - projects with higher probability to startup by GENA estimate.

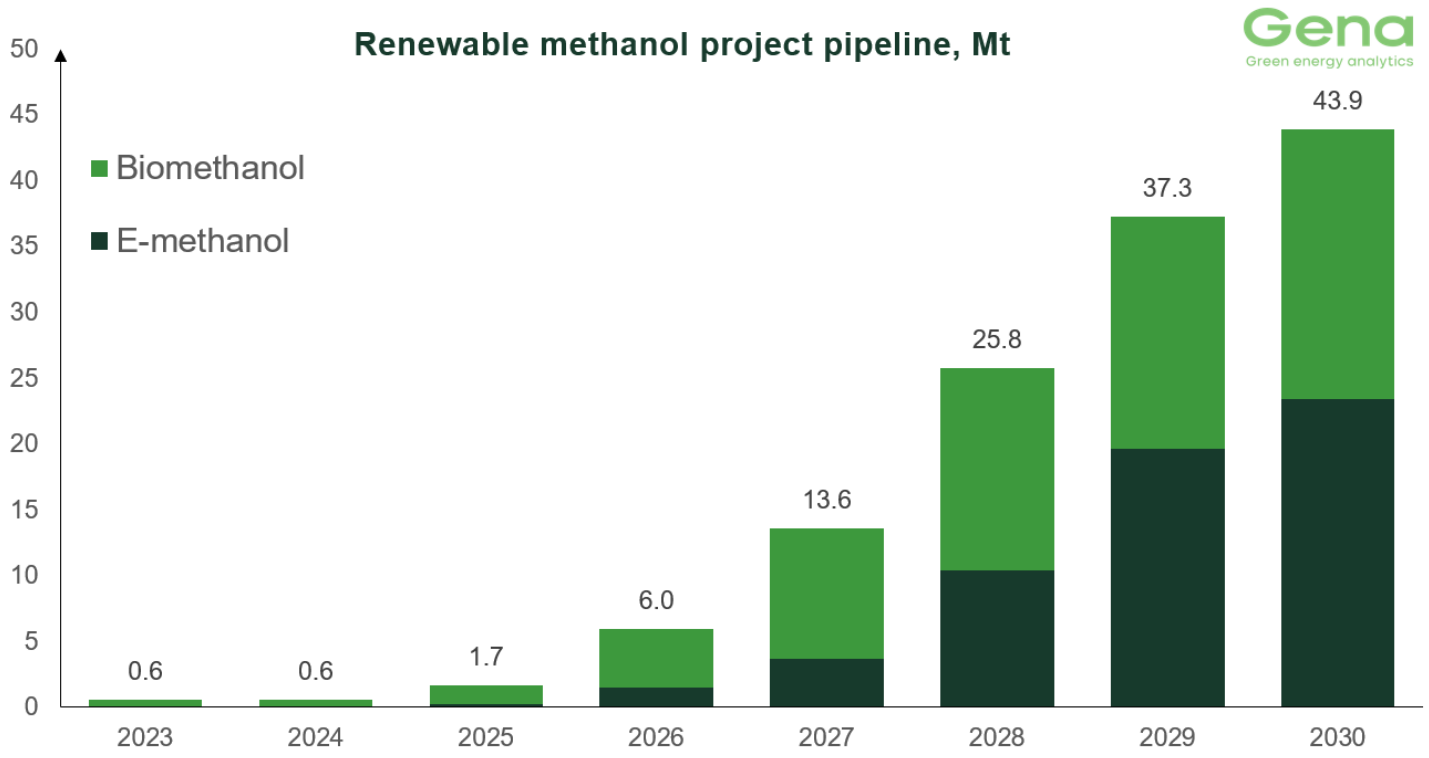
Summary:

- **High production costs** compared with mainly fossil-fuel-based alternatives, **lack of off-take agreements**, and **regulatory uncertainty** are among the key factors limiting the probability of renewable methanol projects entering operation.
- Renewable methanol capacity scenarios show that global capacity **could reach 4.5–14 Mt** by 2030. Considering GENA Solutions' **demand scenarios (7–13 Mt by 2030)**, we believe capacity is **likely to reach 8–14 Mt** by the end of the decade.
- This corresponds to about 18–32% of the current project pipeline.

➢ *Based on ~20,000 mtpa per df vessel, 1200 vessels in service by 2030 would consume ~24M mtpa*

Source: GENA, GCGF

Renewable Methanol Projects



Source: GENA Solutions, www.genasolutions.com. Note: As of September 2025. Based on announced startup dates.

Sources: GENA, GCGF

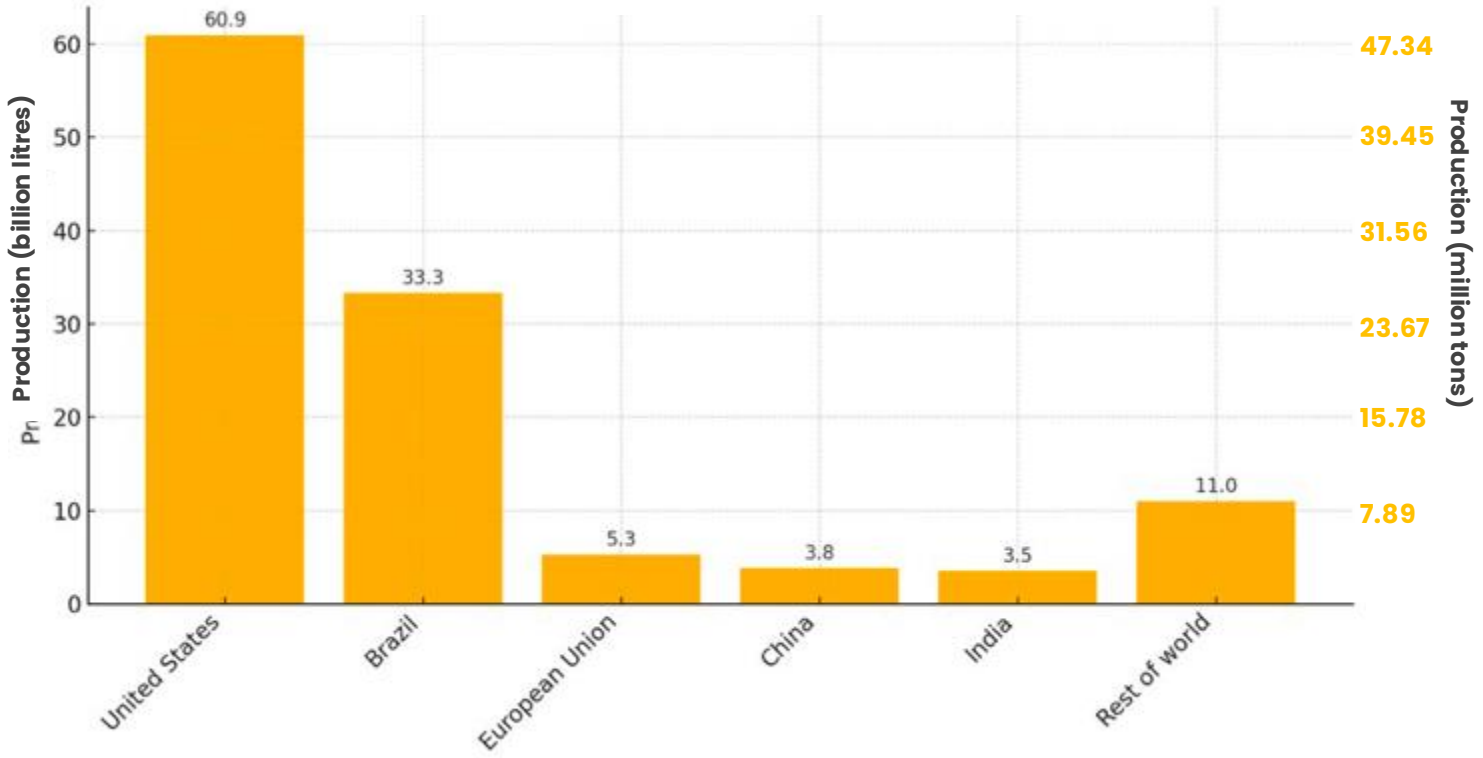
Renewable methanol projects are based on several key feedstocks:

- The renewable methanol project pipeline **expanded by 2.0 Mt in September 2025**, rising from 41.9 Mt in August **to 43.9 Mt**. With this update, the combined renewable and low-carbon methanol pipeline reached **53.9 Mt**. Six new projects were added during the month, while one was removed.
- As of September 2025, GENA is tracking **133 e-methanol projects totaling 23.4 Mt** of planned capacity by 2030, **110 biomethanol projects totaling 20.5 Mt**, and 17 low-carbon methanol facilities with a combined capacity of 10.1 Mt.
- One 100 kta e-methanol project reached FID last month. The total **post-FID capacity of renewable methanol increased to 4.5 Mt**.
- GENA estimates that **renewable methanol capacity will reach 8–14 Mt by 2030** (18–32% of the project pipeline).
- All methanol projects together could utilize up to **34 Mt of CO2, 27 Mt of residual biomass and waste, 6 Mt of hydrogen**, and **1.7 billion nm³ of biomethane.** Actual feedstock consumption will be several times lower, depending on which capacity and demand scenario plays out.

Global Supply Dynamics 2024 – 2030

93 Mln Tons → ~27% increase ~5% CAGR → **118** Mln Tons

Global Ethanol Production, 2024



2024 snapshot: World fuel-grade ethanol output stands at roughly **118 billion litres (93.2 million tons)**, led by the United States (52%), Brazil (28%) and a long tail of smaller producers; only the EU is already near its production ceiling.

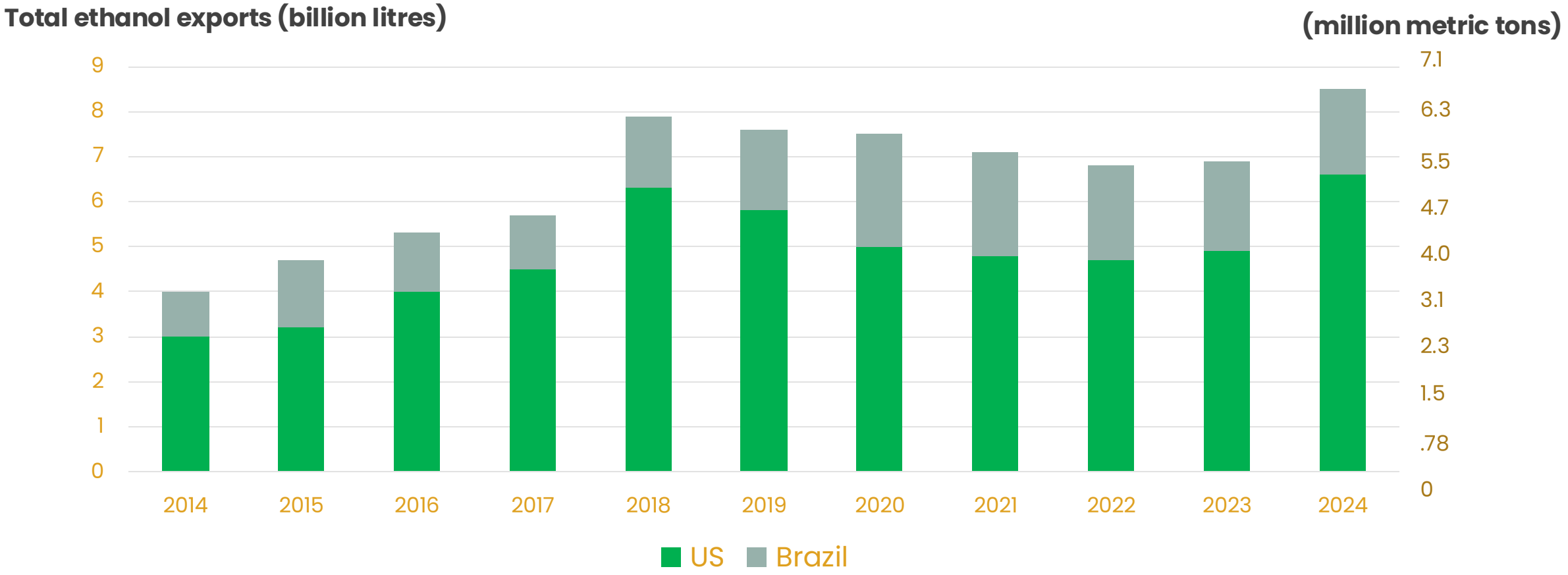
Global Ethanol Forecast to 2030

2030 Base Case: Announced policies and projects push global supply to **145–150 billion litres (114.5 – 118.5 million tons)**

- **Brazil**'s corn-ethanol (+8.7 mil tons)
- **US** E15 Potential (+7.9 mil tons)
- **India**'s E20 drive (+5.9 mil tons)
- **Asia** mandates (+5.5 mil tons)
- **Maritime** use in dual-fuelled alcohol engines (+3.5 mil tons)
- **EtJ** growth against other SAF technologies such as HEFA, PTL and FT (+1.0 mil tons)

Source: GCGF

US & Brazil Exports



Sources: https://grains.org/markets-tools-data/tools/top-u-s-export-customers/
https://www.spglobal.com/commodity-insights/en/news-research/latest-news/refined-products/012425-feature-traders-weigh-potential-increase-in-brazil-eu-ethanol-flows-in-2025
EIA & UNICA
Compiled by: GCGF

Chemical Properties | Physical Availability

- Ethanol (C_2H_5OH) is a **polar solvent with a high octane rating** (113), making it resistant to engine knocking

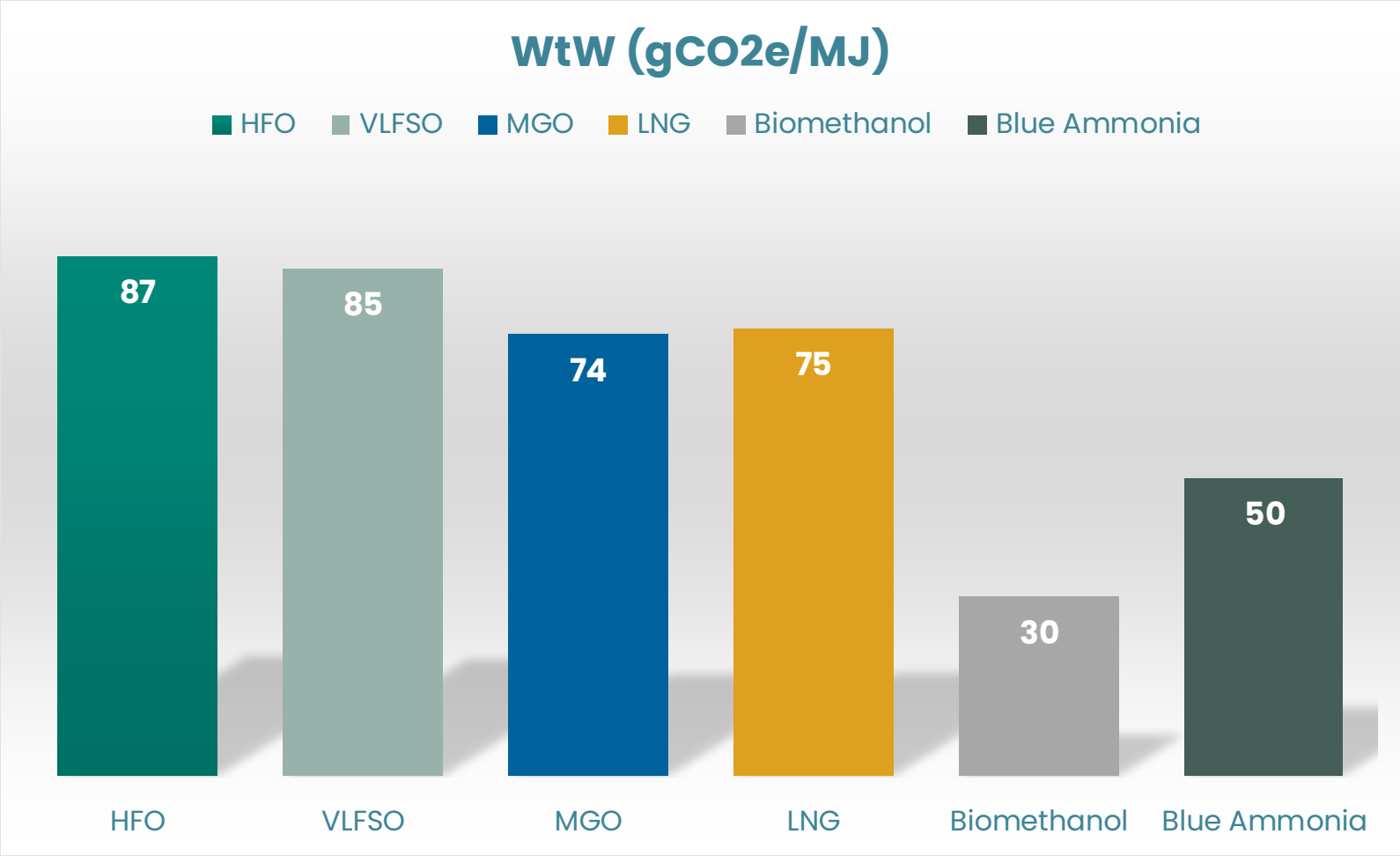
- **Energy density of 26.8 MJ/kg** is:
  - 34% lower than marine gas oil (MGO)
  - 30% higher than methanol

- Its **oxygenated** structure promotes cleaner combustion, reducing particulate matter (PM) and sulfur oxide (SO_x) emissions by up to 30% compared to heavy fuel oil (HFO).

- Ethanol is relatively **safer and benign** compared to other fuels.

- Widely available

Sustainable and Environmental Performance



WtW = WtT + TtW

- Bio-methanol has low Well-to-Tank (WtT) carbon intensity, which leads to the low overall WtW value.
- It is unsurprising that bio-methanol is one of the top choices based on CI values alone.
- **Bioethanol has similar WtT values**


BUNKERING

Methanol/Ethanol as a **Fuel**

International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (**IGF Code**)

Interim Guidelines for the safety of ships using methyl/ethyl alcohol as a fuel (**IMO MSC.1/Circ. 1621**)

Methanol/Ethanol as **Cargo**

MARPOL Annex II - Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (**IBC Code**)

Bunkering Methods

Using a road tanker, truck-to-ship bunkering **Truck**	Ship-to-Ship bunkering **Barge**	Pipe or hose connection from a land storage tank-to-ship bunkering **Terminal**
		
+ Bunkering directly at berth + Low investment + Experience in place	+ High flexibility + High bunkering rates + High bunkering volume + Bunkering directly at berth or anchor	+ High tank capacity + Fast bunkering
- Low bunkering rates - Low volumes	- High investment	- Fixed location - High investment

Specialised Training on MeOH | EtOH DF Vessels

Bunkering Compatibility Assessment

- Local and Site requirements
- Mooring
- Equipment
- Manifold
- Connection
- Bunkering and safety measures
- People
- Incident response
- Communications

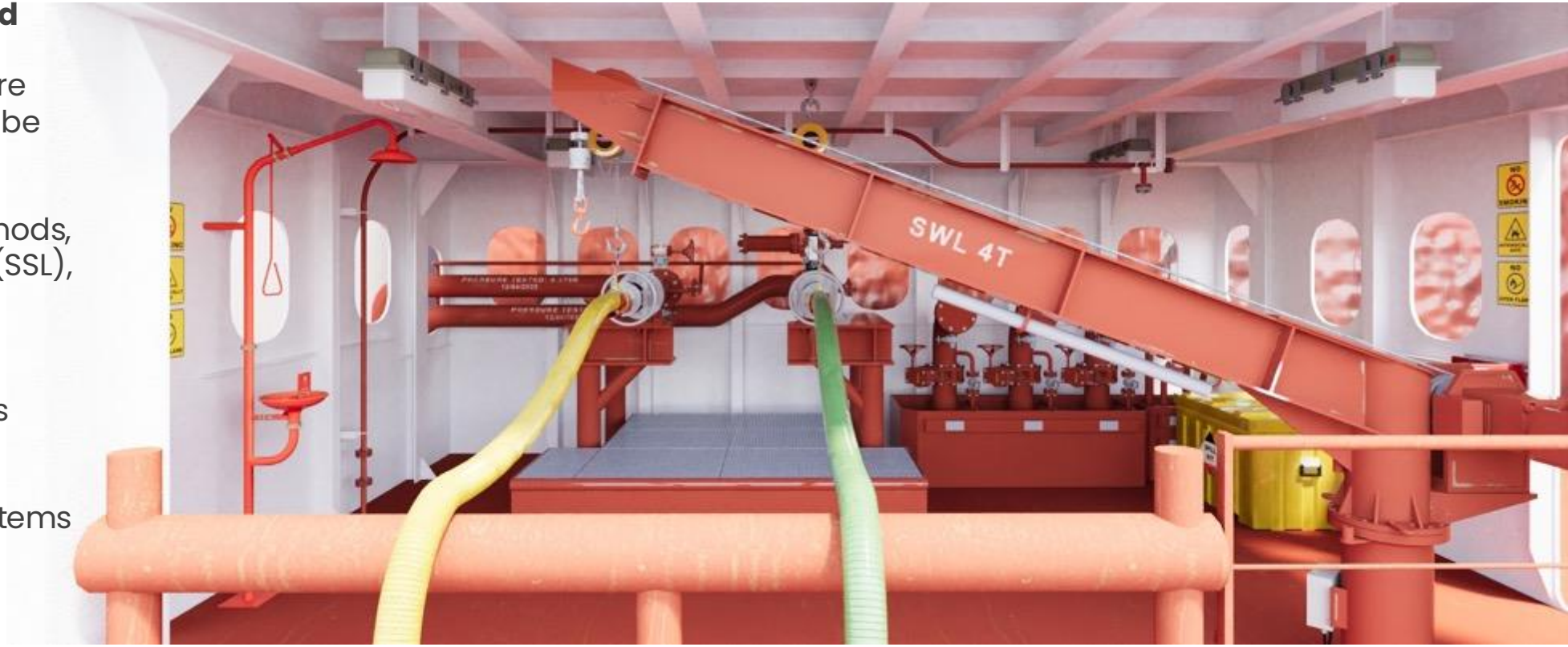
Specialised Training on MeOH | EtOH DF Vessels

Joint Plan of Bunker Operations

- General
- Transfer system
- Roles and Responsibilities
- Bunker operation
- Vessels details
- Bunker preparation
- Emergencies

Manifold Station

The bunker stations can be:
Open / Closed / Semi closed



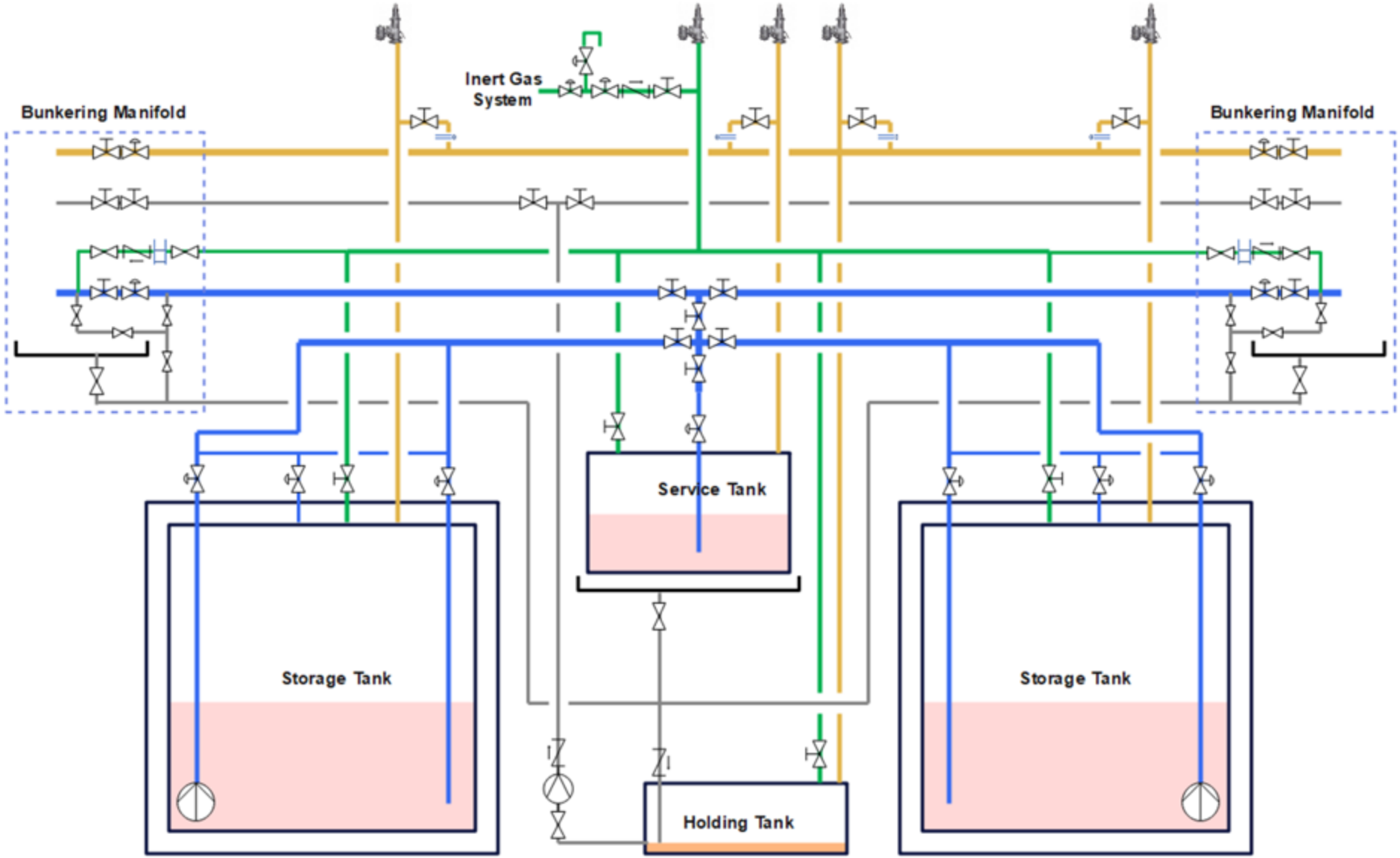
However it appears, there are certain elements that must be checked:

1. all communications methods, including ship shore link (SSL), if fitted.
2. operation of fixed fire detection equipment.
3. operation of portable gas detection equipment.
4. readiness of fixed and portable fire-fighting systems and appliances.
5. operation of remote-controlled valves.
6. inspection of hoses and couplings.

Work Flow

- Planning / Preparation – Before Mooring
- Risk Assessment / Compatibility Assessment
- JPBO / Inspection & Testing
- Arrival / Maneuvering / Mooring
- After Mooring – Before Pre-bunkering Meeting
- During Pre-bunkering Meeting
- After Pre-bunkering Meet – Before Start of Transfer
- Hose Connection / Pressure Testing
- Equipment Test / Line-up / Open Manifold Valves
- During Transfer
- Monitoring / Repetitive Checks
- At completion of Transfer – After Hose Disconnection
- Line Draining / Line Blowing / Line Inerting
- Final Paper Works
- Close Manifold Valves / Hose Disconnection
- After Hose Disconnection – Before Unmooring
- Unmooring / Departure

Schematics



Managing:

- Temperature
- Pressure
- Vapours

Automatic Shutdown of Bunkering Valve

- High-Level Fuel Tank
- High-High Level Fuel Tank
- Loss of ventilation in the annular space in the bunkering line
- Gas detection in the annular space in the bunkering line
- Manual shutdown
- Liquid methyl/ethyl alcohol detection in the annular space of the double walled bunkering line
- Vapour detection in cofferdams surrounding fuel tanks. Two detectors giving 40% of LEL

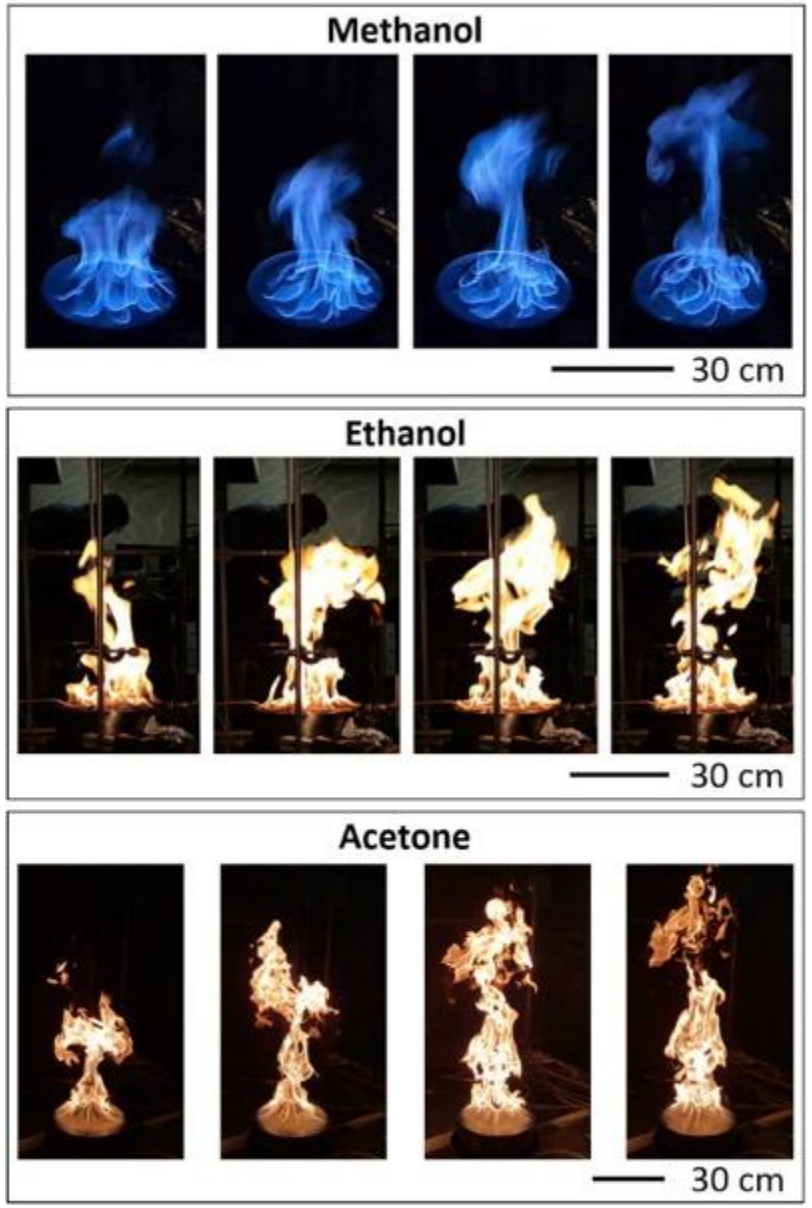
Comparisons in terms of safety and hazardous fuels

	ETHANOL	METHANOL	BIOFUELS	VLSFO	LNG	AMMONIA	HYDROGEN
Hazard Pictograms (CPL)							
Signal Word (CPL)	Danger	Danger	Danger	Danger	Danger	Danger	Danger
Hazard Statements (CPL)	H225 H319 Highly flammable liquid and vapour Causes serious eye irritation	H225 Highly flammable liquid and vapour K301 Toxic if swallowed. H311 Toxic in contact with skin. H331 Toxic if inhaled. H370 Causes damage to organs	H226 - Flammable liquid and vapour H304 - May be fatal if swallowed and enters airways EUH066 – Repeated exposure may cause skin dryness or cracking	H226: Flammable liquid and vapour. May be fatal if swallowed and enters airways H315: Causes skin irritation. H351: Suspected of causing cancer. 1373. May cause damage to organs through prolonged or repeated exposure. H411: Toxic to aquatic life with long lasting effect	H220 Extremely flammable gas. H280 Contains gas under pressure; may explode if heated	Flammable gas. May form explosive mixtures with air. Contains gas under pressure; may explode if heated. May displace oxygen and cause rapid suffocation. Harmful if inhaled. Causes severe skin burns and eye damage. Very toxic to aquatic life.	H220: Extremely flammable gas. H280: Contains gas under pressure; may explode if heated.
Precautionary Statements (CPL)	P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking P233 Keep container tightly closed	P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. P260 Do not breathe dust/fume/gas/mist/vapours/spray. P280 Wear protective gloves/protective clothing/eye protection/face protection. P301+P310 IF SWALLOWED: Immediately call a POISON CENTER/doctor. P308+P311 IF exposed or concerned: Call a POISON CENTER/doctor. P370+P378 In case of fire: Use sand, carbon dioxide or powder extinguisher to extinguish. P403+P233 Store in a well-ventilated place. Keep container tightly closed. P403+P235 Store in a well-ventilated place. Keep cool.	P260 - Do not breath dust/fumes/gas/mist/vapours/spray P280 - Wear protective gloves No other hazards	Obtain special instructions before use. Do not breathe dust/fume/gas/mist/vapours/spray. Use personal protective equipment as required. IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician DO NOT induce vomitting. Avoid release to the environment	P102 Keep out of reach of children P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. P243 Take precautionary measures against static discharge.	P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. P260 Do not breathe dust/fume/gas/mist/vapours/spray. P280 Wear protective gloves/protective clothing/eye protection/face protection/hearing protection/ ... P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. P310 Immediately call a POISON CENTER/doctor. P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P403+P233 Store in a well-ventilated place. Keep container tightly closed.	P210: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. P377: Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381: In case of leakage, eliminate all ignition sources. P403: Store in a well-ventilated place.

Sources: GCGF, VARIOUS SMD

Ethanol Safety, Fire, Storage, Bunkering

- **Although a low flash-point fuel, ethanol flames are not invisible.**
- **Fire Detection System less complex.**
- **Leakage detection has the same proven design with methanol.**
  - Not classified as MARPOL Annex II cargo
  - Ongoing IMO workstream on ethanol fuel classification (via CCC & MSC)
  - Low flash point – requires similar safety measures as methanol
  - Tank cleaning and segregation methods established
  - Compatible with existing chemical/product tankers for bunkering



Sources: GCGF

Methyl/Ethyl Fuel Supply System

- **ALFA LAVAL, SunRui, Headway** – Low Flash Point Supply System is suitable for ethanol.
- **ELTRONIC** – Fuel Valve Train and Supply System.
- **On-Board Nitrogen Generators are compatible to ethanol** as this has been the case for ethanol as a chemical cargo.
- **Everllence** – Have developed their own supply system for dual fuel applications.
- **Wartsila** – Package includes supply, FVT and nitrogen systems.
- **WindGD** – producing 82 bore methanol engines will look to provide the same in ethanol

Sources: ALFA LAVAL, GREEN MARINE,. GCGF

Methanol/Ethanol Bunkering Infrastructure

- **All infrastructure for Methanol can be utilized for Ethanol**
- Essential Equipment Ready
  - ✓ Quick connect / Disconnect Coupling
  - ✓ Safety Break-away coupling
  - ✓ Emergency Shutdown Devices
- Bunkering guidelines are the same under development

Sources: GREEN MARINE, GCGF

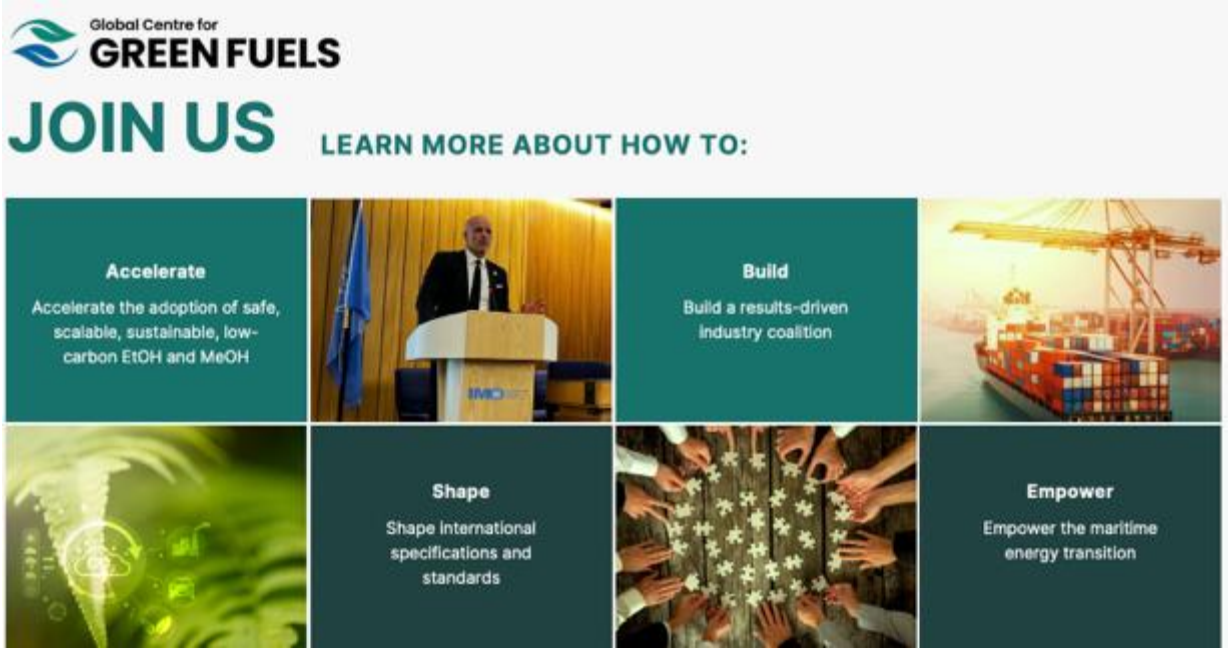
Launch of MEMA (2025)

The Maritime Ethanol & Methanol Alliance

- **Launched in October 2025 under GCGF to unify the global alcohol fuel ecosystem with potential Members:**
  - Producers, shipowners, charterers, OEMs, ports, class, traders

- **Purpose:**
  - Bridge between policy, technical, and operational stakeholders
  - This bridge role is becoming increasingly obvious across shipping

- **Initial WG | Task Force focus:**
  - **Policy**
    - IMO Consultative Status (projected)
    - ISO | LCA | ILUC
    - Feed & Fuel Integration
  - **Technical**
    - EtOH compatibility & blending
    - Material compatibility and FSS
    - Tank innovation & testing/pilots
  - **Safe Handling & Bunkering**
    - Training
    - Bunkering procedures & eBDN
    - Sampling standards & port pilots



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